MEASURES FOR INTEGRATING NEW PROVISIONS OF THE MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT AND NATIONAL STANDARD 1 GUIDELINES INTO COASTAL PELAGIC SPECIES MANAGEMENT

AMENDMENT 13 TO THE COASTAL PELAGIC SPECIES FISHERY MANAGEMENT PLAN

DRAFT PRELIMINARY ALTERNATIVES AND ANALYSES

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1.0 INTRODUCTION

The Magnuson-Steven Fishery Conservation and Management Reauthorization Act of 2006 (MSRA) established several new fishery management provisions pertaining to National Standard 1 (NS1) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), which states "Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry." [MSA Section 301(a)] On January 16, 2009, the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (74 *FR* 3178) to implement the new MSRA requirements and amend the guidelines for NS1.

The MSRA and amended NMFS guidelines introduce new fishery management concepts including overfishing levels (OFLs), annual catch limits (ACLs), annual catch targets (ACTs), and accountability measures (AMs) that are designed to better account for scientific and management uncertainty and to prevent and end overfishing. These important aspects of the MSRA are required to be implemented by 2011 for most species and by 2010 for those species experiencing overfishing. It is anticipated the Council will need to amend some or all of its Fishery Management Plans (FMPs) to accommodate the new NS1 guidelines.

The Pacific Fishery Management Council's (Council's) Coastal Pelagic Species (CPS) FMP includes harvest control rules for actively managed species (Pacific sardine and Pacific mackerel) that are intended to prevent overfishing while maintaining relatively high and consistent catch levels over the long-term and provide a solid foundation for new fishery management provisions such as OFLs, ACLs, and ACTs. The CPS FMP's monitored stocks are either exempt from the new requirements because of their short life cycle (market squid) or are currently harvested at relatively low levels (anchovy, jack mackerel). ACLs for monitored stocks may be implemented with greater flexibility, but also greater precaution, than for actively managed species because they are assessed with less frequency.

Determining the degree to which the provisions in the existing harvest control rules adequately buffer CPS stocks from overfishing will be a critical step in insuring the amended CPS FMP meets the new NS1 requirements. The Scientific and Statistical Committee (SSC) and the Coastal Pelagic Species Management Team are developing a framework for factoring scientific uncertainty into harvest control rules. Much of the work is focused on quantifying assessment variability for CPS and groundfish stocks with a history of multiple assessments as a basis for evaluating the size of a scientific uncertainty buffer (i.e., the difference in yield between the OFL and the ABC) and the associated risk of overfishing the stock.

The Council held a scoping session at its March 2009 meeting on amending the CPS FMP to address the National Standard 1 guidelines. Scoping comments included recommendations to assess scientific and management uncertainty, include krill and other forage species as ecosystem components of the FMP, improve accountability of live bait harvest and overall fishery discards, and improve inseason harvest reporting. Additionally, the review of CPS harvest control rules has been identified by the Council as a high priority research need.

In November 2009, the Council supported alternatives proposed by Council staff regarding stock status determination criteria and alternative management frameworks. Specifically, the Council supported analyses of sector- specific ACLs and requested an analysis of ACTs to address management uncertainty and to buffer against overfishing. As additional guidance, the Council placed a higher priority on time-sensitive MSA requirements such as ACLs and ABC control rules and put a lower priority on the consideration of optional provisions such as including additional forage species in the CPS FMP and the development of mechanisms to streamline inseason management.

This document was prepared by the Council's CPSMT and Council staff. This report presents Amendment 13 alternatives derived from Council deliberations, Council Advisory Body recommendations, scoping comments, and Council staff to bring the CPS FMP into compliance with the reauthorized MSA. The intent of the report is to inform preliminary Council decision-making at its March 2010 meeting and is not intended to limit or constrain future development of Amendment 13. ***Some of the information in this document utilizes methods and analyses currently under development by the SSC, the CPSMT, and Council staff and should be considered preliminary and subject to change until approved by the SSC and the Council as the best scientific information available for fishery management.*** Background material on the history and status of CPS stocks and CPS fisheries can be found in the latest version of the *Stock Assessment and Fishery Evaluation* document which is posted on the Council's web page.

At its March 2010 meeting, the Council is scheduled to review a preliminary range of amendment alternatives and analysis and adopt a preliminary preferred alternative for public review. Final Council action is schedule for the June 2010 Council meeting to allow for the Secretarial approval process and full implementation by 2011.

2.0 DESCRIPTION OF ALTERNATIVES

Legal requirements of the MSRA and the MSA combined with the policy guidance from NMFS on implementing NS1 require the new provisions such as OFLs and ACLs be included in FMPs and management practices to end and prevent overfishing within a specific timeframe. Therefore, status quo alternatives in the strict sense for many of the following alternatives, is not a reasonable alternative given these legal mandates and policy directives. For Council decisions under these circumstances, status quo may not be listed under the alternatives.

2.1 STOCK CLASSIFICATIONS

Stocks in the CPS FMP are classified under the following management categories: actively managed; monitored; and prohibited harvest species (Table 2.1-1). The CPS FMP is based on a management framework designed to react quickly to changes in the fisheries and/or stocks, with the CPSMT providing advice on classification changes in accordance with fishery/stock dynamics.

Table 2.1-1 Stocks currently managed under the CPS FMP.

Management Category	Common Name	**Scientific Name**
Actively Managed	Pacific sardine	*Sardinops sagax*
	Pacific (chub) mackerel	*Scomber japonicus*
Monitored	Northern anchovy Central and Northern Subpopulations	*Engraulis mordax*
	Market squid	*Loligo opalescens*
	Jack mackerel	*Trachurus symmetricus*
Prohibited Harvest	Krill or Euphausiids All West Coast EEZ Species Eight dominant species First two species are common and are the most vulnerable to fishing.	*Euphausia pacifica* *Thysanoessa spinifera* *Nyctiphanes simplex* *Nematocelis difficilis* *T. gregaria* *E. recurva* *E. gibboides* *E. eximia*

2.1.1 STOCKS "IN THE FISHERY"

According to NS1 guidelines (' 600.310(d)(1)), all stocks in an FMP are considered to be "in the fishery" by default, unless they are identified as ecosystem component (EC) species. Species "in the fishery" are generally targeted and sold commercially or retained for personal use. All species in the fishery require specification of status determination criteria (SDC), including: OFL; maximum sustainable yield (MSY); allowable biological catch (ABC); optimum yield (OY); and most require ACLs and AMs to prevent overfishing. Stocks that exhibit annual life cycles or stocks managed

under international agreements to which the United States is a party are exempt from the new measures, such as the ACL, AM, etc. requirements. No CPS are currently managed under international agreements, but market squid would be considered exempt, given this species' longevity is less than one year.

The NS1 guidelines identify reference points (see Table 2.1.1-1) that must be specified for stocks "in the fishery," which will likely include FMP species in the actively managed and monitored categories and may include krill in the prohibited harvest category. As noted above, market squid are exempt from ACL and AM requirements because of their annual life cycle, but MSY, OY, and SDCs must nevertheless be specified for these stocks.

Table 2.1.1-1 Required reference points for stocks in the fishery.

Maximum Sustainable Yield (MSY) *600.310(e)(1)*	The largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technology characteristics (e.g., gear selectivity)
Optimum Yield (OY) *600.310(e)(3) and (e)(3)(iv)*	A decisional mechanism to address MSA and FMP objectives. OY definition(s) must account for the need to prevent overfishing. A long-term average amount of desired yield that accounts for economic, social, and ecological factors - an FMP must contain ACLs and AMs to achieve OY. See (e)(3)(iii) and (iv) for factors to be considered in determining OY.
Status Determination Criteria (SDC): *600.310(e)(2)*	The FMP must describe which one of two methods will be used to determine overfishing status: (1) F > MFMT or reasonable proxy or (2) Catch > OFL;
Maximum Fishing Mortality Threshold (MFMT)	The level of fishing mortality (F), on an annual basis, above which overfishing is occurring
Overfishing Limit (OFL)	Annual amount of catch that corresponds to the estimate of MFMT applied to a stock or stock complex's abundance expressed in terms of numbers or weight of fish
Minimum Stock Size Threshold (MSST)	The level of biomass below which the stock or stock complex is considered overfished

Table 2.1.1-1 Required reference points for stocks in the fishery.

Acceptable Biological Catch (ABC) / ABC Control Rule *600.310(f)*	ABC is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of OFL and any other scientific uncertainty and should be based on the ABC control rule. ABC control rule means a specified approach to setting ABC for a stock or stock complex as a function of the scientific uncertainty in the estimate of OFL and any other scientific uncertainty. Councils should develop a process for receiving scientific information and advice used to establish ABC including the body that will apply the ABC control rule (calculate the ABC) and the review process. The SSC must recommend the ABC to the Council.
Annual Catch Limit (ACL); mechanisms for specifying ACLs *600.310(f)*	The level of annual catch of a stock or stock complex that serves as the basis for invoking AMs. ACL cannot exceed ABC but may be divided into sector-specific ACLs.
Accountability Measures (AMs) *600.310(g)*	Management controls to prevent ACLs from being exceeded and to correct or mitigate overages of the ACL if they occur. There are two categories: inseason AMs and AMs for when the ACL is exceeded.
Annual Catch Target (ACT) (optional) *600.310(f)(6) & (g)(2)*	An optional AM. An amount of annual catch that is the management target of the fishery, and accounts for management uncertainty in controlling catch at or below the ACL.

Species in the actively managed category as well as market squid and northern anchovy in the monitored species category are target species and thus, would be considered "in the fishery". The other species in the monitored category, jack mackerel, is currently targeted to a much lesser degree than the two actively managed species, but when encountered is generally retained for sale.

Regarding the krill species in the prohibited harvest category, and harvest for krill is currently prohibited under the FMP and Federal regulation. Ecosystem considerations were a key element of the rationale for the prohibition and krill may be a good candidate for an EC species.

2.1.2 ECOSYSTEM COMPONENT SPECIES

The specification of EC species is optional and there are several criteria that should be met for a species to be included in the EC category (' 660.310(d)(5)(i)). These are:

- Be a non-target stock/species;
- Not be subject to overfishing, approaching overfished, or overfished and not likely to become subject to overfishing or overfished in the absence of conservation and management measures; and,

- Not generally retained for sale or personal use, although "occasional" retention is not by itself a reason for excluding a species from the EC category.

Comments received during the scoping sessions have requested that the Council consider the addition of forage species not currently in the FMP as EC species (i.e., Pacific saury, myctophids, Pacific sand lance, white bait smelt, and other smelts). The intent of the request is to monitor a set of forage species and to report on their trends, status, and ecological roles, and not to develop a fishery.

2.1.3 Summary of Stock Classification Alternatives

Alternative 1 – All species currently in the CPS FMP, including krill are included "in the fishery" in their existing category and no EC species are established.

Alternative 2 - All species currently in the actively managed and monitored species categories of the CPS FMP are "in the fishery" and krill are reclassified as an EC species.

Alternative 3 – Add additional forage and/or bycatch species to the CPS FMP as EC species. (This alternative can be eliminated or coupled with Alternative 1 or 2 above.

2.2 Status Determination Criteria

Status Determination Criteria exist in the current CPS FMP (Table 2.2-1)(with the exception of the new OFL provision, see Section 2.3). Although the Council and the CPSMT have identified the review of some of the existing SDCs as priority research needs, the process of reviewing and potentially revising the existing SDCs is outside the scope and the allotted time of Amendment 13.

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

The main use of an MSY control rule for a monitored stock is to help gauge the need for active management and to trigger such consideration before a stock is experiencing overfishing. While landings are low and the stock remains in the monitored category, its status is assessed infrequently making estimates of MSY or MSST difficult and impractical. MSY control rules and harvest policies for monitored CPS stocks may be more generic, precautionary, 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.

Table 2.2-1. **Existing** CPS FMP specifications for Status Determination Criteria

	MSY	MFMT	MSST	ABC	OY
Pacific sardine	MSY control rule	Catch exceeding ABC	50,000 mt	Equal to MSY control rule calculation	Currently at or below MSY
Pacific (chub) mackerel	MSY control rule	Catch exceeding ABC	18,200 mt	Equal to MSY control rule calculation	Currently at or below MSY
N. anchovy Northern Subpop.	Unknown	Catch exceeding ABC	Not specified	25% of MSY Catch level (unknown)	Unknown
N. anchovy Southern Subpop.	Estimated at 123,000 mt	Catch exceeding ABC	Not specified	25% of estimated MSY or 31,000mt 26,000mt in U.S.	26,000mt
Market squid	F_{MSY} resulting in egg escape-ment ≥ 30%	F_{MSY} resulting in egg escape-ment ≤ 30%	Not specified	F_{MSY} resulting in egg escape-ment ≥ 30% mt	107,047mt
Jack mackerel	Age/Area based potential yield	Catch exceeding ABC	Not specified	48,000mt 31,000mt in U.S.	31,000mt
Krill or Euphausiids	Not specified	Catch over de minimus or trace amounts	Not specified	Not specified	0

The CPS FMP currently does not include an estimate of or proxy for MSY or OY for the Northern subpopulation of Northern Anchovy. As for other species in the monitored category, an estimate of biomass and a proxy MSY harvest level is an important part of establishing reference points for determining if and when the stock status warrants active management (see section 2.3).

2.2.1 Summary of Stock Determination Criteria Alternatives

Alternative 1 – Status Quo – Maintain existing SDCs for CPS FMP stocks.

Alternative 2 - Maintain existing SDCs for CPS FMP stocks and develop an MSY proxy for the Northern subpopulation of Northern anchovy.

2.3 Overfishing Levels, Acceptable Biological Catch, and Annual Catch Limits

The NS1 guidelines envision OFL to correspond to the best available estimate of MSY stock size. The guidelines also call for an assessment of scientific uncertainty in the estimate of MSY and the development of an ABC control rule that addresses scientific uncertainty and management risk when setting an ABC level below the OFL. Given the differences in harvest levels and available information on stock status between actively managed and monitored stocks it is recommended

that the existing "tiered" system be modified to meet new provisions to prevent overfishing while recognizing the amount of available data for each tier and the appropriate management response based on fishing pressure.

2.3.1 ACTIVELY MANAGED SPECIES

Because of their importance to current fisheries Pacific sardine and Pacific mackerel are actively managed. Assessments and management measures are revised, reviewed, and adopted on an annual basis. This relatively intensive management strategy responds to year-to-year changes in stock dynamics for these productive stocks and places these species in the top management tier due to a greater understanding of stock status and management performance.

The CPSMT has proposed that the MSY control rules for actively managed species could serve as an adequate buffer to account for scientific uncertainty as it explicitly and significantly reduces harvest as biomass approaches an overfished condition, or in the case of Pacific sardine as biomass approaches a level three times the current designation of MSST. The Scientific and Statistical Committee (SSC) has not supported this approach stating that the MSY control rules "were selected to maximize long-term yield given variation in recruitment (an MSY control rule)."

The harvest control rule for actively managed species.

HARVEST = (BIOMASS-CUTOFF) x FRACTION x DISTRIBUTION

where:

FRACTION is the fraction of the BIOMASS above the CUTOFF value that can be harvested, for Pacific sardine this is an environmental driven component that is based on sea surface temperature.

DISTRIBUTION is the percentage of the stock assumed to be in U.S. waters.

CUTOFF is the estimated biomass below which directed harvest is not allowed. 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 for the spawning stock that is protected from fishing and available for use in rebuilding if a stock becomes overfished. CUTOFF may alone serve as an adequate buffer between OFL and ABC to prevent overfishing while providing long-term yield.

Determining the degree to which the provisions in the existing harvest control rules adequately buffer CPS stocks from overfishing will be a critical step in ensuring the amended CPS FMP meets the new NS1 requirements. The SSC Groundfish and CPS Subcommittees are working on the development of a framework for factoring scientific uncertainty into harvest control rules by quantifying assessment variability for stocks with a history of multiple assessments as a basis for evaluating the size of a scientific uncertainty buffer (i.e., the difference in yield between the OFL and the ABC) and the risk of overfishing the stock. Scientific uncertainty would be expressed in terms of a BUFFER that is a combination of quantified assessment uncertainty and a policy choice by Council regarding the estimated risk of overfishing (see Agenda Item G.5.b, Supplemental SSC Groundfish and CPS Subcommittees Report, *An Approach to Quantifying Scientific Uncertainty in West Coast*

Stock Assessments, from the November 2009 Council Briefing Book available on the Council web page). Revised SSC recommendations will be brought forward at the March meeting.

Alternative 1 – Status Quo – Maintain the existing harvest control rules as modified to specify the new management reference points.

OFL	BIOMASS x FRACTION x DISTRIBUTION(MSY proxy)
ABC	(BIOMASS x CUTOFF) x FRACTION x DISTRIBUTION
ACL	Equal to ABC or reduced by OY considerations.

Alternative 2 – Scientific Uncertainty Buffer – Modify the existing harvest control rules to include a buffer or reduction in ABC relative to OFL to account for scientific uncertainty. This reduction would be in addition to the precautions build into the FRACTION term in the existing rule. Because the CUTOFF term is intended to address economic an ecological issues (OY considerations) it is proposed as a reduction from ABC to ACL.

OFL	BIOMASS x FRACTION x DISTRIBUTION (MSY proxy)
ABC	(BIOMASS x BUFFER) x FRACTION x DISTRIBUTION
ACL	[BIOMASS x BUFFER)-CUTOFF] x FRACTION x DISTRIBUTION.

2.3.2 MONITORED SPECIES

Monitored stocks are either currently landed at relatively low levels or are managed primarily at the State level. The default MSY control rule for monitored stocks sets the ABC at 25 percent of estimated MSY levels making it more conservative than the MSY control rules for actively managed species for which more data and more current assessments exist. This approach is similar to "tiered" approaches used in North Pacific Fishery Management Council FMPs and the Council's Groundfish FMP where harvest specifications and reference points differ for categories or tiers of species based on the amount and quality of data that is available for management. Because monitored stocks are not annually assessed or managed, the Council may recommend that ACLs for monitored species be specified for multiple years until such time as the species becomes actively managed or new scientific information becomes available.

Alternative 1 – Status Quo – Maintain the default harvest control rules as modified to specify the new management reference points. ACLs would be specified for multiple years until such time as the species becomes actively managed or new scientific information becomes available.

OFL	BIOMASS*F_{MSY} * DISTRIBUTION (MSY proxy)
ABC	BIOMASS x 0.25
ACL	Equal to ABC or reduced by OY considerations.

Alternative 2 – Scientific Uncertainty Buffer – Modify the existing harvest control rules to include a buffer or reduction in ABC relative to OFL to account for scientific uncertainty. This reduction would be in addition to the precautions build into the default control rule. In practice either a BUFFER recommended by the SSC could be added to the ABC control rule as shown below, or a greater than 75 percent reduction from OFL could be instituted. ACLs would be specified for

multiple years until such time as the species becomes actively managed or new scientific information becomes available.

OFL	BIOMASS*F_{MSY} * DISTRIBUTION (MSY proxy)
ABC	BIOMASS x 0.25 X BUFFER
ACL	Equal to ABC or reduced by OY considerations.

2.3.3 SECTOR-SPECIFIC ACLS

The NS1 guidelines allow for sector specific ACLs and recommend their use if a stock is targeted by multiple fishery sectors, each with their own level of monitoring and inseason management. Alternatively, the landings associate with the following activities could be incorporated into management as AMs or ACTs (see section 2.4).

The Council has expressed an interest in continuing the practice of setting aside a portion of the Pacific sardine harvest for the purpose of conducting research under an exempted fishing permit (EFP). In November 2009, the Council recommended including this EFP research in the management framework as fishery sector with a specific ACL. Mortality associated with other research programs with NMFS or other agencies is not intended to be included in this EFP research sector. Those impacts are currently proposed to be considered as AMs.

California live bait fishery may be a candidate for a sector specific portion of the overall ACL. In November 2009, the Council did not recommend this management approach. However, the CPSMT and Council staff discussed the merits of establishing a sector-specific ACL for the live bait fishery and is asking the Council to reconsider or reaffirm their November 2009 recommendation. This fishery is small but important and supplies bait fish primarily for recreational vessels. The fishery is not actively monitored or managed inseason, but landings are estimated at the end of the year. The Council could choose to adopt one or both of Alternatives 2 and 3.

Alternative 1 – No sector-specific ACLs.

Alternative 2 - Assign a sector-specific ACL to EFP research activities.

Alternative 3 – Assign a sector-specific ACL for the live bait fishery.

2.4 ANNUAL CATCH TARGETS AND ACCOUNTABILITY MEASURES

Annual catch targets (ACTs) are optional reference points designed to account for management uncertainty when setting target levels below ACLs. Accountability Measures (AMs) are management controls to prevent ACLs from being exceeded and to correct or mitigate overages of the ACL if they occur. Good inseason management of CPS fisheries exists through catch monitoring, and the fishery can be closed quickly by NMFS through an automatic regulatory action. However, several aspects of CPS fisheries warrant the consideration of ACTs.

2.4.1 MANAGEMENT UNCERTAINTY

Harvest levels for the directed Pacific sardine fishery have been declining in recent years and have created a derby-style fishery. This has increased the rate at which the seasonal allocations are taken and added additional management uncertainty. The Council has recently begun setting aside

portions of the Pacific sardine and Pacific mackerel harvest to account for "management uncertainty" or the potential errors in monitoring and reporting landings and closing the fishery before overfishing occurs. This proactive approach could be included as part of the establishment of an ACT. In recent years, the CPSMT and the CPSAS have assessed the nature of the fishery, the effectiveness of inseason reporting mechanisms, and the regulatory processes necessary to close the fishery when recommending buffers to account for management uncertainty.

2.4.2 TOTAL CATCH ACCOUNTING

Under the NS1 guidelines "catch" is defined to include all sources of mortality associated with a fishery (discards, research impacts, incidental landings, etc.). To meet the NS1 requirements and account for total mortality in the catch, a consideration of additional sources of mortality when setting an ACT could be prudent.

Discard Mortality

Discards do occur in CPS fisheries when a vessel captures more fish than can be brought onboard or when a school of an undesirable species composition is captured and then released. There is limited observer and logbook data available to enumerate the mortality associated with these discards. To meet the NS1 requirements and account for total mortality in the catch, the estimation of discard mortality when setting an ACT could be analyzed as an alternative. The CPSMT has discussed ways of assessing discard mortality and could, on an annual basis, make recommendations on discard mortality.

Incidental Fishery Impacts

Under the current management regime, the Council has been in the practice of setting aside a portion of the Pacific mackerel and the Pacific sardine HGs for the purpose of protecting other CPS fisheries that may land these species incidentally after their respective directed fisheries close. The Council may recommend an approach within the scope of the existing management strategies that would set aside a portion of an ACT to cover incidental landings.

Research Impacts (not including set asides for EFPs, see Section 2.3.3)

The California Cooperative Oceanic Fisheries Investigations and NMFS conduct annual research cruises for the purposed of monitoring many ecological and biological parameters in the support of fishery management. A substantial portion of these research initiatives is focused on CPS. Although small (generally assessed at around 1 mt for Pacific sardine in recent years), these sources of mortality are well documented and easily incorporated in

Live Bait Fisheries

As noted in Section 2.3.3, there is mortality associated with live bait fisheries. In November 2009 the Council recommended that mortality associated with live bait harvest not be included as a separate fishery sector with its own ACL, but rather be treated as an AM in the directed commercial fishery. Under this scenario, a preseason estimate of

mortality, however small, from live bait fisheries would be taken into account when establishing and ACT for the directed fishery.

2.4.3 Annual Catch Targets for Monitored Stocks

The current management framework for monitored stocks is intended to provide a mechanism for alerting the CPSMT and the Council to potential conservation concerns that may warrant elevating a species from the monitored category to the actively managed category. Current OYs or proposed ACLs currently function as the level of landings that are generally used to assess the need for active management. The CPSMT and the SSC CPS Subcommittee have discussed using either a recent average catch or a recent highest catch level as an ACT that would alert the Council of increasing landings to allow time to plan for the management response to moving to an actively managed status (i.e. scheduling a stock assessment and revising harvest control rules and SDCs).

2.4.4 Summary of ACT and AM Alternatives

The Council could choose to adopt one or both of Alternatives 2 and 3.

Alternative 1 – No ACTs.

Alternative 2 – Develop ACTs only for actively managed stocks.

Alternative 3 – Develop ACTs for actively managed and monitored stocks.

2.5 State and Federal Management of Coastal Pelagic Species

In recent years, the CPSMT has discussed the suite of stocks in the CPS FMP and their appropriate classification as monitored or actively managed species (e.g., moving Pacific mackerel to the monitored species category in light of multiple years of low harvest and diminished data series for assessing stock status, and potentially moving northern anchovy to the actively managed category). The CPSMT has also reviewed the science and harvest policies for market squid in recent years to determine the need, if any, to revise management. The CPSMT has informally discussed the costs and benefits of including two monitored species in the CPS FMP versus transferring management authority to the State of California. Commercial landings of market squid and jack mackerel occur almost exclusively in California and are either currently managed under a California State FMP (market squid) or have been landed at low and generally declining levels for many years (jack mackerel). There are a considerable number of research and data needs identified for the CPS FMP and focusing available science and management resources on fewer FMP stocks may have benefits. Given the need to review stock classifications and reference points for Amendment 13, exploring Federal versus State management of CPS FMP stocks could be prudent at this time.

At its November 2009 meeting, the Council requested that the CPSMT consider the following alternatives for changes to species in the CPS FMP:

Alternative 1 – Status Quo – All species, including market squid and jack mackerel remain in the CPS FMP and no species is transferred to state management.

Alternative 2 – Remove market squid from the CPS FMP and Federal management and transfer that authority to the State of California.

Alternative 3 – Remove jack mackerel from the CPS FMP and Federal management and transfer that authority to the State of California.

2.6 Alternatives Considered but Rejected

Several preseason and inseason accountability measure exist in the CPS fisheries. In March 2009, under the scoping period for this amendment, the CPSMT and the CPS Advisory Subpanel recommended several ways to improve the inseason monitoring and management of CPS fisheries. Recommended actions for consideration include:

- Improving inseason management flexibility to open or close the fishery faster by revising reporting requirements (e.g., processors faxing information daily), setting daily trip limits, and opened/closed days, and
- Exploring a shift in the start date of the Pacific sardine fishery from January 1 to July 1 to allow additional time for stock assessment work and the development of new fishery-independent indices of abundance.

Council has been receptive to the potential management improvements these measures could provide, but Council direction since March 2009 has consistently recommended focusing efforts on those aspects of Amendment 13 that are required to be in place by 2011 and only address these improvements to the FMP as time and workload allows. The CPSMT briefly discussed the merits of these alternatives, but has not had time to fully consider their implementation under this amendment. Unless the Council recommends elevating the priority of these optional alternatives, it is likely that these alternatives will be postponed.

3.0 Supporting Analyses

3.1 Stock Classification Considerations

Alternative 1 – All species currently in the CPS FMP, including krill are included "in the fishery" in their existing category and no EC species are established.

Species in the actively managed category as well as market squid and northern anchovy in the monitored species category are target species and thus, would be considered "in the fishery". The other species in the monitored category, jack mackerel, is currently targeted to a much lesser degree than the two actively managed species, but when encountered is generally retained for sale.

Regarding the krill species in the prohibited harvest category, harvest for krill is currently prohibited under the FMP and Federal regulation, and no directed fishery for krill existed in the West Coast Exclusive Economic Zone (EEZ) when this action was taken. Ecosystem considerations were a key element of the rationale for the prohibition and krill may be a good candidate for an EC species. However, the prohibition prevents the conceivable development of a targeted fishery in the future and this may be sufficient rational to include krill and its broad regulatory harvest prohibition as a species in the fishery. Additionally, the requisite SDCs for krill were established or

omitted with good rationale under Amendment 12 to the CPS FMP. Currently OY for krill is defined as zero and harvest has been prohibited. Because of these reasons it was determined during the implementation of Amendment 12 that specifications of MSY and of SDC do not have any operational purpose. Therefore, a similar relatively simple approach to establishing OFLs and ACLs at de minimus levels while maintaining the harvest prohibition may be advisable. As with the management reference points adopted for krill under Amendment 12, Establishment of OFLs and ABCs may not be an onerous task for a prohibited harvest species and NMFS staff are reviewing cases around the nation for similar applications to draw from in this unique situation.

Alternative 2 - All species currently in the actively managed and monitored species categories of the CPS FMP are "in the fishery" and krill are reclassified as an EC species.

As noted above, ecosystem considerations were a critical component of the rationale behind prohibiting their harvest. Recognition of the vital role krill play in the food web and the importance of this species to the productivity and recovery of groundfish stocks declared overfished and salmon stocks listed under the Endangered Species Act. However, the EC category is in part intended as a vehicle to monitor fishery impacts to non-target species to determine if such impacts could be contributing to the overfishing of and EC species. This is not a good fit for krill which is not targeted in any fishery and is not a substantial bycatch species in CPS fisheries.

The Council has initiated the development of an Ecosystem Fishery Management Plan (E-FMP) and has appointed a plan development team and advisory subpanel. The identification and monitoring of indicator species and the role species play in the food web are likely to be important issues for the E-FMP, which is intended as an over-arching framework for all four of the Council's existing FMPs. It may become more practical to monitor species for their ecological role and associated ecosystem functions under the E-FMP rather than in the EC categories of the Council's four FMPs.

Alternative 3 – Add additional forage and/or bycatch species to the CPS FMP as EC species. (This alternative can be eliminated or coupled with Alternative 1 or 2 above.

A review of available landings and bycatch information from the CPS fisheries indicates that the incidence of what might be considered EC species in the landings and in the bycatch of West Coast CPS fisheries appears to be very low (Harrington et al. 2005; PFMC 2008, 2009).

There are many small pelagic nekton species (primarily fish and squid) that are not presently a target of commercial fisheries and not likely to be subjected to overfishing. However, these species are critical for the ecosystem services (forage) they provide to living marine resources in the California Current. These forage species are not generally retained for sale or personal use, but may be caught as bycatch in many fisheries. These forage species, together with presently managed coastal pelagic species, comprise the forage base for the California Current ecosystem. Large and small upper-trophic level species feed on this suite of forage. At this time, the abundance, status, and trends of many forage species are poorly understood. However, the abundance and distribution of these forage species probably affects the total number of the CPS that are consumed by upper-trophic species. As the Council moves to developing an E-FMP, it is important that key

populations of forage species are monitored, their role in the food web identified, as well as identifying how fluctuations in forage species abundances affect CPS abundance.

3.1.1 LIST OF POSSIBLE FORAGE SPECIES

A list of potential forage species is shown in Table 3.1-1. Euphausiids are included in this list because they play a similar role in the ecosystem as forage species, as do small fishes and squid. Also presented are fish species characterized by early life stages (larval, young-of-the-year, etc.) that contribute to the overall forage base and thus, could be considered forage species in a broader context.

Table 3.1-1. List of important forage species. YOY indicates young-of-the-year.

Common Name	Scientific Name
Euphausiid (krill)	Euphausiidae
California market squid	*Loligo opalescens*
Neon flying squid	*Ommastrephes bartramii*
Boreal Clubhook Squid	*Onychoteuthis borealijaponica*
American shad	*Alosa sapidissima*
Pacific herring	*Clupea pallasi*
Smelts	Osmeridae
Surf smelt	*Hypomesus pretiosus*
Night smelt	*Spirinchus starksi*
Longfin smelt	*Spirinchus thaleichthys*
Eulachon	*Thaleichthys pacificus*
Whitebait smelt	*Allosmerus elongatus*
Topsmelt	*Atherinops affinis*
Jacksmelt	*Atherinopsis californiensis*
Californian grunion	*Leuresthes tenuis*
Lantern fish	Myctophidae
Codfishes YOY	Gadidae
Pacific tomcod	*Microgadus proximus*
Pacific saury	*Cololabis saira*
Rockfishes YOY	*Sebastes* spp.
Greenlings YOY	*Hexagrammos* spp.
Pacific sandlance	*Ammodytes hexapterus*
Sanddab spp.	*Citharichthys* spp.

3.1.2 ANNUAL FLUCTUATIONS IN ABUNDANCE OF FORAGE SPECIES

At this time, there are three annual pelagic nekton surveys in the California Current that provide information on the abundance and distribution of forage species. The Predator/Plume survey, Stock Assessment Improvement Survey (SAIP) and NMFS Juvenile Rockfish Surveys (Bograd et al. In Press; Brodeur et al. 2003, 2006; Emmett et al. 2006; Wyllie-Echeverria et al. 1990).

Annual fluctuations in abundance of potential forage species off Oregon/Washington are shown in Table 3.1-2. Fluctuations in abundance of six major species off central California are shown in Figure 3.1-2. While these surveys adequately sample the continental shelf, there are some habitats, very nearshore, off the shelf, and estuaries that are presently under-sampled. Future research into forage species issues needs will necessarily require annual sampling programs in these habitats to adequately estimate forage species abundance and distributions. Information on forage species abundance, combined with a comprehensive food habit and ecosystem modeling effort, would be required to identify how forage species and CPS interact in the California Current ecosystem.

Table 3.1-2. Annual densities (number/$10^6 m^3$) of pelagic nekton forage species found off the Oregon/Washington coast during bi-monthly pelagic trawl surveys (R. Emmett unpublished data)

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
California market squid	1.5	12.2	0.9	38.0	58.5	40.5	5.9	16.4	10.9	3.6	0.2	0.5
Boreal clubhook squid	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.8
Neon flying squid	<0.1	<0.1	<0.1	0.2	1.7	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
American shad	0.7	1.7	0.2	1.1	3.2	13.6	1.8	2.9	1.3	2.7	4.1	3.0
Pacific herring	195.0	50.8	369.9	1,088.2	372.5	898.0	99.7	104.8	47.5	98.9	70.6	88.7
Pacific sardine	128.2	88.1	521.1	502.1	444.8	603.7	219.3	451.8	180.8	485.0	249.7	180.8
Northern anchovy	20.6	11.4	478.9	1,064.2	1,911.4	3,184.8	1,470.1	1,797.4	166.8	205.8	241.6	531.3
Surf smelt	<0.1	0.1	<0.1	0.7	2.2	1.0	0.1	0.4	<0.1	<0.1	0.4	<0.1
Whitebait smelt	19.3	7.0	1,685.9	3,478.0	1,285.1	2,417.5	960.4	259.0	130.9	245.9	164.0	774.4
Eulachon	<0.1	0.3	0.6	1.0	11.5	57.4	4.5	<0.1	<0.1	0.1	0.3	0.1
Longfin smelt	<0.1	0.5	2.9	12.6	1.3	<0.1	<0.1	<0.1	3.6	0.4	1.8	2.2
Night smelt	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pacific sand lance	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pacific saury	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pacific hake YOY	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	9.2	0.7	288.3	1.0	1.0	0.0
Pacific tomcod	<0.1	8.4	12.1	2.1	22.3	0.7	0.0	<0.1	<0.1	1.8	3.4	61.3
Rockfishes YOY	<0.1	0.1	0.7	0.1	1.0	0.5	3.2	4.9	7.9	0.3	6.4	0.5
Lingcod YOY	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	2.4	0.3

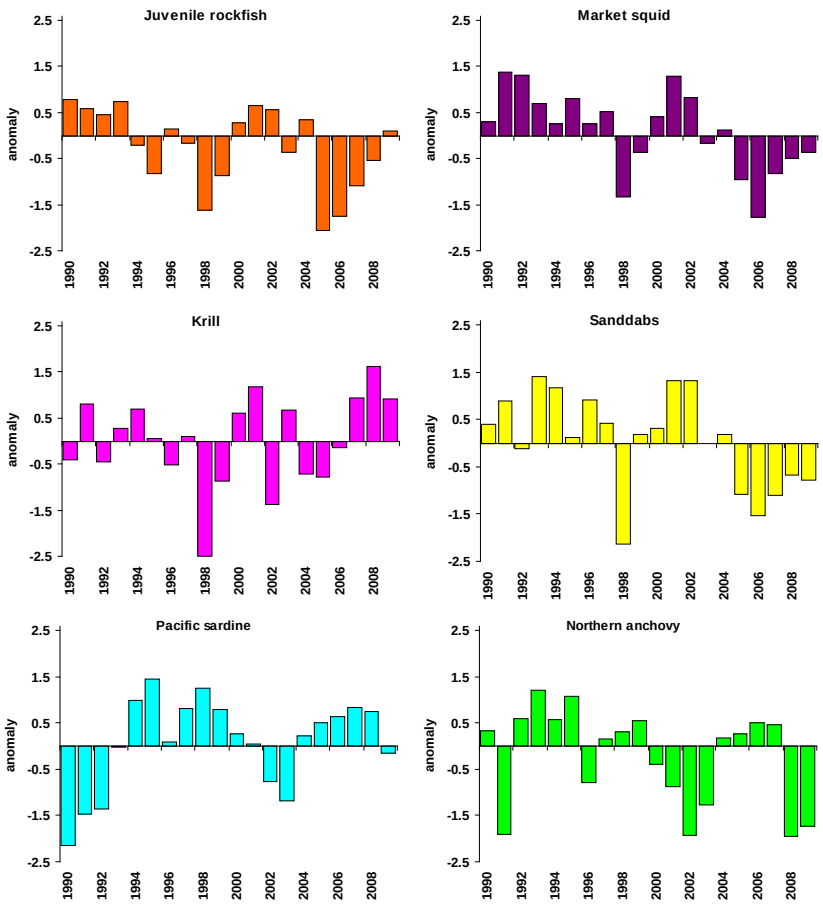

Figure 3.1-1: Long-term standardized anomalies of several of the most frequently encountered pelagic forage species from the central California rockfish recruitment survey in the core region (anomalies are based on the entire 1983-2009 period for all groups except krill) (S. Ralston, NOAA Fisheries, unpublished data).

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3.2 Status Determination Criteria Considerations

Revising the status quo SDCs in the CPS FMP is not required by the MSRA. Reviewing and potential revising some SDCs (such as the harvest control rule for Pacific sardine) has been identified as a priority research need, but completing that analysis would require more time than the current Amendment 13 timeframe allows. However, the lack of any biomass or MSY estimate for the Northern subpopulation of Northern anchovy is potentially problematic in the development of OFLs and ACLs for this species and the establishments of these management reference points is required by the MSRA. Therefore, it seems prudent to adopt Alternative 2 and direct the CPSMT to work with NMFS on the establishment of these reference points in advance of the June 2010 Council meeting. Additionally, funding constraints in Oregon, have led the Oregon Fish and Wildlife Commission and the Oregon Department of Fish and Wildlife to suspend the Oregon Developmental Fishery Program that, in turn, has removed State permitting requirements and regulations from limiting potential fishing pressure on Northern anchovy.

3.3 OFL, ABC, and ACL Considerations

The NS1 guidelines envision OFL to correspond to the best available estimate of MSY stock size. The guidelines also call for an assessment of scientific uncertainty in the estimate of MSY and the development of an ABC control rule that addresses scientific uncertainty and management risk when setting an ABC level below the OFL.

The CPSMT has proposed that the MSY control rules for actively managed species could serve as an adequate buffer to account for scientific uncertainty as it explicitly and significantly reduces harvest

as biomass approaches an overfished condition, or in the case of Pacific sardine as biomass approaches a level three times the current designation of MSST. The Scientific and Statistical Committee (SSC) has not supported this approach stating that the MSY control rules "were selected to maximize long-term yield given variation in recruitment (an MSY control rule)."

3.3.1 ACTIVELY MANAGED SPECIES

This section is comprised of two preliminary analyses completed by the CPSMT, one on Pacific sardine and the other on Pacific mackerel. These two analyses provide background on the development of the existing harvest control rules for actively managed species and a preliminary analysis of the potential need for additional buffering of these harvest policies due to scientific uncertainty in estimated biomass. Please note, these analyses are preliminary and are based, in part, on draft recommendations of the CPS and groundfish SSC Subcommittees. The Council will need to consider revised analyses and recommendations of the SSC and the CPSMT at the March meeting before considering a preferred alternative on this matter.

Pacific Sardine

Background

The harvest control rule (HCR) in the Coastal Pelagic Species Fishery Management Plan (CPS-FMP) was first implemented for management of northern anchovy and Pacific mackerel in the early 1980s (Huppert et al 1980; MacCall et al. 1985; Jacobson and Thomson 1989). The HCR formula for Pacific sardine is:

HARVEST = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION, where:

HARVEST is the target harvest level each management year;
BIOMASS is the population biomass of fish ages 1 and older;
CUTOFF is the threshold below which fishing is prohibited; typically CUTOFF is the overfished threshold but in the case of sardine, it is 3x the overfished level;
FRACTION (or F_{MSY}, or proxy) is the temperature-dependent exploitation fraction;
DISTRIBUTION is the average U.S. distribution;
MAXCAT is the maximum allowable catch regardless of total biomass. MAXCAT is 200K mt for sardine.

Simulations for evaluating management options for Pacific sardine are fully documented in Amendment 8 to the CPS-FMP, Appendix B (PFMC 1998). The FRACTION term of the HCRs has also been referred to as F_{MSY}, however this is somewhat of a misnomer for sardine because FRACTION levels explored along with other variables (e.g., CUTOFF, MAXCAT) were in some cases lower or higher than 'true' F_{MSY} values. Jacobson and MacCall (1995) examined the relationship between SST and sardine productivity, and their analysis was the theoretical basis for the temperature-based control rule currently used for management (PFMC 1998). Jacobson and MacCall (1995) provided estimates of B_{MSY}, F_{MSY}, and MSY:

Mean three season SST (°C)	Equilibrium spawning biomass	Maximum sustained yield (MSY)	Spawning biomass at MSY (B_{MSY})	F_{MSY} (%)
16.5	700	9	274	0.04
17.0	2700	156	1272	0.16
17.3	>4000	346	1819	0.26

(Biomass and Yield units = 1,000mt)

The three temperatures listed were quartiles of sea surface temperature (SST) observed at Scripps Institute of Oceanography (SIO) pier since 1916. Estimates of F_{MSY} in their analyses ranged from 4% to 26% under this range of temperatures, but F_{MSY} can be even higher under warmer conditions (Jacobson and MacCall 1995). In developing management options for Amendment 8, the relationship between SST and F_{MSY} was reexamined using new simulations that included longer time series and different assumptions regarding spawning stock biomass (SSB) (age 1+ instead of age 2+) and age at recruitment (age 1 instead of age 2). The Amendment 8 simulations resulted in slightly different levels of productivity than reported by Jacobson & MacCall (1995). For example, F_{MSY} under the FMP is now 0.015 at 16.5 °C, 0.085 at 17.0 °C, and 0.186 at 17.3 °C. The relationship from Amendment 8, currently used for management, is described by a second order polynomial equation, where '*T*' is the 3-season SST at SIO pier (Figure 1):

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

The upper range of FRACTION ('F_{MSY} proxy*)*' chosen by the Council was capped at 15%, so the control rule currently in place is already more conservative than 'true F_{MSY}' when temperature exceeds 17.2 °C. Conversely, the lower bound for FRACTION (5%) actually specifies harvest at a rate higher than F_{MSY} when temperatures are lower than 16.85 °C, a policy that is inconsistent with the NS1 goal of preventing overfishing (Figure 1).

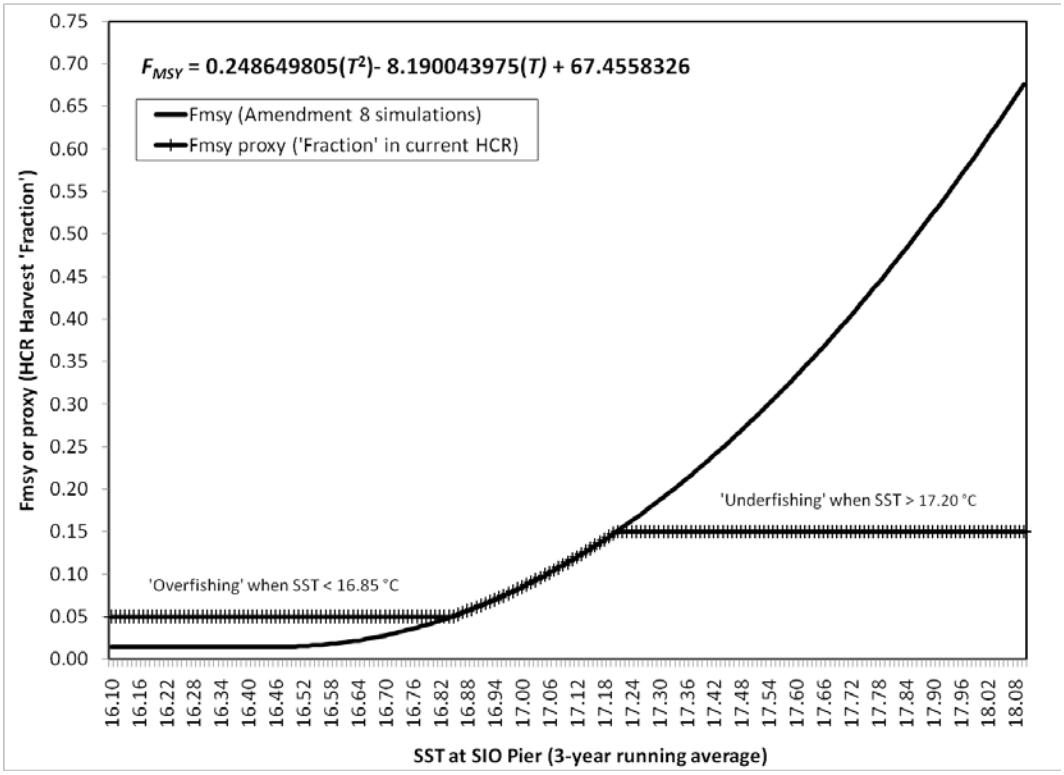

Figure 1. Relationship between SST (°C) at SIO pier and F_{MSY} for Pacific sardine (solid line). Harvest 'Fraction' in the PFMC's HCR policy, bracketed between 0.05 and 0.15, is represented by the segmented line.

Accounting for Uncertainty in Pacific Sardine Stock Assessments (P* and the ABC/OFL buffer)

The revised NS1 guidelines require FMPs to define an overfishing limit (OFL), acceptable biological catch (ABC), and annual catch limit (ACL) for each managed stock. For Pacific sardine, the values are defined:

OFL = BIOMASS * F_{MSY} * DISTRIBUTION

ABC = BIOMASS * BUFFER * F_{MSY} * DISTRIBUTION

ACL = [(BIOMASS * BUFFER) - CUTOFF] * $FRACTION_{(0.05\text{-}0.15)}$ * DISTRIBUTION

In November 2009, the SSC's Groundfish and CPS Subcommittees presented an approach to account for uncertainty in biomass estimates, both within and among stock assessments. Three full sardine assessments (Conser et al. 2004, Hill et al. 2007, and Hill et al. 2009) were examined in their analysis, with the following estimates of variation: Sigma(within)=0.411 and Sigma(among)=0.403. At the SSC subcommittee meeting in January 2010, 'Method 3' was determined to be the best approach for describing variation among assessments. For sardine, the new estimate of Sigma(among) is 0.335, giving a combined Sigma(total) equal to 0.5302. Applying Sigma(total) to the normal probability distribution, the following range of uncertainty buffers was obtained (Table 1, Figure 2), where P* is the probability of overfishing, and 'Buffer' is the corresponding ratio of ABC/OFL applied to BIOMASS.

Table 1. Uncertainty buffers for various P* values for Pacific sardine when Sigma(total)=0.5302. See also Figure 2.

P*	Buffer (ABC/OFL)
0.50	1.00000
0.49	0.98680
0.45	0.93554
0.40	0.87430
0.35	0.81521
0.30	0.75726
0.25	0.69933
0.20	0.64002
0.15	0.57721
0.10	0.50686

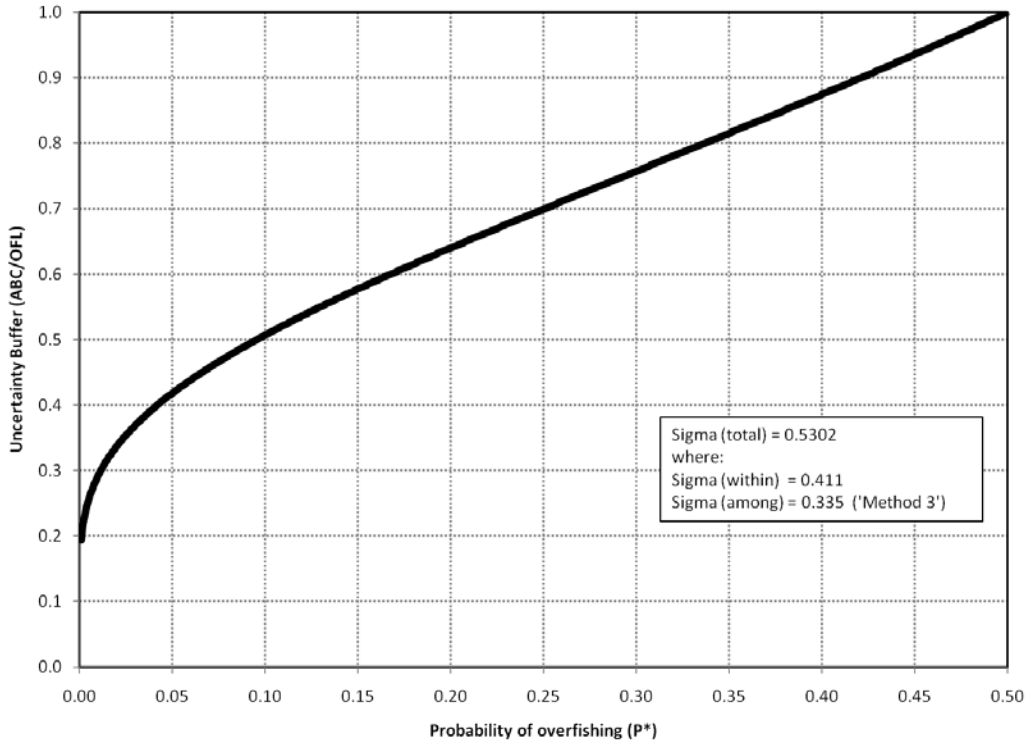

Figure 2. Relationship between the probability of overfishing (P*) and uncertainty buffers (ABC/OFL) for Sigma(total)=0.5302.

Proposed Method for Application of an Uncertainty Buffer to Pacific Sardine

The necessity of an additional uncertainty buffer to Pacific sardine harvests will depend upon prevailing environmental conditions. The current sardine HCR already provides a *de facto* 'buffer' from F_{MSY} which continuously increases with temperature (Figures 1 & 3). Under the HCR, when SST is greater than 17.2 °C the harvest FRACTION remains fixed at 0.15 while true F_{MSY} (and thus OFL) continue to increase with temperature (Figures 1 & 3). The relationship between temperature, F_{MSY} and the *de facto* buffer (ABC/OFL) is presented in Table 2 and Figure 3. The last column of Table 2 shows P* 'equivalents' to these *de facto* HCR buffers. Temperatures chosen for this analysis range from 17.20 °C (no *de facto* buffer) to the upper quartile of temperatures observed at the SIO pier from 1916 to 2009 (17.53 °C; *de facto* buffer equivalent to a P* of 0.1). Note that the level of *de facto* buffering afforded under the current

HCR captures almost the full range of buffering that would be considered by the Council through application of the P* concept (P* equivalents range from 0.5 to 0.1). Therefore, the application of additional buffers under warmer temperatures is unnecessary (Figure 4), but the threshold temperature below which the new P* buffer is required will depend upon the Council's policy decision regarding P*. For example, were the Council were to choose a P* value of 0.4 for sardine (i.e. probability of overfishing is 40% or less under any environmental condition), then the new P* buffer would only be invoked when SST is less than or equal to 17.26 °C (Table 2; see row highlighted in **bold**), and for conditions warmer than 17.26 °C no additional buffering is needed to reduce the risk of overfishing. An example application of the additional P* buffer under cooler conditions is displayed in Figure 5.

Table 2. Relationship between temperature, F_{MSY}, HCR *de facto* buffers and their P* equivalents for temperatures between 17.20 °C and 17.53 °C (the upper quartile of temperatures at SIO pier from 1916 to 2009 (see also Figure 3). OFL and ABC values were based on a BIOMASS of one million metric tons as an example, but the ABC/OFL ratio does not change at other biomass values. Bold highlighted row is provided as an example and is not a specific recommendation for P*.

SST at SIO	F_{MSY} (A8 simulations)	F_{MSY} proxy ('Fraction' in HCR)	OFL	ABC	HCR *de facto* 'buffer' (ABC/OFL)	P* equivalent
17.20	0.1476	0.1476	128,442	128,442	1.000	0.500
17.21	0.1513	0.1500	131,626	130,500	0.991	0.494
17.22	0.1550	0.1500	134,854	130,500	0.968	0.475
17.23	0.1588	0.1500	138,124	130,500	0.945	0.457
17.24	0.1626	0.1500	141,438	130,500	0.923	0.440
17.25	0.1664	0.1500	144,796	130,500	0.901	0.423
17.26	**0.1703**	**0.1500**	**148,196**	**130,500**	**0.881**	**0.405**
17.27	0.1743	0.1500	151,640	130,500	0.861	0.389
17.28	0.1783	0.1500	155,127	130,500	0.841	0.373
17.29	0.1824	0.1500	158,657	130,500	0.823	0.356
17.30	0.1865	0.1500	162,231	130,500	0.804	0.341
17.31	0.1906	0.1500	165,847	130,500	0.787	0.326
17.32	0.1948	0.1500	169,508	130,500	0.770	0.311
17.33	0.1991	0.1500	173,211	130,500	0.753	0.297
17.34	0.2034	0.1500	176,957	130,500	0.737	0.283
17.35	0.2078	0.1500	180,747	130,500	0.722	0.270
17.36	0.2122	0.1500	184,580	130,500	0.707	0.257
17.37	0.2166	0.1500	188,457	130,500	0.692	0.244
17.38	0.2211	0.1500	192,377	130,500	0.678	0.232
17.39	0.2257	0.1500	196,339	130,500	0.665	0.220
17.40	0.2303	0.1500	200,346	130,500	0.651	0.211
17.41	0.2349	0.1500	204,395	130,500	0.638	0.199
17.42	0.2396	0.1500	208,488	130,500	0.626	0.189
17.43	0.2444	0.1500	212,624	130,500	0.614	0.179
17.44	0.2492	0.1500	216,803	130,500	0.602	0.170
17.45	0.2541	0.1500	221,026	130,500	0.590	0.161
17.46	0.2590	0.1500	225,291	130,500	0.579	0.152
17.47	0.2639	0.1500	229,601	130,500	0.568	0.144
17.48	0.2689	0.1500	233,953	130,500	0.558	0.136
17.49	0.2740	0.1500	238,348	130,500	0.548	0.128
17.50	0.2791	0.1500	242,787	130,500	0.538	0.121
17.51	0.2842	0.1500	247,269	130,500	0.528	0.114
17.52	0.2894	0.1500	251,795	130,500	0.518	0.108
17.53	0.2947	0.1500	256,363	130,500	0.509	0.102

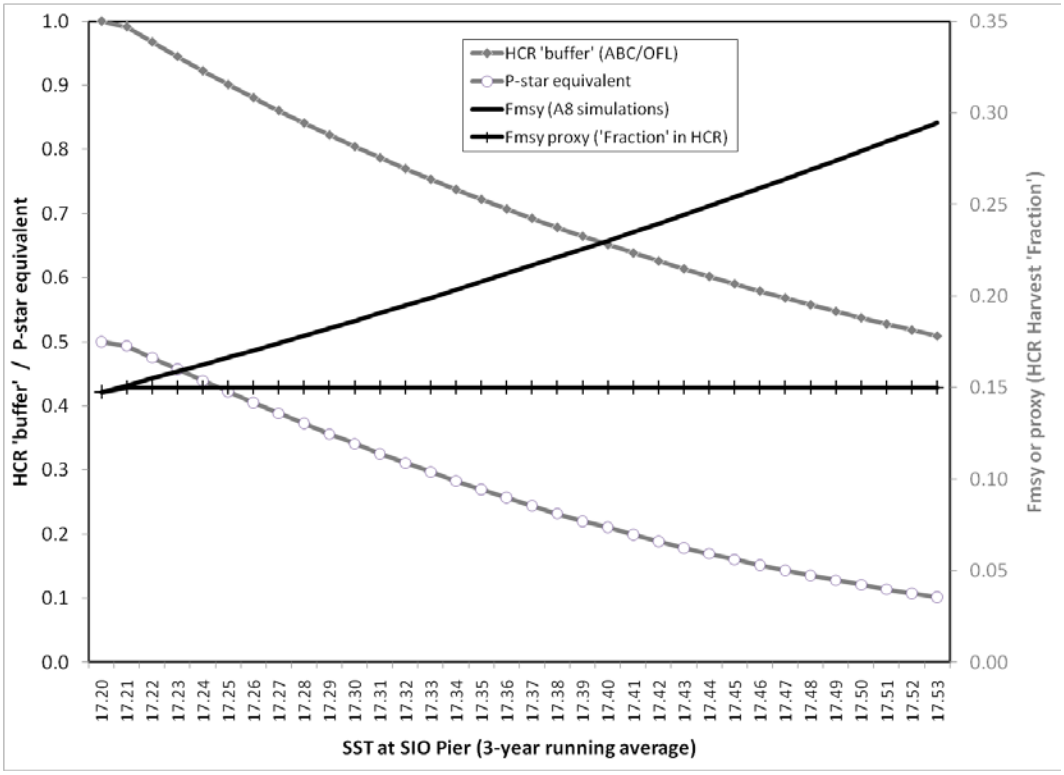

Figure 3. Relationship between temperature, F_{MSY}, HCR *de facto* buffers and their P* equivalents for temperatures between 17.20 °C and 17.53 °C (the upper quartile of temperatures at SIO pier from 1916 to 2009. Values are provided in Table 2.

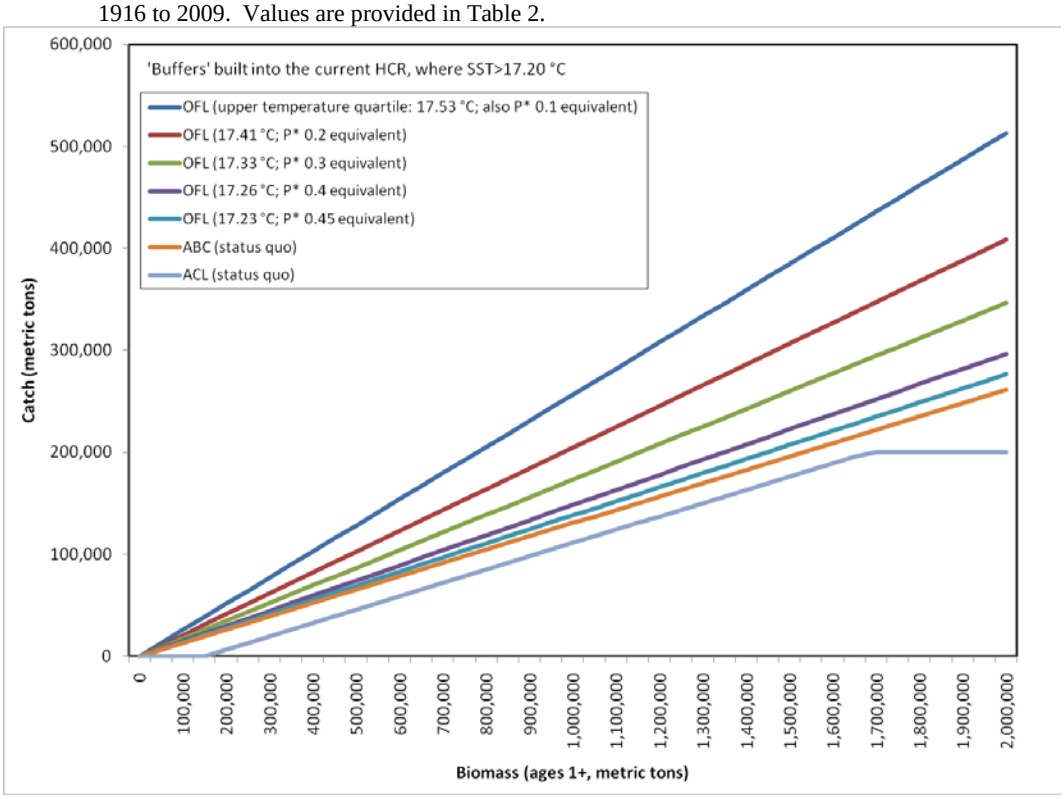

Figure 4. Relationship between biomass and catch (OFL, ABC, ACL) for a range of warmer conditions (SST>17.20 °C), where no additional buffering is required or applied.

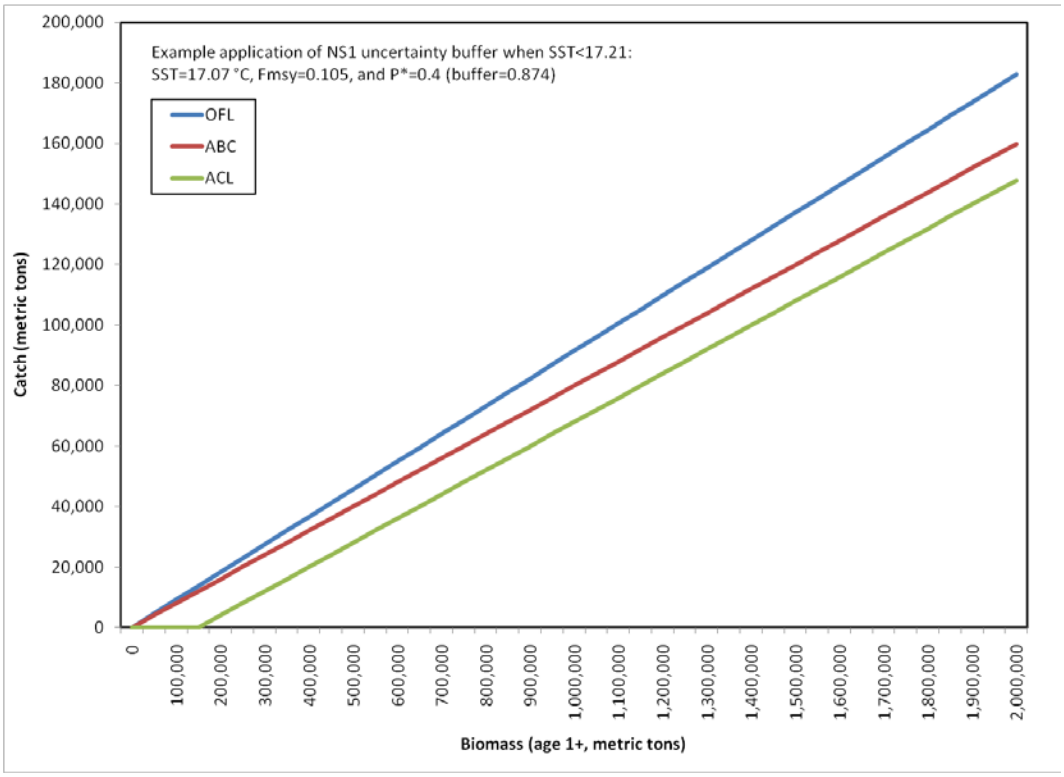

Figure 5. Relationship between biomass and catch (OFL, ABC, ACL) when temperature drops below the necessary trigger level to invoke new P* buffering. In this example, SST=17.07 °C (the mid-quartile since 1916), the F_{MSY} at that temperature is 0.105, and the P* policy is 0.4 (again, for example only).

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Pacific Mackerel

The general form of the harvest control rule (HCR) in the Coastal Pelagic Species Fishery Management Plan (CPS-FMP) was first implemented for management of northern anchovy and Pacific mackerel in the early 1980s (Huppert et al. 1980; PFMC 1983, 1990; MacCall et al. 1985; Jacobson and Thomson 1989). The general formula is:

HARVEST = (BIOMASS - CUTOFF) * FRACTION * DISTRIBUTION

For Pacific mackerel, this is:

$Harvest_{yr\ x} = (B_{yr\ x} - 18{,}200) * 0.30 * 0.70$

HCR parameters are defined as follows:

HARVEST is the target harvest level for each management year;
BIOMASS is the population biomass of fish ages 1 or older;
CUTOFF is the threshold below which fishing is prohibited (typically the same as the overfished threshold = 18,200 mt)
FRACTION is an F_{MSY} proxy (an exploitation fraction = 30%); and
DISTRIBUTION is the distribution of the stock, on average, in USA waters (70%).

MacCall et al.(1985) conducted an analysis for evaluating management options for Pacific mackerel in the early 1980s (; and pertinent statistics and discussion are also presented in *Amendment 8 to the CPS-FMP*, Appendix B (PFMC 1998). Since the inception of the HCR, the HARVEST term has been defined as a Harvest Guideline (essentially equivalent to an Acceptable Biological Catch (ABC)), but is more akin to an Annual Catch Limit (ACL) in terms of the required statistics stipulated in the 2006 Magnuson-Stevens Reauthorization Act. The CUTOFF parameter is intended "to provide a buffer of spawning stock biomass that is protected from fishing and available for use in rebuilding if a stock becomes overfished" (PFMC 1998). The FRACTION term has also been referred to as F_{MSY} (i.e., a proxy for the fishing level that produces MSY). However, it is important to note that the F_{MSY} parameter in this regard should not be considered a strict MSY-based term, given it is based on analysis that considered a suite of exploitation rates in combination with a fixed CUTOFF value and alternative models of stock-recruitment (S/R) compensation, with the current F_{MSY} = 30% based largely on qualitative decisions concerning the 'best' rate for management over a long-term horizon.

The following sections describe important aspects of the simulation that addressed management options for the Pacific mackerel stock (MacCall et al. 1985).

The fishery opened from 1929-69, closed from 1970-76 (due to low estimated abundance), and re-opened in 1977 (due to increased abundance). Fishery harvest was substantially higher during the 1980s and 1990s than during the 2000s. Pacific mackerel population dynamics (biology, distribution, abundance, etc.) are highly variable, which necessarily hinders robust model development, as well as long-term (equilibrium-based) recommendations regarding appropriate exploitation strategies. The temporal pattern of reproductive success was cyclical, with high points in a recruits per spawning biomass trend followed a 5-10 yr cycle. The historical relationship between spawners and recruits (S/R) was also highly variable, with strong recruitment years happening rarely, approximately every 50 years or so. The most recent

strong recruitment period occurred in the 1970s and early 1980s. Recruitment strength was much less variable when spawning biomass exceeded 100,000 mt.

Abundance (age-specific) estimates using cohort analysis for the time period 1929-84 assumed F to be 0.3-0.5/year and the selectivity (i.e., availability to the fishery) of the oldest (age 4) and plus (age 5) age groups was assumed to be fully and equally available to the fishery (i.e., F-ratio = 1). The *potential productivity* of the stock was investigated via simulations involving alternative S/R models and results generated from the cohort analysis. In other words, simulated average standing stock biomass (SSB) estimates were compared to historical estimates.

The overall simulation preserved the history of reproductive success, and two null models (i.e., 'states of nature') were considered. One assumed constant reproductive success (based on historic reproductive success without modification), and one assumed a constant recruitment (based on historical recruitment estimates used without modification). Other elements of the simulations included:

- The two extremes provide a reasonable bound for the estimated productivity of the stock;
- Intermediate compensation was represented as a suite of modified Ricker S/R relationships;
- Average harvests were compared over a 40-yr time frame, given the HCR and suite of alternative S/R compensation assumptions; and the comparison ultimately examined the set of harvest formulas consisting of various FRACTIONS, given a CUTOFF = 18,144 mt;
- The average annual yields were consistent between FRACTIONS from 0.2 to 0.25 (however, see additional sensitivity analysis below);
- The influence of different assumed models of compensation (S/R) was minimal;

Sensitivity analysis considered HARVEST in concert with varying CUTOFFs and FRACTIONs, and included the following elements:

- Estimated HARVEST (via yield isopleths) indicated higher CUTOFFs required higher FRACTIONs to maximize yield;
- Standard deviation of estimated HARVEST increased with larger FRACTIONs, but nearly independent of the range of CUTOFFs considered;
- Resource 'collapse' was not associated with positive CUTOFFs, which inherently protected the stock's ability to rebound from low abundance levels;
- FRACTIONS between 0.2 to 0.3 were the most robust in terms of similarities in estimated simulated SSB and the historical average;

Examination of the management strategy required consideration of *both* interacting components of the policy (the HCR and the abundance estimates used to implement it).

- In terms of the CUTOFF, "there is little reason to change the present *cutoff* level of 18,144 mt (i.e., currently, 18,200 mt is used), given this level provides sufficient protection from severe depletion while allowing a fishery in nearly all years";
- In terms of the FRACTION, "it is more amenable to change, given the simulations indicated that a higher *fraction* is likely to increase average yield up to a maximum of about 29,000 mt/yr at a *fraction* of 0.28";

- In terms of a harvest policy adopted in other fisheries globally, such as $F_{0.1}$ (as the proxy for F_{MSY}), would translate to a $FRACTION_{0.1} = 0.24$;
- In terms of bottom-line advice, "the effective *fraction* must be considered to be somewhat larger than the nominal *fraction* wording of the official management policy" (i.e., at that time 0.20).

An HCR has been in place since 1978, with an initial FRACTION of 20%. This initial HCR was not based on extensive fishery analysis, yet provides a perspective for the evaluation of the formula in concert with a range of alternative management measures. Sometime between the late 1980s and early 1990s (say approximately), the California Department of Fish and Game (CDFG) increased the FRACTION from 0.2 to 0.3 and added the DISTRIBUTION parameter to the overall HCR, i.e., strictly state-based (California) management law transitioned to federal law in the late 1990s.

Based on the above analysis and recent stock assessment efforts, the Coastal Pelagic Species Management Team (CPSMT) generally supports the current form of the HCR as a reasonable exploitation strategy that provides stable yields to the fishery, while not jeopardizing the long-term sustainability of the stock. However, further deliberations will likely be necessary to ensure consensus is realized as methods/policies are developed to meet the new requirements of the 2006 Magnuson-Stevens Reauthorization Act (MSRA).

Tables and figures associated with the current SSC-related methods to address scientific uncertainty (with respect to the MSRA requirements) are included here (Ralston 2009); however, displays should be considered preliminary, given the overall process has not been formally finalized.

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Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384. 34 p.

Table 1. Probability of Overfishing (*P**) and associated 'buffers' for Pacific mackerel, based on σ-between = 0.689, σ-within = 0.25, and σ-total = 0.733 (Punt Method '1').

P profile*	
*P**	Buffer
0.50	1.0000
0.49	0.9818
0.45	0.9120
0.40	0.8305
0.30	0.6809
0.20	0.5396

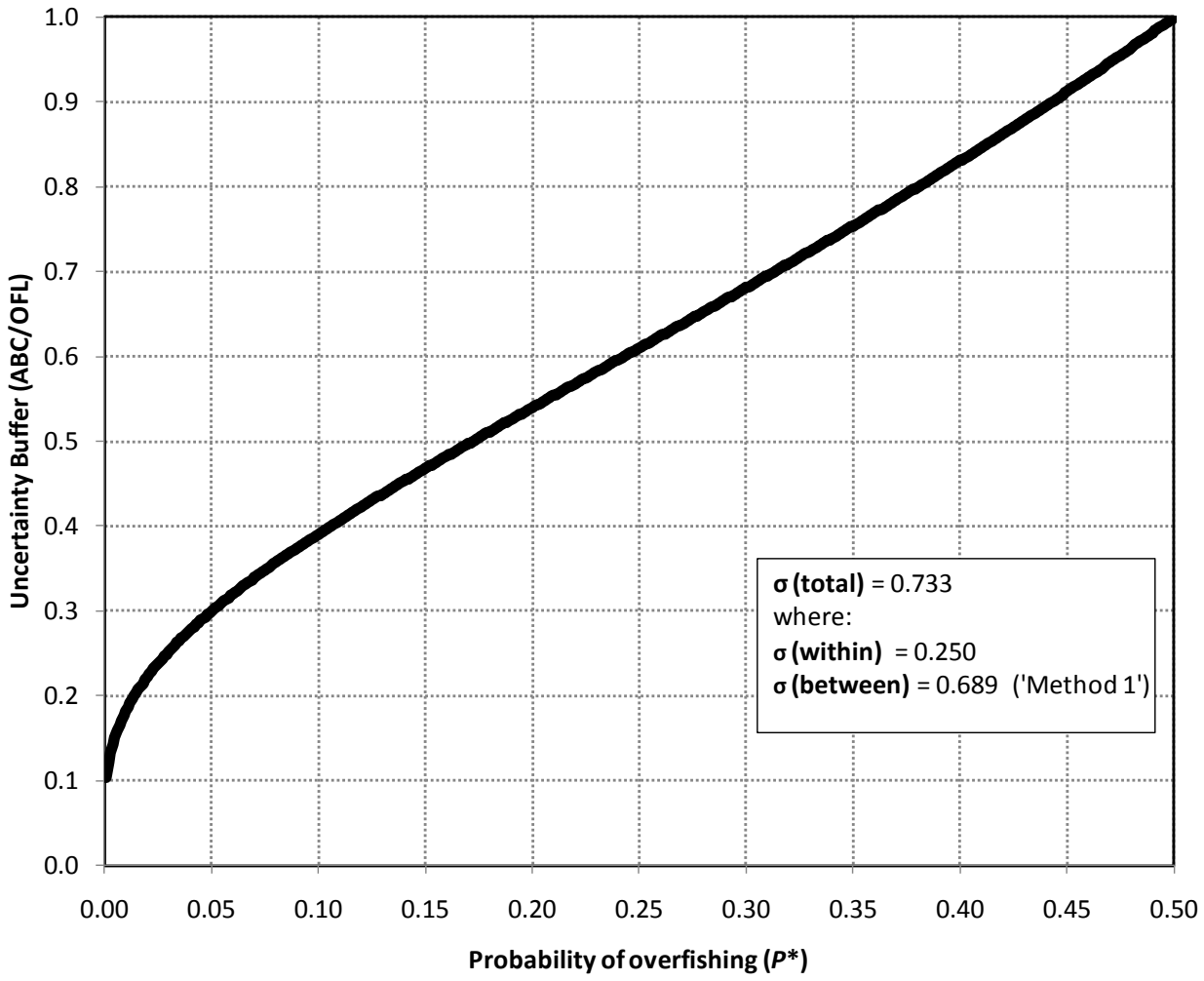

Figure 1. Relationship between Probability of Overfishing (*P**) and associated 'buffers' (ABC/OFL) for Pacific mackerel, based on σ-between = 0.689, σ-within = 0.25, and σ-total = 0.733 (Punt Method '1').

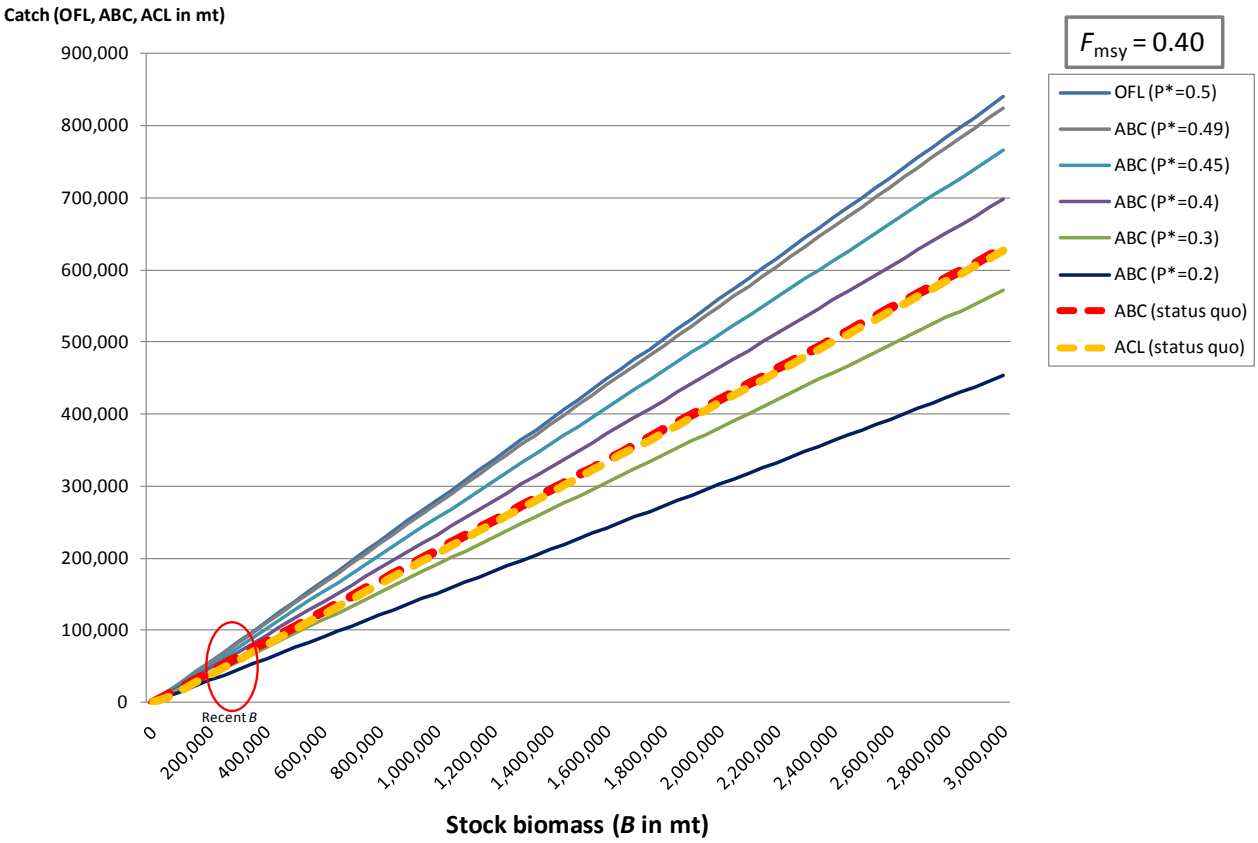

Figure 2. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.4. A 'status quo' ACL trajectory is shown that includes no additional buffer, i.e., see example in Figure 5. Recent estimated biomass (*B*) is denoted by red oval.

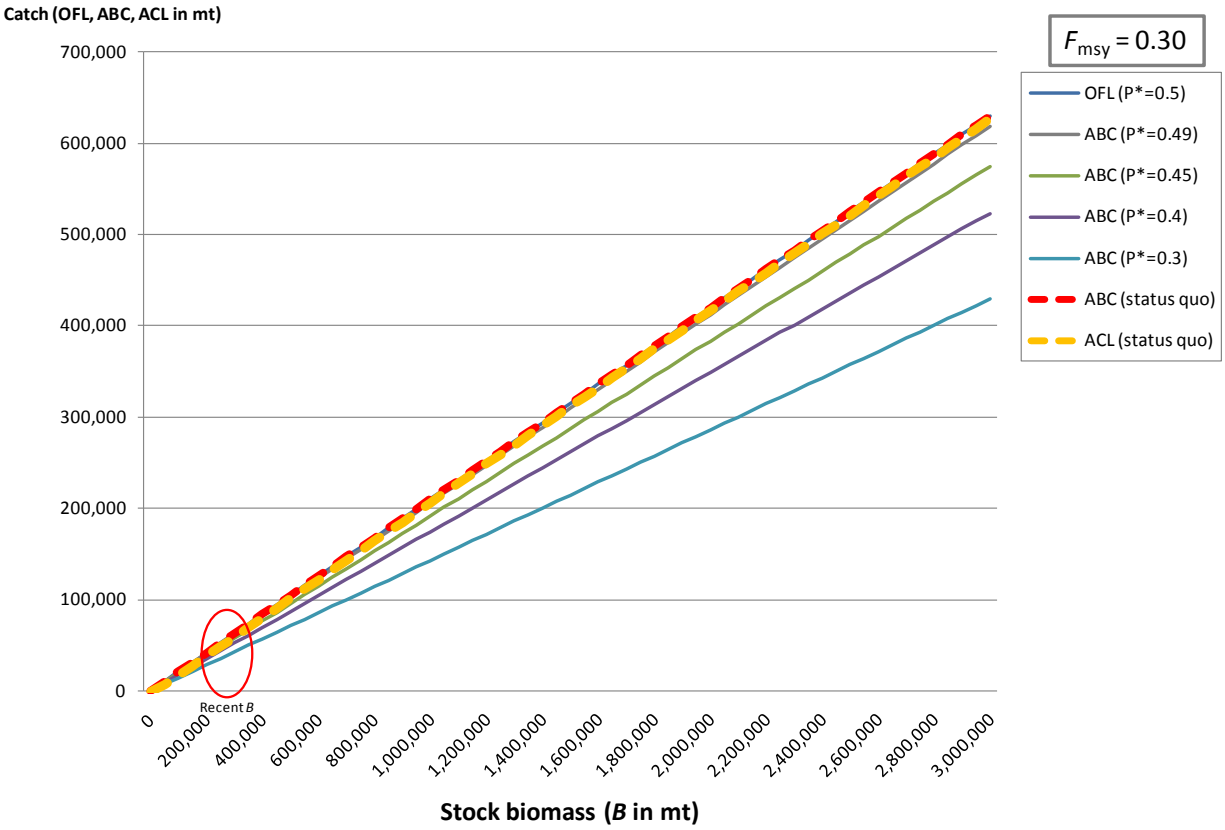

Figure 3. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.3, i.e., the current formulation of the HCR. A 'status quo' ACL trajectory is shown that includes no additional buffer, i.e., see example in Figure 5. Recent estimated biomass (*B*) is denoted by red oval.

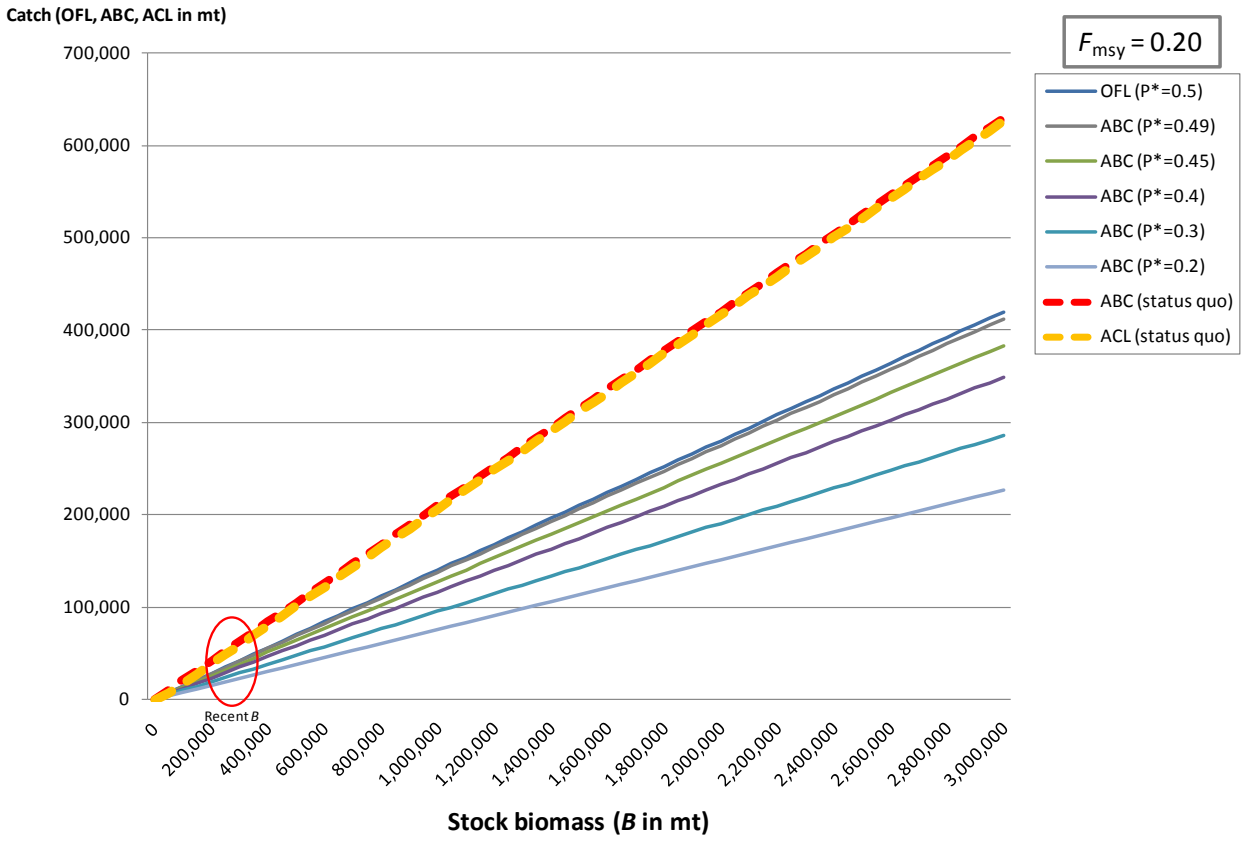

Figure 4. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.2. A 'status quo' ACL trajectory is shown that includes no additional buffer, i.e., see example in Figure 5. Recent estimated biomass (*B*) is denoted by red oval.

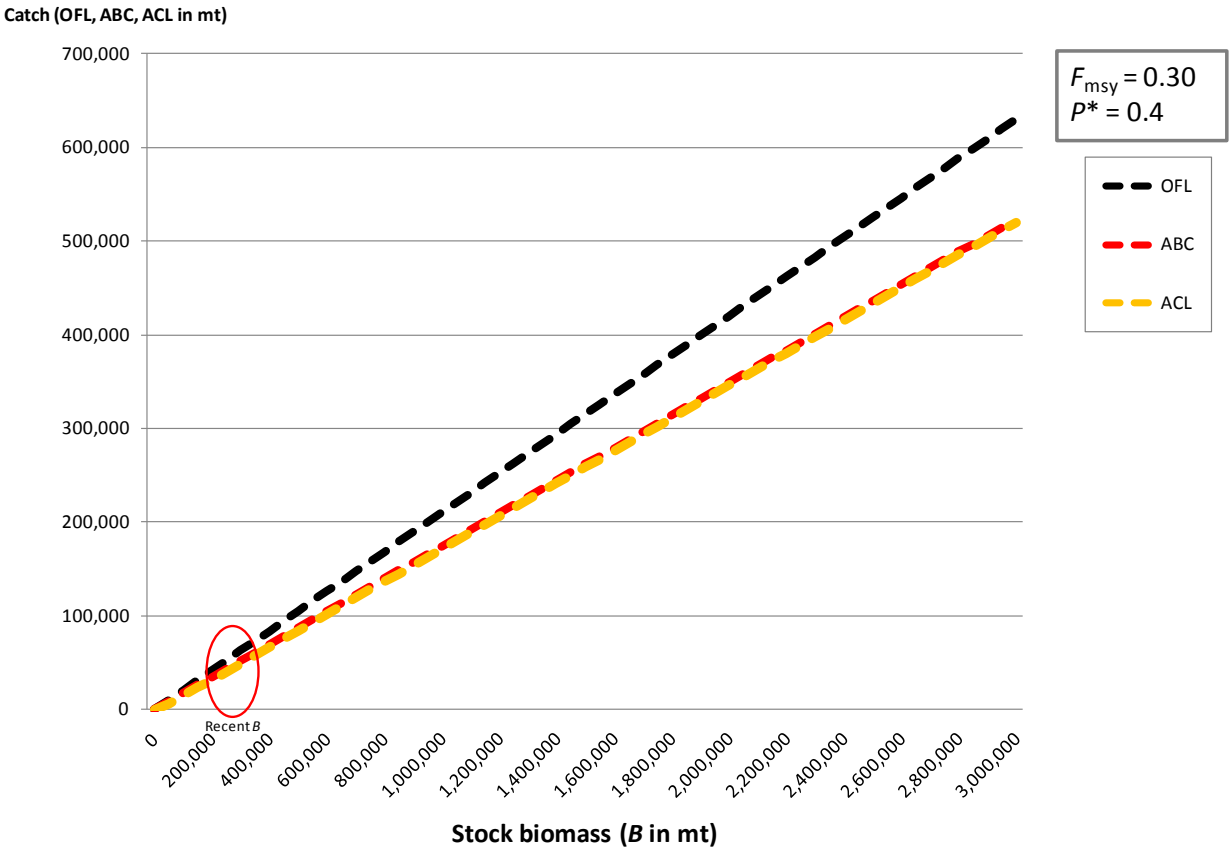

Figure 5. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt), based on a FRACTION (say F_{MSY} proxy) equal to 0.3 (i.e., current HCR) and a Probability of Overfishing (*P**) equal to 0.40. Recent estimated biomass (*B*) is denoted by red oval.

3.3.2 MONITORED SPECIES

Alternative 1 – Status Quo – Maintain the default harvest control rules as modified to specify the new management reference points, ACLs would be specified for multiple years until such time as the species becomes actively managed or new scientific information becomes available.

OFL	BIOMASS*F_{MSY} * DISTRIBUTION (MSY proxy)
ABC	BIOMASS x 0.25
ACL	Equal to ABC or reduced by OY considerations.

The default control rule specified for monitored species reduces the MSY harvest level by 75 percent, in part, to account for the relatively data-poor status of these species. Under this system ACLs are intended more as a decision point for moving the species into an actively managed category than to signal a conservation concern or potential overfishing. Under both of these alternatives, it is presumed that as landings approach the ACL, the CPSMT and the SSC may recommend an elevation of a species to the higher actively managed tier.

Table 3.3-1 Existing Reference Points in the CPS FMP as Proposed Under Alternative 1

Jack Mackerel	Source: MacCall and Stauffer (1983)	
OFL	$B*F_{MSY}$ * Distribution 195,000mt*0.65	124,800 mt
ABC	OFL * 0.25	31,000 mt
ACL	Equal to ABC	31,000 mt
Northern Anchovy, Northern Subpop.	Source**:** Preliminary **a**coustic biomass estimate, Zwolinski et al., in prep; Advanced Survey Technologies-SWFSC, 2010	
OFL	$B*F_{MSY}$ 159,800 mt (CV>0.88) * F_{MSY}?	Unknown – see Sections 2.1 and 3.1 for discussion of SDC considerations
ABC	OFL * 0.25	Unknown
ACL	Equal to ABC	Unknown
Northern Anchovy, Central Subpop.	Source: Conrad (1991) 123,000 F_{MSY} at biomass of 733,000mt	
OFL	$B*F_{MSY}$ * Distribution 123,000mt*0.82	100,860 mt
ABC	OFL * 0.25	25,215 mt
ACL	Equal to ABC	25,215 mt
Market Squid	Source: CPS FMP Amendment 10 and California State FMP for market squid.	
OFL/MSST	F_{MSY} Resulting in Egg Esc > 30%	NA
ABC	F_{MSY} Resulting in Egg Esc > 30%	NA
ACL/ACT	California Landing Limit	107,047 mt
Krill	Source: Amendment 12 to the CPS FMP	
OFL	No Operational Purpose	
ABC	No Operational Purpose	
ACL	Prohibited Harvest, de minimus amounts tolerated	0

Alternative 2 – Scientific Uncertainty Buffer – Modify the existing harvest control rules to include a buffer or reduction in ABC relative to OFL to account for scientific uncertainty. This reduction would be in addition to the precautions build into the default control rule. In practice either a BUFFER recommended by the SSC could be added to the ABC control rule as shown below, or a greater than 75 percent reduction from OFL could be instituted. ACLs would be specified for multiple years until such time as the species becomes actively managed or new scientific information becomes available.

OFL	BIOMASS*F_{MSY} * DISTRIBUTION (MSY proxy)
ABC	BIOMASS x 0.25 X BUFFER
ACL	Equal to ABC or reduced by OY considerations.

The SSC's CPS Subcommittee has preliminarily reviewed the management approach listed under Alternative 1 above. There are concerns regarding the dated nature of the assessment used to estimate both biomass and F_{MSY}. The full SSC will review theses two alternative approaches and may recommend additional analyses to further inform a decision on management reference point

for monitored stocks to prevent overfishing. The degree to which these species are targeted and the magnitude of recent landings should be considered when investing limited financial and human resources to developing and analyzing alternate control rules for monitored stocks.

Additional Considerations for Market Squid

Market squid is a short-lived species, and the relationship between F_{MSY} and stock abundance is poorly understood. Current management establishes a threshold egg escapement of at least 30 percent as a proxy for MSY.

OFL [1] = F_{MSY} * Biomass (egg esc. Proxy)	(PFMC 2002)
ABC = 245,348 mt	(PFMC 2002)
ACL/ACT= 107,048 mt	(CDFG 2005)

Although an ACL is not required for market squid, the California Department of Fish and Game implements an annual landings cap on the fishery. This cap is intended as an accountability measure and approaching or exceeding this harvest level could trigger the elevation of this species to the actively managed category.

Additional accountability measures currently in place for market squid include:

1. Temporal closures (weekend closures);
2. Spatial closures (marine protected areas, which include Channel Islands MPAs and new and proposed MPAs under the California Marine Life Protection Act);
3. Gear closures (i.e., Santa Monica Bay, leeward side of Catalina, lighting restrictions in Gulf of the Farallones Marine Sanctuary);
4. Gear restrictions for light shields and wattage limits;
5. Continued monitoring programs used to evaluate the impact of the fishery on the resource;
6. Restricted access program designed to limit fleet participation in order to maintain a moderately productive and specialized fleet; and
7. State management framework (Marine Life Management Act), which provides specific guidelines for making management decisions.

Other constraints that protect squid from overfishing include:

8. The population is utilized for commercial purposes within a fraction of the geographic range;
9. Fishing occurs within a limited portion of the depth range; and
10. Fishing pressure does not usually shift from traditional fishing areas to new areas when there is a decrease in availability of squid.

References:

[1] The relationship between F_{MSY} and stock abundance is poorly understood, and biomass is unknown at this time. Although monitoring/modeling efforts to date provide useful (descriptive) statistics regarding population dynamics surrounding this species, further work would be necessary before implementing the method for long-term management purposes. The substantial spatial and temporal variability in productivity of the population(s) off the central-southern California coast hinders the applicability of the method in practical terms and ultimately, emphasized the need for timely data collection, laboratory processing, and modeling, if the method is employed formally in the future.

CDFG. 2005. Market Squid Fishery Management Plan. March 25, 2005.

PFMC 2002. Coastal Pelagic Species Fishery Management Plan. Limited Entry

3.3.3 Sector-Specific Annual Catch Targets

Alternative 1 – No sector-specific ACLs.

Adoption of this alternative would deviate from the recent Council practice of setting aside a portion of the overall Pacific sardine for EFP research. This set aside has been "taken off the top" or deducted from the overall harvest guideline before allocating harvest across the seasonal allocation schedule of Amendment 11. Additionally, EFP research is often conducted during times when the directed fishery is closed and accounting for a portion of a fishing sector as an AM when impacts are anticipated outside the open fishing season in inconsistent.

Alternative 2 - Assign a sector-specific ACL to EFP research activities.

This alternative is most in keeping with recent Council treatment of EFP proposals and their associated impacts. This alternative would provide the maximum flexibility in terms of taking the set aside in closed area, with alternate gears, or some other experimental design that may be outside the regulations in place for the directed fishery. EFP landings are heavily monitored and reported so it is unlikely that a sector-specific ACL would be necessary, but unlike Alternative 1, Alternative 2 would provide the flexibility to create a sector-specific ACT should the need arise.

Alternative 3 – Assign a sector-specific ACL for the live bait fishery.

Mortality associate with this fishery is thought to relatively low, and the overall take from this fishery is a small proportion of the total commercial landings of Pacific sardine. Therefore, the use of AMs as a means of including this fishery in the total catch is reasonable and is explored in the next section. However, this low volume high value fishery is important to the California commercial passenger fishing vessel and recreational fishery sectors and under the current FMP this fishery remains open after the directed commercial fishery is closed. The Council may consider further analysis of using sector-specific ACLs for this fishery as a means of preserving the regulatory framework that allows this fishery to operate outside the directed fishery. Additionally, this fishery is not monitored inseason to the degree that the directed fishery is managed and impacts are estimated postseason via logbook data. Alternative 3 would allow the Council to further prevent overfishing or a fishery closure by considering an ACT for this sector that is commensurate with it lower tier of monitoring.

3.4 Annual Catch Target and Accountability Measure Considerations

Alternative 1 – No ACTs.

This alternative would not be in keeping with recent CPS management strategies that have proactively attempted to prevent overfishing while preserving harvest opportunities for exploitable stocks. The Council has a history of accounting for management uncertainty and has set aside a portion of the directed harvest (in this case an ACT) to cover incidental landings of a limiting CPS

stock in pursuit of a harvestable CPS stock and to forego lost opportunity associated with the closing of all fisheries to the retention of a particular species.

Alternative 2 – Develop ACTs only for actively managed stocks.

Alternative 2 best matches the current management regime and is more likely to minimize the chance of exceeding the ACL than Alternative 1. Framework language could be developed for the FMP that generally describes methods for assessing management uncertainty and total catch accounting while the specific set aside amounts for these AMs could be developed, reviewed, and approved on an annual basis.

Alternative 3 – Develop ACTs for actively managed and monitored stocks.

Developing ACTs is optional for all stocks and, unlike the actively managed species, this approach has not been applied to monitored species. The CPSMT discussed the potential benefits to establishing early trigger points or ACT for monitored species that could act as an early indicator of increasing harvest. There is no requirement to take management actions if an ACT is exceeded, this approach would simply provide an opportunity for advanced planning if a monitored stock is a candidate for active management. However, should harvest of a monitored stock exceed its ACL in more that one of four years, the Council would be required to address the situation with additional AMs in response.

3.5 STATE AND FEDERAL MANAGEMENT CONSIDERATIONS

Alternative 1 – Status Quo – All species, including market squid and jack mackerel remain in the CPS FMP and no species is transferred to state management.

a. Pro
    i. Provides a vehicle to account for climate change and shifts in range distribution.
    ii. Maintains the potential for federally supported research for species with distributions that occur along entire US coast.
b. Con
    i. The additional workload costs associated with the establishment and monitoring of Federal reference points for these species can outweigh the benefits to either a currently small fishery (jack mackerel) or to an already resilient and effectively managed State fishery.

Alternative 2 – Remove market squid from the CPS FMP and Federal management and transfer that authority to the State of California.

c. Pro
    i. There is currently an extensive California State-managed fishery and State FMP, with the following management elements:
        1. Limited Entry (restricted access) program in place that is not associated with the federal CPS limited entry program.
        2. Mandatory logbook and sampling program.
        3. Fishery Control Rules in place:
            a. Seasonal Catch limit

b. Temporal closures (Weekends)
c. Spatial closures (MPAs)
d. Gear-related closures (i.e., Santa Monica Bay, leeward side of Catalina, lighting restrictions in Gulf of the Farallones Marine Sanctuary).

ii. Fishery prosecuted primarily in CA state waters (within 3 miles of coast).
iii. Fishery impacts are not known to carry over from state to state.

d. Con
i. Potential loss of access to federally supported research support.
ii. Potential loss of federal collaboration/expertise for assessment to determine SDCs.
iii. Potential development of a fishery off the Pacific Northwest.
iv. Market squid may be a candidate species under the new Ecosystem FMP since squid provides an important role as forage for a large number of species and population levels fluctuate dramatically with environmental conditions.
v. Would decrease the ability to provide coast-wide Federal management should the species' distribution and harvest extend northward.

Alternative 3 – Remove jack mackerel from the CPS FMP and Federal management and transfer that authority to the State of California.

e. Pro
i. Although the vast majority of the harvest is in California, surveys in the Pacific Northwest catch this species.
ii. There is no evidence of significant recent exploitation on the Pacific coast for this species, although there have been substantial harvest years in the past.

f. Con
i. Jack Mackerel may be a candidate species under the new Ecosystem FMP; thus remain associated with Federal management.
ii. The infrastructure to provide federal support and management is already available if a fishery for jack mackerel develops in more than one state.

4.0 AMENDMENT SCHEDULE

The implementation of Amendment 13 and the promulgation of associated fishery regulations are targeted for the 2011 fishing year. The Council is scheduled to review a range of amendment alternatives and adopt a preliminary preferred alternative at its March 2010 meeting. Final Council action is scheduled for the June 2010 Council meeting to allow for full implementation by 2011.

Table 4.0-1Proposed Timeline for CPS FMP Amendment 13

Stage	Date
Council Announces Scoping –Initiates FMP Amendments	March 2009
Potential alternatives for draft FMP Amendment	November 2009
Adopt Preliminary Preferred Alternative for Public Review	March 2010
Final Council Action	June 2010
Proposed and Final Rulemaking	Late 2010
Secretarial Approval	January 2011
Changes in Existing Fishing Regulations	2011