Agenda Item H.1
Situation Summary
March 2010

NATIONAL MARINE FISHERIES SERVICE REPORT

Mr. Mark Helvey (NMFS SWR) will provide the Council a report on the 2009 and 2010 coastal pelagic species fisheries, the recent NOAA Catch Shares Workshop, and other recent activities.

Council Task:

Discussion.

Reference Materials:

None.

Agenda Order:

a. Regulatory Activities — Mark Helvey
b. Fisheries Science Center Activities — Russ Vetter
c. Reports and Comments of Management Entities and Advisory Bodies
d. Public Comment
e. Council Discussion

PFMC
02/17/10

NMFS Report
Southwest Region

Catch Shares Workshop

NMFS Southwest Region and Southwest Fisheries Science Center hosted a workshop on catch shares as that management approach may relate to the west coast coastal pelagic species fisheries (CPS). The two and half day event was held in San Francisco on February 2-4, 2010. The purpose of the informational workshop was two-part. The first part was to bring together west coast individuals with a range of interests in CPS to learn more about different types of rights-based management programs implemented in other fisheries. Case studies were presented by economists, political scientists, and fisheries biologists with experience in implementing and evaluating catch share programs. The cast studies included lessons learned in the West Coast groundfish trawl rationalization fishery, Chilean sardine fishery, Namibian fisheries, South Australian sardine fishery, New Zealand rock lobster fishery, and the Bering Sea pollock fishery. Presentations were also made on current conditions in the West Coast coastal pelagic species fishery, an analysis of price responses in the U.S. Pacific sardine fishery, the theories behind catch shares and fisheries management, and an overview of types of rights-based management programs.

The second part was to generate meaningful discussions and gauge current thinking on the utility of rights-based fisheries management for the U.S. west coast CPS fisheries. Participants interacted in panel discussions with the case study investigators and engaged in group discussions to consider pros and cons of rights-based management programs.

Throughout the workshop, an undercurrent of resistance to discuss catch shares management for the CPS fishery was present. Participants regularly commented that resource concerns were not an issue in the CPS fisheries. However, some individuals expressed concerns about overcapitalization and the existence of derby fishery conditions in years of low biomass. Catch shares and other allocation schemes were discussed as potential tools to improve fishery operations in low biomass years. Proceedings from the workshop are being prepared by NMFS and a spring release date is planned.

CPS Regulatory Activities

Annual Specifications for 2010 Pacific Sardine Fishing Season: On January 13, 2010, the proposed rule for the 2010 Pacific sardine annual specifications and management measures was published in the *Federal Register* (75 FR 1745). The comment period for this action ended on February 2, 2010. The final rule for this action is currently going through the rulemaking process and NMFS expects it to publish in the *Federal Register* in the near future.

Agenda Item H.1.c
Supplemental CPSAS Report
March 2010

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON NATIONAL MARINE FISHERIES SERVICE (NMFS) REPORT

The Coastal Pelagic Species Advisory Subpanel (CPSAS) discussed the Catch Shares Workshop held by NMFS Southwest Region and Southwest Fisheries Science Center in San Francisco in February of this year.

We believe the NMFS Report (Agenda Item H.1.a) correctly describes the "undercurrent of resistance" aspect which pervaded the conference amongst industry members.
Several comments were:

- "If is not broken, why fix it?"
- "The other nations that are represented are almost entirely vertically integrated. Processors most often own the fleet and the quota. Are these foreign harvest and processing infrastructures comparable to our own?"
- "What is the cost?"

The CPSAS does not endorse a Catch Share based program for Pacific sardine. We believe there are other management measures that are better suited to address any present or future management issues.

We believe that if there is money available for a Sardine Catch Share program it would be better spent to support research.

PFMC
03/09/10

FISHERY MANAGEMENT PLAN AMENDMENT 13: ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

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." On January 16, 2009, the National Marine Fisheries Service (NMFS) published a final rule 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 overfishing. These important aspects of the MSRA are required to be implemented by 2011 for most species and by 2010 for those species subject to overfishing.

The Pacific Fishery Management Council's (Council's) Coastal Pelagic Species (CPS) Fishery Management Plan (FMP) include 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.

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.

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) Groundfish and CPS Subcommittees met with members of the CPS and Groundfish Management Teams January 26-28, 2010 to refine the development of 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 risk of overfishing the stock. SSC Subcommittee recommendations will be brought forward at this meeting to the full SSC and the Council under this Agenda Item as well as Agenda Item E.4, *Groundfish Fishery Management Plan Amendment 23--Annual Catch Limits and Accountability Measures.*

At this 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.

Council Action:

Adopt Preliminary Preferred Alternative for Public Review.

Reference Materials**:**

1. Agenda Item H.2.a, Attachment 1, *Preliminary Alternatives and Analyses for Amendment 13 to the Coastal Pelagic Species Fishery Management Plan*.
2. Agenda Item H.2.b, Supplemental SSC Report.
3. Agenda Item H.2.b, Supplemental CPSMT Report.
4. Agenda Item H.2.b, Supplemental CPSAS Report.

Agenda Order:

a. Agenda Item Overview — Mike Burner
b. Reports and Comments of Management Entities and Advisory Bodies
c. Public Comment
d. **Council Action**: Adopt Preliminary Preferred Alternative for Public Review

PFMC
02/19/10

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

FEBRUARY 2010

PREPARED BY:

PACIFIC FISHERY MANAGEMENT COUNCIL
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CONTENTS

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

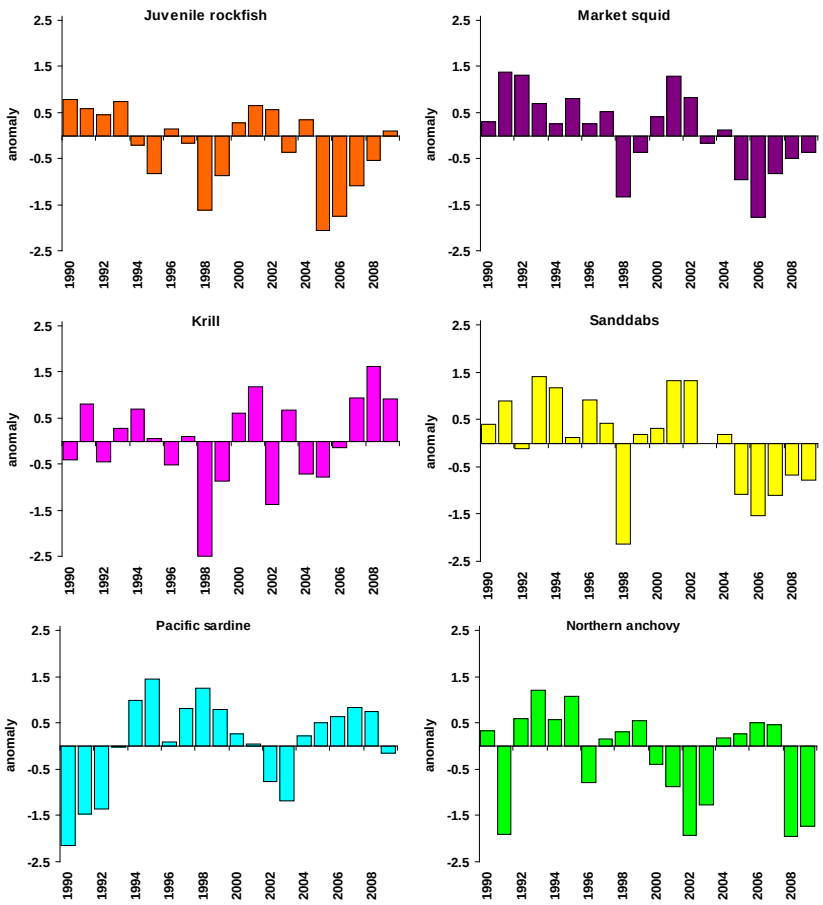

Figure 3.1-1: Long-term standardized anomalies of several of the most frequently encountered pelagic forage species from the central California rockfish recruitment survey in the core region (anomalies are based on the entire 1983-2009 period for all groups except krill) (S. Ralston, NOAA Fisheries,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

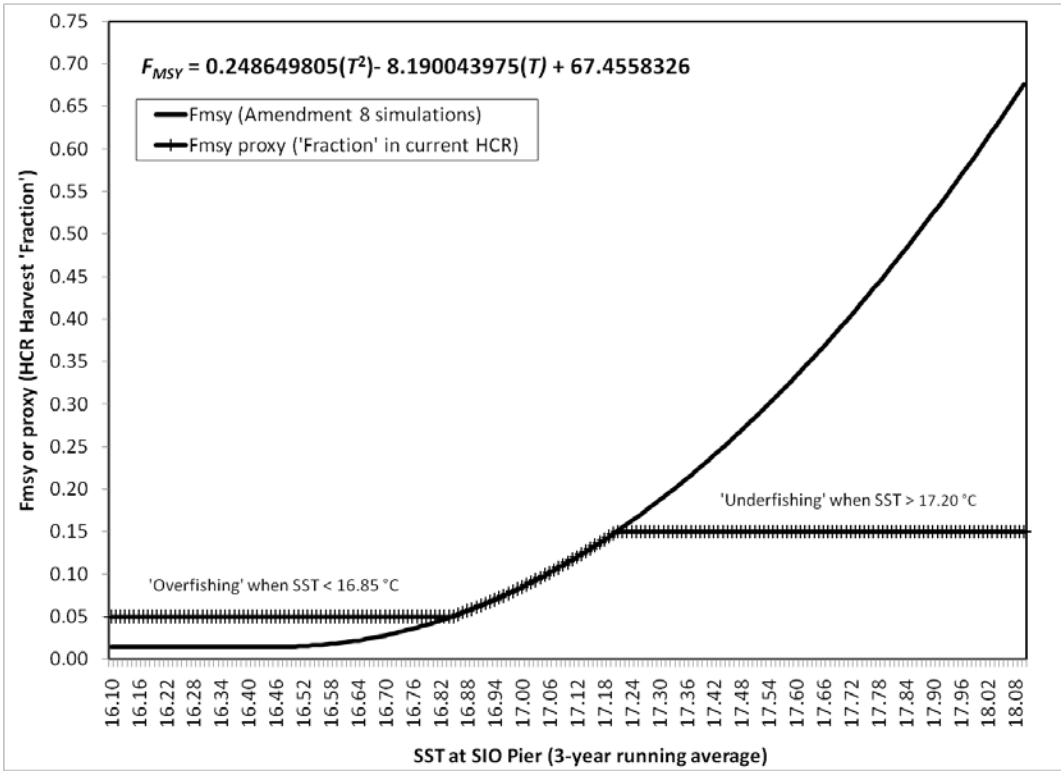

Figure 1. Relationship between SST (°C) at SIO pier and F_{MSY} for Pacific sardine (solid line). Harvest 'Fraction' in the PFMC's HCR policy, bracketed between 0.05 and 0.15, is represented by the segmented line.

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

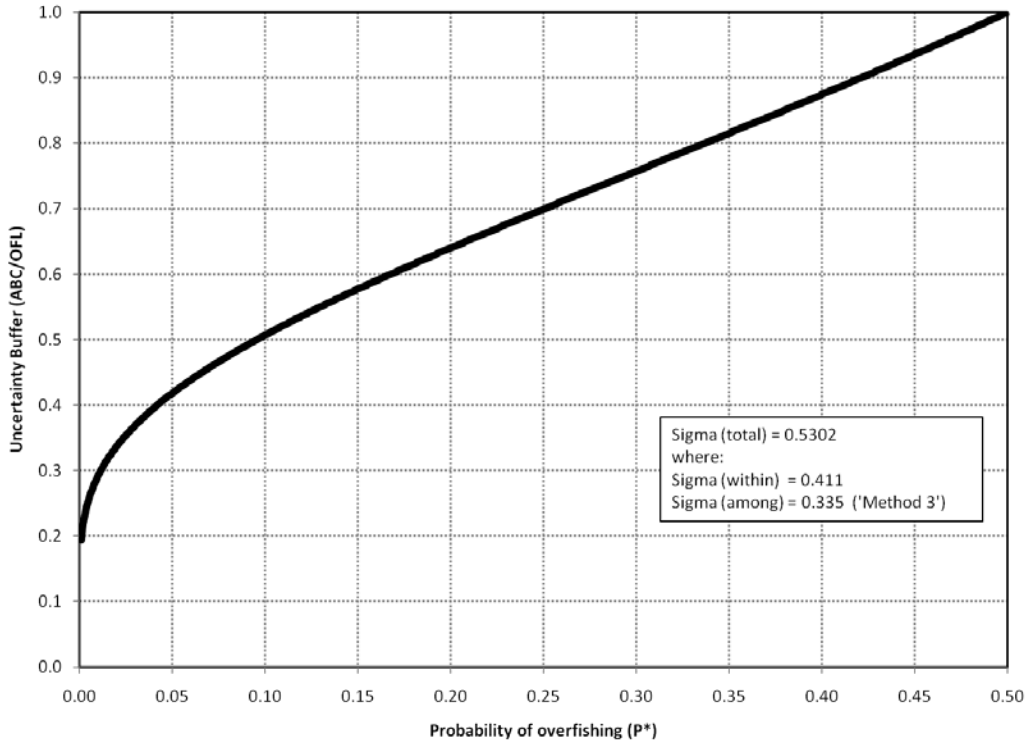

Figure 2. Relationship between the probability of overfishing (P*) and uncertainty buffers (ABC/OFL) for Sigma(total)=0.5302.

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

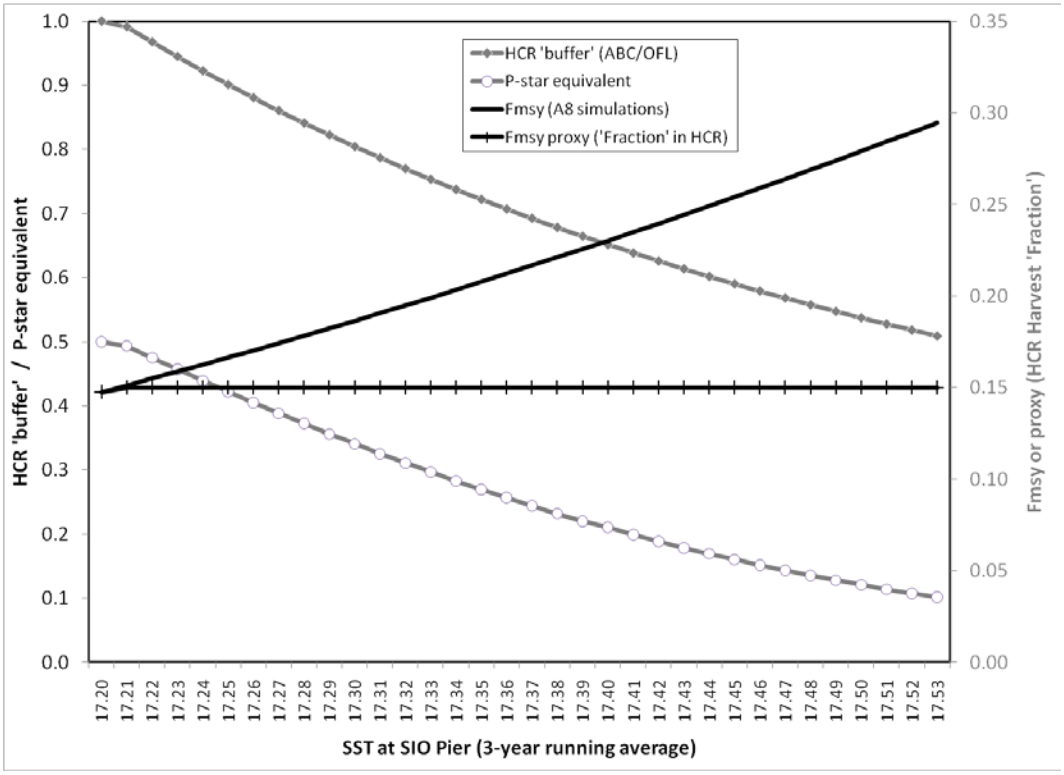

Figure 3. Relationship between temperature, F_{MSY}, HCR *de facto* buffers and their P* equivalents for temperatures between 17.20 °C and 17.53 °C (the upper quartile of temperatures at SIO pier from 1916 to 2009. Values are provided in Table 2.

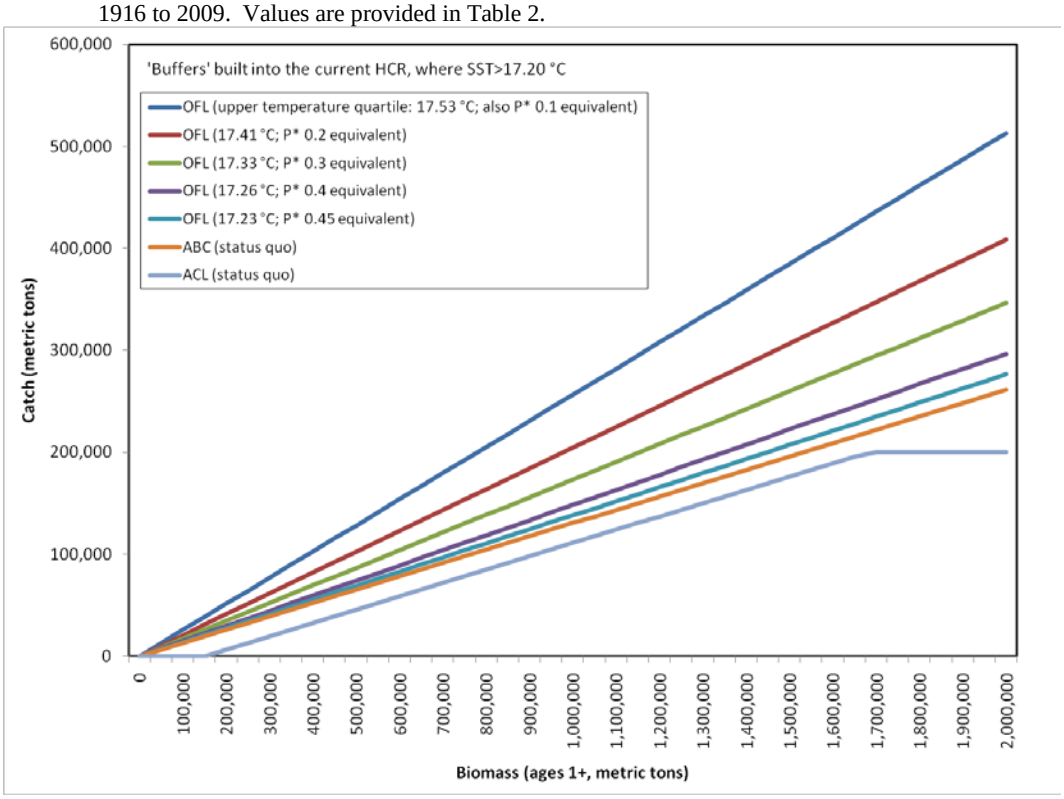

Figure 4. Relationship between biomass and catch (OFL, ABC, ACL) for a range of warmer conditions (SST>17.20 °C), where no additional buffering is required or applied.

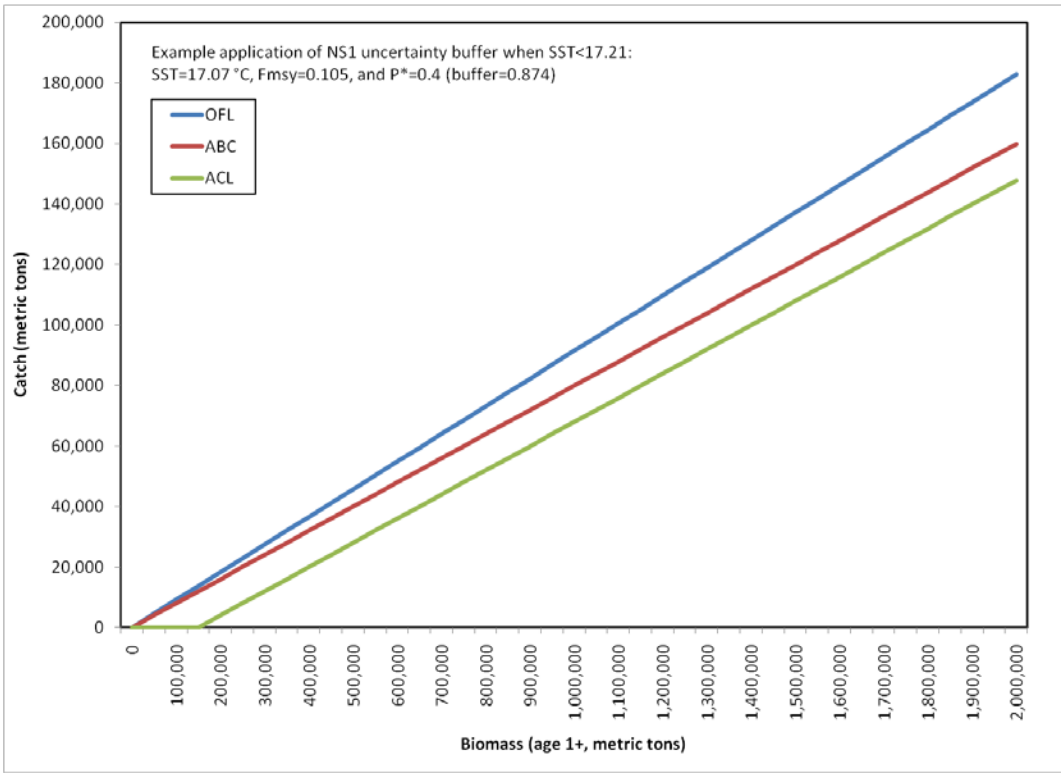

Figure 5. Relationship between biomass and catch (OFL, ABC, ACL) when temperature drops below the necessary trigger level to invoke new P* buffering. In this example, SST=17.07 °C (the mid-quartile since 1916), the F_{MSY} at that temperature is 0.105, and the P* policy is 0.4 (again, for example only).

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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

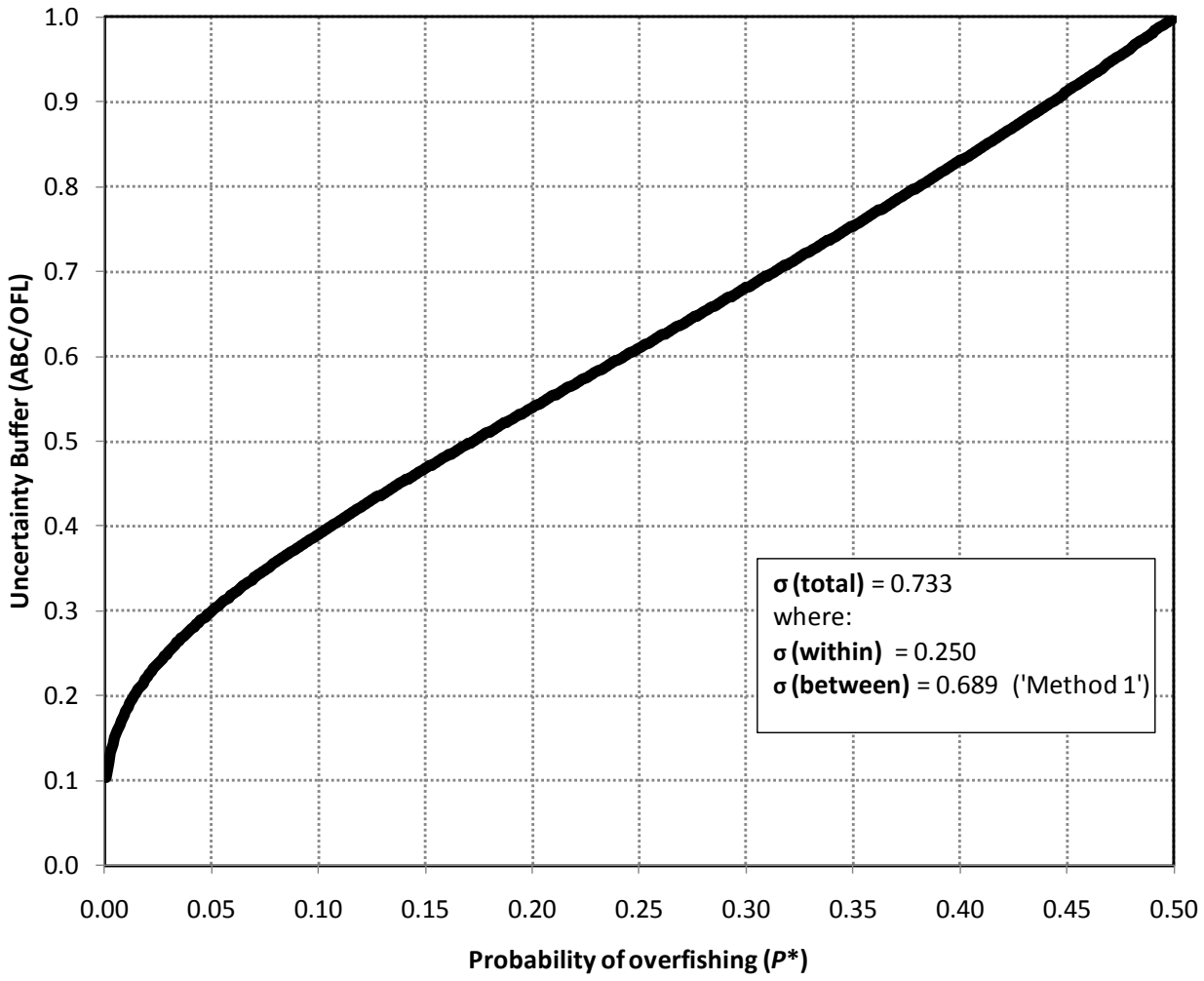

Figure 1. Relationship between Probability of Overfishing (*P**) and associated 'buffers' (ABC/OFL) for Pacific mackerel, based on σ-between = 0.689, σ-within = 0.25, and σ-total = 0.733 (Punt Method '1').

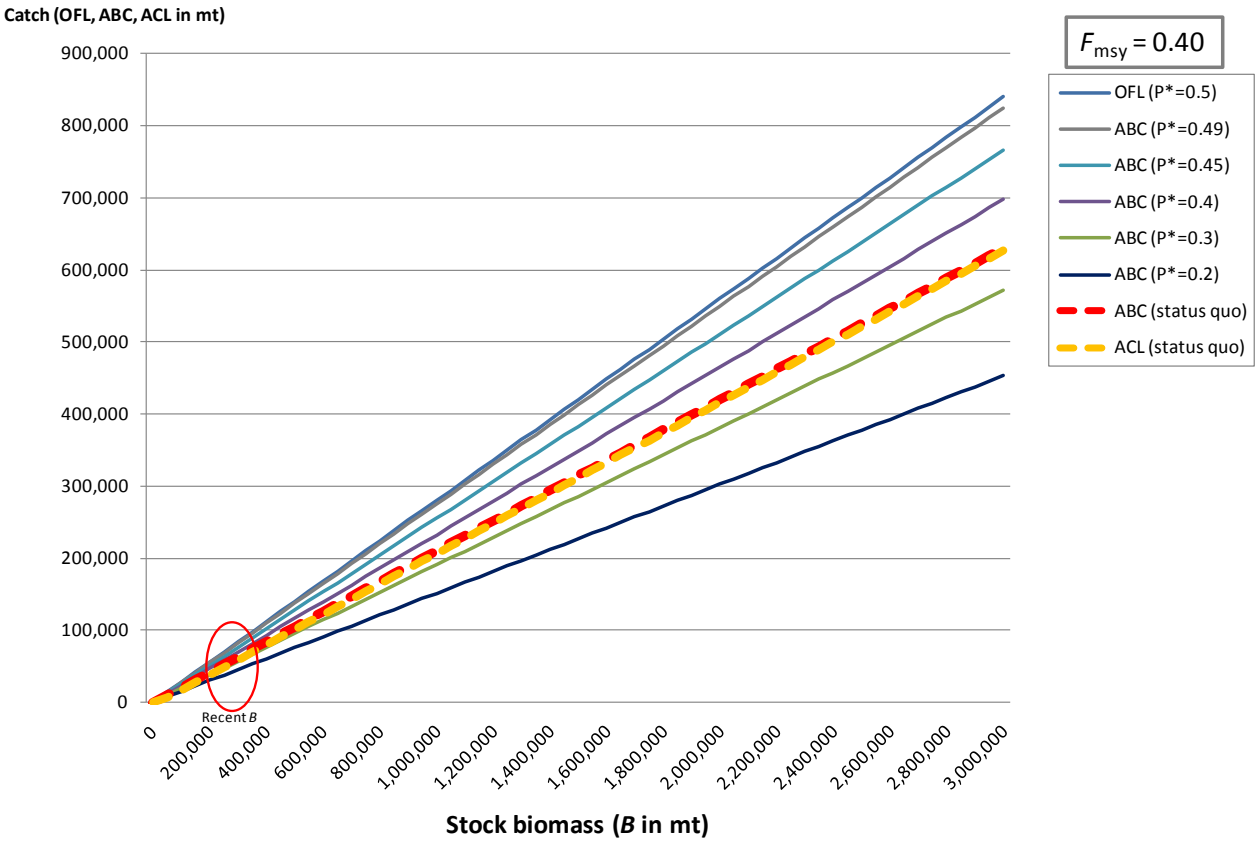

Figure 2. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.4. A 'status quo' ACL trajectory is shown that includes no additional buffer, i.e., see example in Figure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

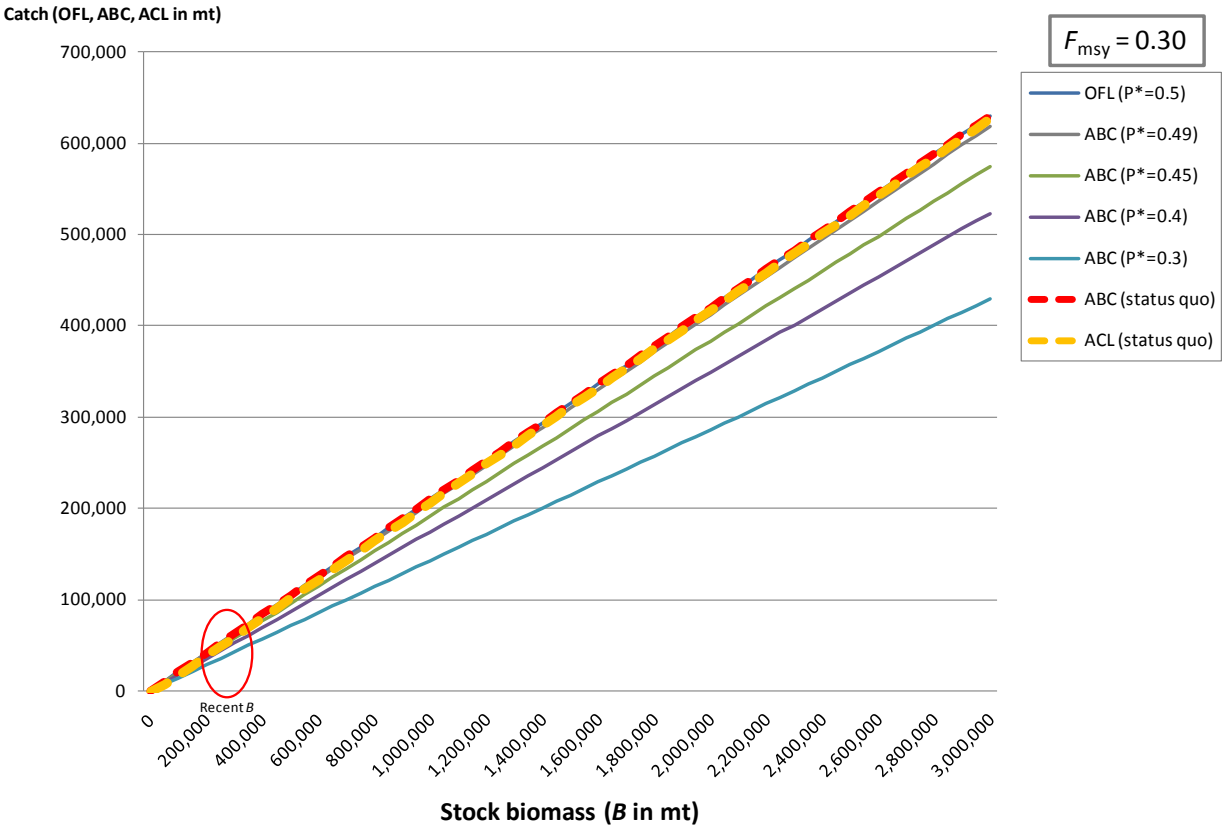

Figure 3. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.3, i.e., the current formulation of the HCR. A 'status quo' ACL trajectory is shown that includes no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

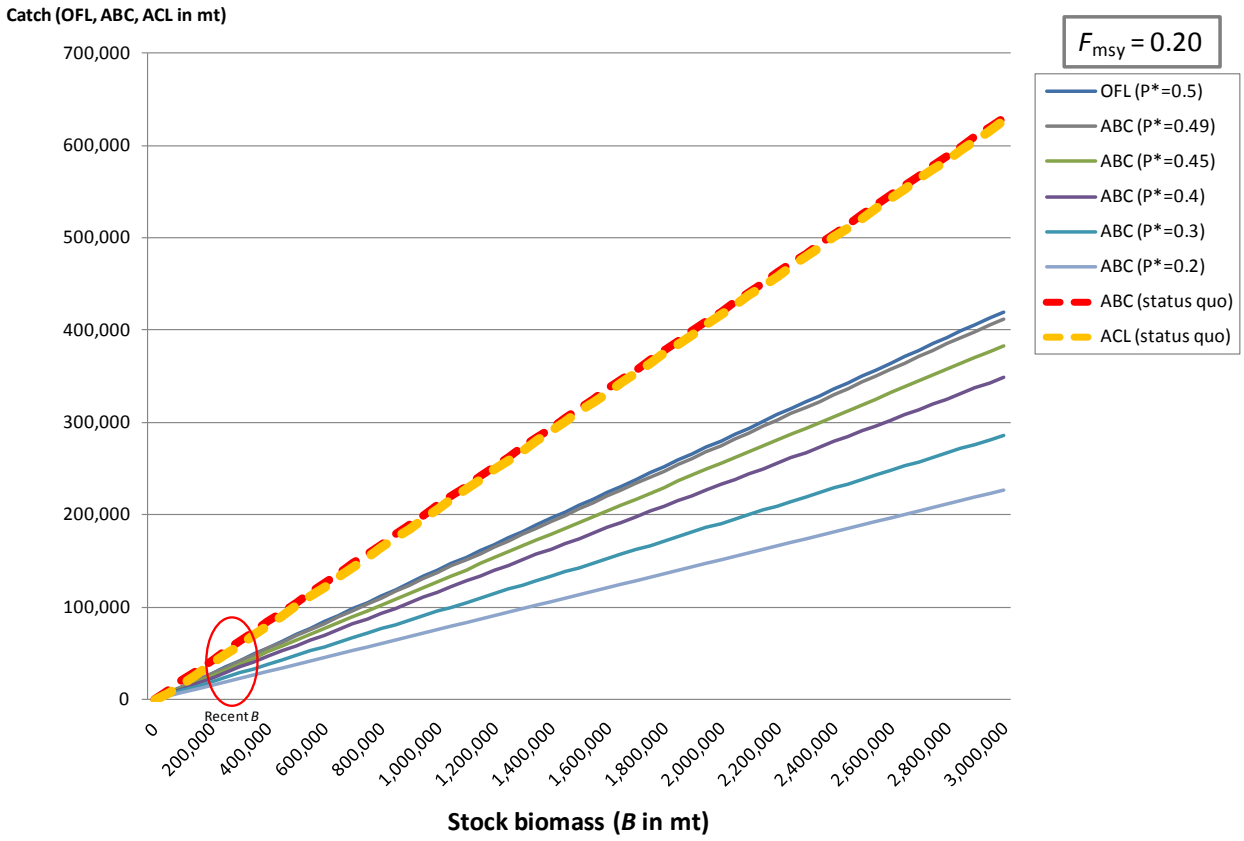

Figure 4. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt) across a range of Probability of Overfishing (*P**) levels, based on a FRACTION (say F_{MSY} proxy) equal to 0.2. A 'status quo' ACL trajectory is shown that includes no additional buffer, i.e., see example in Figure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

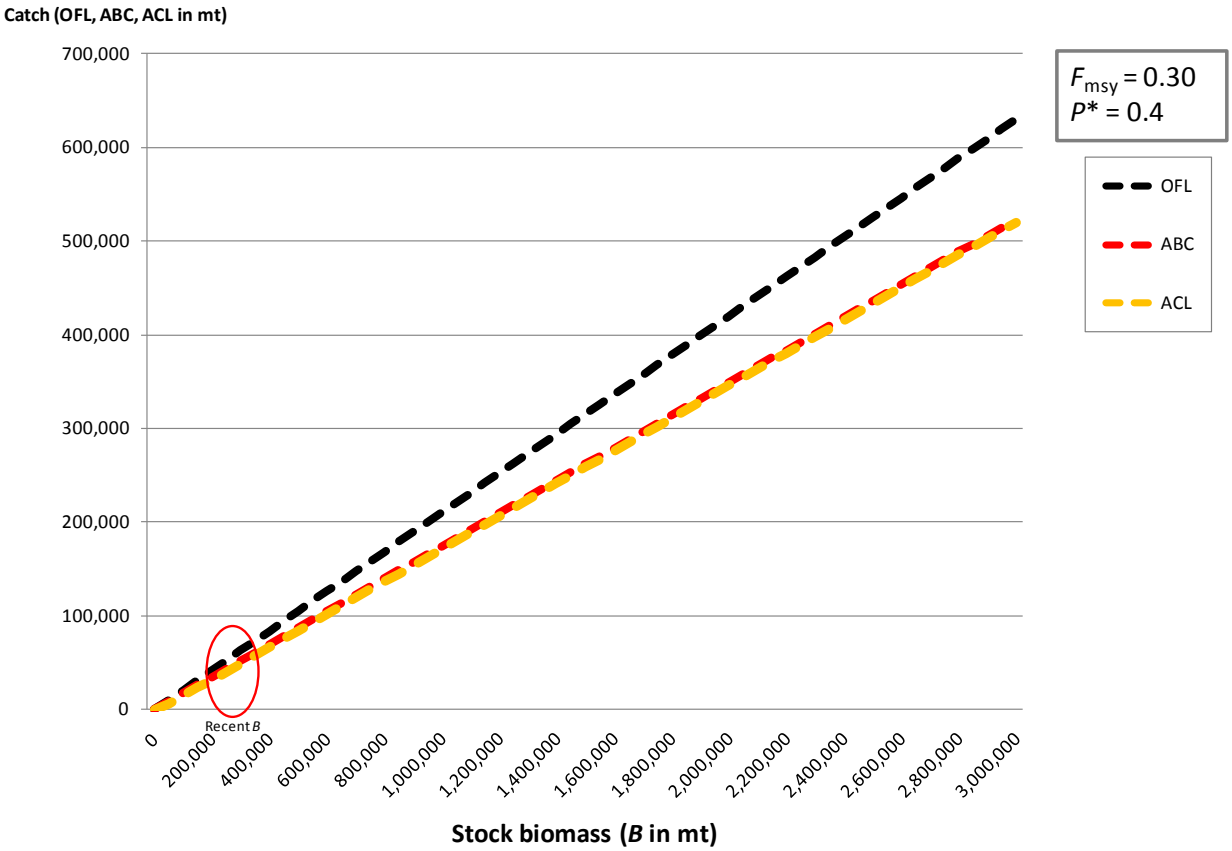

Figure 5. Relationship between stock biomass (*B* in mt) and catch (OFL, ABC, ACL in mt), based on a FRACTION (say F_{MSY} proxy) equal to 0.3 (i.e., current HCR) and a Probability of Overfishing (*P**) equal to 0.40. Recent estimated biomass (*B*) is denoted by red oval.

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

This document is intended to correct errors and improve clarity in the following sections of Agenda Item H.2.a, Attachment 1, *Measures for Integrating New Provisions of the Magnuson-Stevens Act and National Standard 1 Guidelines Into Coastal Pelagic Species Management*. Changes are shaded gray in most cases.

Table 2.2-1 on page 7:

Table 2.2-1. 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 25,000mt in U.S.	Currently at or below ABC
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	107,049 mt
Jack mackerel	Age/Area based potential yield	Catch exceeding ABC	Not specified	48,000mt 31,000mt in U.S.	Currently at or below ABC
Krill or Euphausiids	Not specified	Not specified	Not specified	Not specified	0

The description of OFL, ABC, and ACL Considerations under <u>Section 2.3 AND Section 3.3</u> should be amended as follows:

2.3.1 ACTIVELY MANAGED SPECIES ON PAGES 8-9

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 - 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 and 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 (PAGES 9-10) AND 3.3.2(PAGES 33-34) MONITORED FINFISH AND SQUID 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	STOCK SPECIFIC MSY proxy
ABC	OFL 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	STOCK SPECIFIC MSY proxy
ABC	OFL x 0.25 x BUFFER
ACL	Equal to ABC or reduced by OY considerations.

Market squid are also a monitored species under the CPS FMP, but the current MSY proxy for market squid is completely different from the finfish species and uses an escapement method detailed in Section 3.

Table 3.3-1 Existing Reference Points in the CPS FMP as Proposed Under Alternative 1 (Page 34)

Jack Mackerel	Source: MacCall and Stauffer (1983)	
OFL	B x F_{MSY} x Distribution 195,000mt x 0.65	124,800 mt
ABC	OFL x 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 x F_{MSY} 159,800 mt (CV>0.88) x F_{MSY}?	Unknown – see Sections 2.1 and 3.1 for discussion of SDC considerations
ABC	OFL x 0.25	Unknown
ACL	Equal to ABC	Unknown
Northern Anchovy, Central Subpop.	Source: Conrad (1991) MSY proxy = 123,000 based on biomass of ~733,000 mt	
OFL	(MSY proxy) x Distribution 123,000mt x 0.82	100,860 mt
ABC	OFL x 0.25	25,000 mt
ACL	Equal to ABC	25,000 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	107,049 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

References:

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

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

Conrad J. M. 1991. A bioeconimic analysis of the northern anchovy. NMFS, Southwest Fisheries Science Center Admin. Rep. LJ-91-26: 34 p.

MacCall, A.D., and G. D. Stoufer. 1983. Biology and fishery potential of jack mackerel (*Trachurus symemetricus*) CalCOFI Rep. 24: 46-56.

PFMC (1998) CPS FMP Amendment 8 Appendix B http://www.pcouncil.org/wp-content/uploads/a8apdxb.pdf.

PFMC (2002) CPS FMP Amendment 10 http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/amendment-10/

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 13 – ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

The Coastal Pelagic Species Advisory Subpanel (Subpanel) heard a presentation from Mr. Mike Burner on Amendment 13 to the Coastal Pelagic Species (CPS) Fishery Management Plan (FMP): Measures for Integrating New Provisions of the Magnuson-Stevens Fishery Conservation and Management Act and National Standard 1 Guidelines into Coastal Pelagic Species Management.

The Subpanel engaged in extensive internal discussion and discussions with the CPS Management Team (CPSMT) regarding technical aspects and implications of various options. Dr. Kevin Hill provided an explanation for the proposed P* policy alternative.

The Subpanel recommends the following:

2.1 Summary Stock Classifications

Regarding the addition of forage species not currently in the CPS FMP, the Subpanel believes the CCS Ecosystem FMP is the appropriate place to include these species. The Subpanel agrees these species should be monitored to inform and improve ecosystem-based management.

2.2.1 Status Determination Criteria Alternatives

The Subpanel concurs with the CPSMT recommendation to support Alternative 2.

2.3 Overfishing Levels, ABC, and ACLs

The Subpanel supports Alternative 1 for Pacific sardine as a preliminary preferred alternative for analysis at this time. The Subpanel expressed grave concern that information to fully understand and make recommendations on any alternative regarding Pacific sardine management is not yet available, and awaits final SSC and CPSMT analyses. As expressed in past statements, the Subpanel believes strongly that sufficient precaution is already incorporated into the Pacific sardine HCL.

The Subpanel is interested in receiving more specific information if a proposed Alternative 3 is developed: i.e. an additional buffer is unnecessary under warmer water temperatures, but an additional buffer to the Pacific sardine harvest control rule would apply in colder-water periods.

The Subpanel reiterates the critical importance of more comprehensive research to understand the full extent of the Pacific sardine population, and urges the Council to continue supporting the industry-sponsored surveys and also to encourage National Marine Fisheries Service to increase funding for Pacific sardine research, as well as other CPS species.

Regarding Pacific mackerel, the Subpanel supports Alternative 2.

2.3.2 Monitored Species

The Subpanel supports Alternative 1 in light of the low harvest levels on CPS finfish.

2.3.3 Sector-specific ACLs

The Subpanel discussed at length how to account for mortality in the live bait fishery.
The Subpanel acknowledged the importance of the live bait fishery and supports an outcome that preserves optimum fishing opportunity. To ensure optimum fishing opportunity, the Subpanel supports dedicating a portion of the ACL for live bait.

Regarding a sector-specific ACL for EFP research, the Subpanel believes this would be applied as needed.

2.4.4 Summary of ACT and AM Alternatives

The Subpanel supports Alternative 2 – Develop ACTs only for actively managed stocks.
Under this option, the Subpanel agrees that setting aside a portion of the Pacific mackerel and Pacific sardine ACTs for incidental harvest in other CPS fisheries should be continued as is done currently.

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03/09/10

COASTAL PELAGIC SPECIES MANAGEMENT TEAM REPORT ON FISHERY MANAGEMENT PLAN (FMP) AMENDMENT 13 – ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

The Coastal Pelagic Species Management Team (CPSMT) met on March 7 and 8, 2010 to discuss Amendment 13. The CPSMT reviewed Agenda Item E.4.b, SSC Supplemental Report 1 and Agenda Item H.2.b, Supplemental SSC Report. These documents provided guidance on SSC thinking related to quantifying scientific uncertainty for biomass estimates of Coastal Pelagic Species. The CPSMT considered the alternatives presented in Agenda Item H.2.a (Attachments 1 and 2) and the previously mentioned SSC documents. **The CPSMT recommends the alternatives that are in bold type below.** New language and/or alternatives are shaded gray.

2.1.3 Summary of Stock Classification Alternatives (p. 6 of H.2.a Attachment 1).

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

- ***Rationale*: Krill fit the criteria for EC species under the new National Standard 1 guidelines.**

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).

2.2.1 Summary of Status Determination Criteria Alternatives (p. 7 of H.2.a Attachment 1).

Alternative 1 – Status Quo – Maintain existing Status Determination Criteria (SDCs) for CPS FMP stocks.

***Alternative 2* – Maintain existing SDCs for CPS FMP stocks and develop a maximum sustainable yield (MSY) proxy for the Northern subpopulation of Northern anchovy.**

- ***Rationale:* A preliminary acoustic biomass estimate is available and will be considered for the development of an ABC for this subpopulation.**

2.3.1 Overfishing Limit (OFL), Acceptable Biological Catch (ABC) and Annual Catch Limits (ACL) Considerations for Actively Managed Species (p. 8 of H.2.a, Attachment 1 and p. 2 of H.2.a, Supplemental Attachment 2).

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
ABC	(BIOMASS - 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 built into the FRACTION term in the existing rule. Because the CUTOFF term is intended to address economic and ecological issues (OY considerations) it is proposed as a reduction from ABC to ACL.**

- ***Rationale:*** **Analysis suggests this alternative is appropriate for Pacific mackerel.**

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

Alternative 3 **– Scientific Uncertainty Buffer for SARDINE – 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 built into the FRACTION term in the existing rule. Because the CUTOFF term is intended to address economic and ecological issues (optimum yield [OY] considerations) it is proposed as a reduction from ABC to ACL.**

For sardine, the buffer factor can vary from 1 to the buffer associated with the p* policy. The p* buffer would be implemented at or below the appropriate temperature threshold. See method described on page 22 of Agenda item H.2.a, Attachment 1.

OFL	BIOMASS x FRACTION x DISTRIBUTION
ABC	(BIOMASS x BUFFER*) x FRACTION x DISTRIBUTION
ACL	[(BIOMASS x BUFFER*)-CUTOFF] x FRACTION x DISTRIBUTION. *Where change in buffer from 1 to p* is triggered at or below the appropriate temperature threshold.

- ***Rationale:*** **The CPSMT will conduct further analysis to determine the appropriate temperature threshold value based on recommendations provided by the SSC in Agenda Item H.2.b, Supplemental SSC Report. Initial analysis suggests that the present control rule does not provide adequate buffering in all cases.**

2.3.2 OFL, ABC and ACL Considerations for Monitored Species (p. 2 of H.2.a, Supplemental Attachment 2).

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. Market squid are also a monitored species under the CPS FMP, but the current MSY proxy for market squid is completely different from the finfish species and uses an escapement method detailed in Section 3. Market squid are exempt from ACLs because of their one-year life cycle (see Table 3.3-1 of H.2.a, Supplemental Attachment 2).**

OFL	STOCK SPECIFIC MSY proxy
ABC	OFL 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 built 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	STOCK SPECIFIC MSY proxy
ABC	OFL x 0.25 x BUFFER
ACL	Equal to ABC or reduced by OY considerations

3.3.3 Sector-Specific ACLs (p. 36 of H.2.a, Attachment 1).

Alternative 1 **– No sector-specific ACLs.**

- ***Rationale:*** **Exempted fishing permit (EFP) activities and the live bait fishery may be best addressed under annual catch target and accountability measures (AMs) alternatives.**

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

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

3.4 Summary of ACT and AM Alternatives (p. 36 of H.2.a, Attachment 1).

Alternative 1 – No ACTs.

Alternative 2 – Develop ACTs only for actively managed stocks.

***Alternative 3* – Develop ACTs for *some or all* actively managed and monitored stocks.**

- ***Rationale:* ACTs and AMs can accommodate EFP activities and live bait fisheries.**
- ***Rationale:* ACTs and AMs may provide additional management flexibility for monitored species.**

3.5 State and Federal Management of Coastal Pelagic Species (p. 37 of H.2.a, Attachment 1).

***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.**

- ***Rationale:* Current management framework is effective.**

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

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

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03/09/10

2.3.1 OFL, ABC and ACL Considerations for Actively Managed Species (p. 8 of H.2.a Attachment 1).

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
ABC	(BIOMASS - 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 built into the FRACTION term in the existing rule. Because the CUTOFF term is intended to address economic and ecological issues (OY considerations) it is proposed as a reduction from ABC to ACL.**

- ***Rationale:*** **Analysis consistant with the SSC guidance suggests this alternative is appropriate to deal with scientific uncertainty for both species. In the case of Pacific sardine the lesser value of ABC and ACL will depend on BIOMASS, temperature and the P* policy. For Pacific Mackerel the lesser value of ABC and ACL will depend on BIOMASS and the P* policy.**

OFL	BIOMASS x F_{msy} x DISTRIBUTION
ABC	(BIOMASS x BUFFER) x F_{msy} x DISTRIBUTION
ACL	[(BIOMASS)-CUTOFF] x FRACTION x DISTRIBUTION. Or ABC as defined above, whichever is less

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 13 – ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

Mr. Mike Burner provided an overview of "*Measures for Integrating New Provisions of the Magnuson-Stevens Fishery Conservation And Management Act and National Standard 1 Guidelines Into Coastal Pelagic Species Management"* (Agenda Item H.2.a Attachment 1) and Dr. Kevin Hill presented the section on overfishing limit (OFL), acceptable biological catch (ABC), and annual catch limit (ACL) considerations for Pacific sardine. The Scientific and Statistical Committee (SSC) discussion focused primarily on the sardine harvest control rule (HCR).

At several earlier meetings, the SSC and the Coastal Pelagic Species Management Team (CPSMT) have discussed the extent to which the existing Pacific sardine HCR reflects OFL adjustments that account for scientific uncertainty. The issue is somewhat complex because:

1) sardine assessment uncertainty is the largest of all the Council-managed species that have been examined to date – implying the need for a significant buffer between OFL and ABC;
2) the temperature-dependent F_{MSY} for sardine is unique among F_{MSY} definitions for Council-managed species; and
3) to some extent, the existing sardine HCR provides OFL adjustments – particularly during warm temperature regimes.

Using preliminary results from the SSC's work on "Quantifying Scientific Uncertainty in PFMC Stock Assessments" (Agenda Item E.4.a, Supplemental SSC Report 1), the CPSMT addressed this issue quantitatively for the first time. The analysis, although preliminary in nature, was quite helpful in clarifying the SSC's thinking on this matter.

Prior to the Council's final consideration on the FMP Amendment (June 2010), the SSC suggests that the analysis be revised as follows:

a) update the best estimate of scientific uncertainty for sardine (σ=0.39);
b) in Table 2, re-calculate ABC = BUFFER x OFL (for P* in the range 0.2 – 0.5) and add ACL as the minimum of ABC and the catch resulting from application of the HCR;
c) extend the range of sea surface temperatures (SST) considered to that used in Figure 1; and
d) display results (ABC and ACL) as a function of P*, SST, σ, and biomass (ages 1+).

The SSC would also like to see a critical examination of the SST dependent F_{MSY} function. It is quite likely that there is considerable uncertainty in this relationship (especially for warmer SSTs), and if properly accounted for in the value of σ used for calculating buffers, would increase the OFL buffer appreciably, i.e. decrease the ABC. Over the longer term, the concept and support for the F_{MSY} function should be re-evaluated. The original work was carried out in the late 1990's prior to the resurgence of the sardine stock. Considerably more data are now available and should be examined to ascertain whether or not the original function is still

appropriate. The importance of the F_{MSY} function has increased considerably in light of the new NS1 guidelines.

With regard to the monitored species in the CPS FMP, the ABC alternatives (ABC = 0.25 x BIOMASS or ABC = 0.25 x BIOMASS x BUFFER) should be examined in light of the highly dynamic nature of species such as anchovy. Biomass for such species cannot be estimated on a regular basis. As such, if biomass is estimated at a time of high stock size, the resulting ABC may not be appropriate.

Regarding Section 3.5 (State and Federal Management Considerations), some of the status quo advantages should be reconsidered. For example, it is not likely that continuing to include all current species in the FMP will provide a vehicle to account for climate change, etc.

PFMC
03/07/10

Agenda Item H.2.c
Supplemental Public Comment
March 2010

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February 24, 2010

Mr. Dave Ortmann, Chair &
Dr. Don McIsaac, Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place #200
Portland, OR 97220-1384

RE: Agenda item H.2.c. – Public Comment

Dear Chairman Ortmann, Dr. McIsaac, and Council members,

I have operated sardine vessels out of Astoria, Oregon since 1999. I wish to comment on Amendment 13 of the CPS FMP. I attended the SSC CPS subcommittee meeting in Seattle but without reading the forthcoming supplemental SSC, CPSMT, and CPSAS reports it is hard to be specific but I hope my comments are still relevant.

There is already enough precautionary buffering in the existing HG rule to adequately address the uncertainty represented in both the assessment and management of pacific sardine. The buffer (150,000 mT) is three times the MSST for the fishery and there is a very conservative harvest fraction for the exploitation of the stock. Additionally, within the assessment model are many other things (CV values, etc.) representing and accounting for scientific uncertainty. It seems to me that this is nothing more than inserting a couple of new acronyms into the mix and from there it becomes a semantic interpretation. Maybe I am being too simple but it seems that we are buffering something that is good enough to begin with. I do not feel any more precautionary measures are necessary to ensure the sardine catch does not exceed the ABC. I don't believe a Sigma or P* value provides any better solution than what is already in place. If you recall my letter from the June 2009 meeting (Item B.1.b) you will notice that I am not an advocate of the SST relation to F_{msy} so it is safe to say that I am not a big fan of attaching SST to a P* value. I am hopeful that the HG or ACL or ACT or whatever I'm supposed to call it now is not needlessly reduced any further because of this Amendment to the FMP.

Thank you, as always, for your consideration of this matter.

Regards,

Ryan Kapp

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March 5, 2010

Mr. David Ortmann, Chair
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

RE: Agenda Item H.2 Coastal Pelagic Species Fishery Management Plan Amendment 13 – Annual Catch Limits and Accountability Measures.

Dear Mr. Ortmann and Council Members:

The Pacific Fishery Management Council (Council) and National Marine Fisheries Service (NMFS) are in the process of amending the Coastal Pelagic Species Fishery Management Plan (CPS FMP) to comply with new National Standard One (NS1) guidelines issued in January of 2009. Oceana believes that this process and amendments to the plan are extremely important and we have been engaged in this issue since the Council began discussing it a year ago. This process provides the Council and NMFS the opportunity to advance the long-term conservation and management of fisheries targeting coastal pelagic species, refine ecosystem-based management, including approaches to protect the food web, and ensure the health of the California Current ocean ecosystem and related fisheries. To that end, we offer the following comments on the preliminary draft of CPS FMP Amendment 13.[1]

1. Advance alternatives to identify and designate Ecosystem Component species

Oceana supports many elements of the draft analysis and we believe that the Council and NMFS are essentially on the right track. In particular we support adding forage species to the CPS FMP as Ecosystem Component (EC) species. Forage species like sardine and anchovy, and those identified as potential CPS Ecosystem Component species, play a critical functional role as prey in the marine ecosystem. These forage species are important to many other managed fish species, as well as seabirds and marine mammals. For example, the alternative prey hypothesis suggests that juvenile salmon are more likely to survive when populations of forage species are high, as juvenile salmon then become less likely prey as they leave the coastal estuaries and enter the marine ecosystem.[2]

The NS1 guidelines encourage fishery management councils to incorporate ecosystem considerations into management and to protect marine ecosystems. The rule states that

[1] PFMC, Agenda Item H.2.a Attachment 1.
[2] Emmet, R.L., and D.B. Sampson. 2007. The relationship between predatory fish, forage fishes, and juvenile salmonid marine survival off the Columbia River: a simple trophic model analysis. CalCofi Report, Vol 48.

> *[t]he benefits of protection afforded to marine ecosystems are those resulting from maintaining viable populations (including those of unexploited species), maintaining adequate forage for all components of the ecosystem…*[3]

To achieve this, NMFS encourages the designation of EC species:

> *While EC species are not explicitly provided in the MSA, in the MSRA, Congress acknowledged that certain Councils have made significant progress in integrating ecosystem considerations, and also included new provisions to support such efforts (e.g., MSA section 303(b)(12)). As noted in the preamble of this action,* ***NMFS wants to continue to encourage Councils to incorporate ecosystem considerations,*** *and having classifications for ''stocks in the fishery'' versus ''ecosystem component species'' could be helpful in this regard.*[4]

The Council has made progress in integrating ecosystem considerations and is continuing to do so. Amendment 12 to the CPS FMP prohibited the harvest of krill and is an excellent example. In designating krill as a prohibited species, the Council and NMFS articulated these very reasons.

The final rule stated that

> *protecting krill will help to maintain . . . important ecological relationships and to ensure the long-term health and productivity of the West Coast ecosystem . . . NMFS believes it is critical to take preventive action at this time to ensure that a krill fishery will not develop that could potentially harm krill stocks, and in turn harm other fish and non-fish stocks.*[5]

We request that similar to krill, non-target forage species are added to the FMP as EC species and measures are taken to prohibit directed commercial harvest *unless and until there is a plan in place that shows any such fishing can be conducted without harming the health of the marine ecosystem*, including an ecosystem fishery management plan, stock assessment, and a FMP amendment defining appropriate Annual Catch Limits and Accountability Measures. *We stress that krill should retain its prohibited status, placed within the CPS FMP EC category.* Table 3.1-1 of the preliminary draft of Amendment 13 (pg 15) lists other important forage species that could be included in the EC category. We support continued consideration of adding these species to the CPS FMP as EC species.

The Council has already demonstrated it has the authority and responsibility to take such actions and this authority is clearly stated in the NS1 Final Rule.[6] The final rule also reiterates that management of EC species can be undertaken in order to meet obligations to minimize bycatch

[3] 74 FR 11 at 3207 (January 16, 2009).
[4] Id. at 3185 [emphasis added].
[5] 74 FR 132 at 33372-33373 (July 13, 2009).
[6] Prohibition on directed catch and/or retention can be applied to either a stock that is ''in the fishery'' or an ''ecosystem component'' species. 74 FR 11at 3186 (January 16, 2009).

and protect ecosystem health.[7] As with the management of krill, prohibiting the directed commercial harvest of EC species would achieve these mandates.

2. Status Determination Criteria alternatives must be expanded to include alternative criteria, including analyses of other Minimum Stock Size Thresholds.

Status determination criteria (SDC) are quantifiable factors, including Maximum Fishing Mortality Threshold (MFMT), Overfishing Limit (OFL), and Minimum Stock Size Threshold (MSST), or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished. These are required reference points for stocks that are in the fishery.

The preliminary draft Amendment 13 document contains only two alternatives for status determination criteria—status quo and status quo plus an MSY proxy for the Northern subpopulation of Northern anchovy. Status quo MSST for Pacific mackerel and Pacific sardine is not sufficient, and alternative MSST thresholds must be analyzed and considered.

As stated in the NS1 Final Rule:

> *The MSST or reasonable proxy must be expressed in terms of spawning biomass or other measure of reproductive potential. To the extent possible, the MSST should equal whichever of the following is greater: One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years, if the stock or stock complex were exploited at the MFMT specified under paragraph (e)(2)(ii)(A)(1) of this section. Should the estimated size of the stock or stock complex in a given year fall below this threshold, the stock or stock complex is considered overfished.*[8]

The MSST thresholds identified in the preliminary draft Amendment 13 document do not appear to have been determined in the fashion specified in the final rule. We note that page 20 of preliminary draft Amendment 13 document contains B_{MSY} estimates for Pacific sardine. We request that additional alternatives that meet the final rule be analyzed.

3. Include control measures that set a maximum catch value for targeted species.

An important harvest control for commercially harvested coastal pelagic species is a maximum catch threshold. The Pacific sardine control rule currently employs a maximum catch threshold of 200,000 metric tons but other targeted CPS do not have this control in place.

The CPS FMP states:

> *In addition to the CUTOFF and FRACTION parameters, it may be advisable to define a maximum harvest level parameter (MAXCAT) so that total harvest*

[7] Id. at 3205.
[8] Id. at 3206.

> *specified by the harvest formula never exceeds MAXCAT. The 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 term 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.*[9]

We request consideration of a MAXCAT threshold for other CPS that are "in the fishery" including Pacific mackerel and Northern anchovy. While there may be multiple ways to calculate a MAXCAT value, we suggest at least two alternatives to the status quo, 1) an average of the three highest catches in the past ten years and 2) the average catch of the past ten years, for comparison. This would provide an important control for mackerel and anchovy where stock assessments are either nonexistent or highly uncertain.

4. The FMP must address social, economic and ecological factors used to establish Optimum Yield.

The preliminary draft Amendment 13 analysis does not describe the social, economic and ecological factors that must be addressed in determining Optimum Yield. The NS1 final rule states that

> *[a] Council must identify those economic, social, and ecological factors relevant to management of a particular stock, stock complex, or fishery, and then evaluate them to determine the OY . . . [and] . . . [t]o the extent possible, the relevant social, economic, and ecological factors used to establish OY for a stock, stock complex, or fishery should be quantified and reviewed in historical, short-term, and long-term contexts. Even where quantification of social, economic, and ecological factors is not possible,* ***the FMP still must address them in its OY specification.***[10]

We believe the issue of addressing these factors in the FMP is of specific importance, especially given the importance of managing forage fish stocks for a higher biomass than Bmsy to enhance and protect the marine ecosystem. As stated in the final rule:

> *[The] Magnuson-Stevens Act section (3)(33) defines ''optimum,'' with respect to the yield from a fishery, as the amount of fish that 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; that is prescribed on the basis of the MSY from the fishery, as reduced by any relevant economic, social, or* ***e****cological factor; and, in the case of an overfished fishery, that provides for rebuilding to a level consistent with*

[9] Coastal Pelagic Species Fishery Management Plan. (Amendment 8 to the Northern Anchovy Fishery Management Plan) December 1998, at 4-3.
[10] 74 FR 11at 3207 (January 16, 2009) [emphasis added].

> *producing the MSY in such fishery. OY may be established at the stock or stock complex level, or at the fishery level.*[11]

The final rule further clarifies ecological factors, stating that they include forage fish stocks, other fisheries, predator-prey or competitive interactions, marine mammals, threatened or endangered species, and birds.[12]

The discussion of ecological factors also references the importance of forage species and encourages Councils to manage them in a conservative manner. The final rule states that

> ***consideration should be given to managing forage stocks for higher biomass than Bmsy to enhance and protect the marine ecosystem.***[13]

We believe this is sound advice and encourage the Council to incorporate management measures similar to the conservative measures adopted for the management of krill.

5. Amendment 13 to the CPS FMP must follow the environmental review provisions of the National Environmental Policy Act (NEPA).

The FMP amendment process requires NMFS to follow the environmental review provisions of NEPA. In this instance, Council and NMFS staff have developed a skeleton analysis for an FMP amendment and the Council is poised to make a preliminary decision without providing a draft Environmental Assessment or Environmental Impact Statement, a full range of alternatives, or complete analyses of existing alternatives. We believe that more alternatives should be analyzed and therefore request that the Council not select any preliminary preferred alternatives until a draft environmental analysis can be prepared that fully informs the decisions that are to be made and allowing for meaningful public comment.

In closing, Oceana appreciates the work the Council and NMFS are doing to protect important forage species. We believe that building upon the foundation established with the management of krill and the promulgation of the new National Standard 1 guidelines will successfully advance the long-term conservation of both the California Current ecosystem and the fisheries that depend upon a healthy ecosystem. The development of a successful CPS FMP amendment will achieve both of these results and we look forward to continuing to work with you on this important matter.

Sincerely,

Whit Sheard
Pacific Counsel and Senior Advisor
Oceana

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[11] Id.
[12] Id. at 3208.
[13] Id. [emphasis added].

Agenda Item H.2

NATIONAL COALITION FOR MARINE CONSERVATION
4 Royal Street, S.E., Leesburg, VA 20175

March 1, 2010

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220

RE: Coastal Pelagic Species Amendment 13

Dear Council Members,

The National Coalition for Marine Conservation (NCMC) is a non-profit organization supported by conservation-minded fishermen that promotes an ecosystem-based approach to fishery management, emphasizing protection of the ocean forage base. We have previously submitted comments to the council on the Coastal Pelagic Species Fishery Management Plan, most recently in 2009 regarding implementation of new National Standard 1 guidance on setting annual catch limits for forage fish.[1]

We respectfully submit these comments on the preliminary draft of Amendment 13[2], which we believe contains some positive steps forward in CPS management (see Recommendation #1 below), but unfortunately lacks sufficient analysis to determine if existing harvest control rules meet the requirements of the new Magnuson-Stevens Act and NS 1 Guidelines (Recommendation #2).

Recommendation 1. **Add other important forage species to the CPS FMP and prohibit new fisheries until adoption of an E-FMP**

Overall productivity of west coast fisheries depends on preserving the health and integrity of the food web. To take just one example, the survival of Pacific salmon at sea is dependent, in part, on the abundance and availability of

[1] NCMC letter, May 27; Joint letter with Marine Fish Conservation Network, Oceana and Greenpeace, August 27.
[2] 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 CPS FMP, Draft Preliminary Alternatives and Analyses. February 2010.

forage fish.[3] So we are pleased that the council has included in the Draft Preliminary Alternatives for Amendment 13 an alternative to "add additional forage and/or bycatch species to the CPS FMP as EC species."[4] As the document states, there are many small pelagic species that are critical to the ecosystem as forage but which are not currently the target of commercial fisheries. We support adding these species to the CPS FMP as Ecosystem Component species in order to monitor their status, their role in the food web, and eventually to link fluctuations in their abundance to the abundance of managed CPS and the forage base as a whole. Amendment 13 suggests that monitoring and assessment of these EC species could be performed under the council's developing Ecosystem Fishery Management Plan. In our view, then, **Amendment 13 should feature an explicit prohibition on the development of any new fisheries for EC species until such time as the E-FMP is adopted and appropriate regulatory measures implemented through the CPS FMP.**

Recommendation 2. **Evaluate harvest control rules for compliance with new NS1Guidelines before considering final action on Amendment 13**

The NS1 Guidelines require forage fish FMPs to ensure that ecological factors are considered in setting annual catch limits in order to "maintain adequate forage for all components of the ecosystem."[5] Ecological factors, including fishing impacts on forage fish stocks and predator-prey interactions, are to be quantified and, even where quantification is difficult, the FMP must explicitly address them in its OY specification criteria.[6] "Species interactions that have not been *explicitly* taken into account when calculating MSY should be considered as relevant factors for setting OY below MSY" and councils should consider "managing forage stocks for higher biomass than B_{MSY} to enhance and protect the marine ecosystem."[7]

In Draft Amendment 13, the council acknowledges the need to analyze the existing harvest control rules for Pacific sardine and Pacific mackerel in terms of how they meet the new NS1 requirements; however, this analysis has yet to be done. Making this analysis even more critical is the fact that the document admits inconsistencies in how the CPS Management Team and the SSC interpret the existing control rules *and* presents a confounding explanation of where or how the rules address scientific uncertainty or ecological considerations or provide a buffer against overfishing.[8]

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[3] Emmet & Sampson. The Relationships Between Predatory Fish, Forages Fishes, and Juvenile Salmonid Marine Survival Off the Columbia River: A Simple Trophic Model Analysis. CalCOFI Rep., Vol. 48, 2007.

[4] Alternative 3, page 14

[5] 600.310(e)(3)(iii)(c)

[6] 600.310(3)(iv)

[7] 600.310(e)(3)(iv)(C)

[8] Draft Amendment 13. Pages 8-9.

For instance, CUTOFF is defined as a minimum stock size threshold for rebuilding the spawning stock if the stock becomes overfished, but the document also says it is intended as a "buffer" to address economic and ecological considerations in the OY specification. It is not clear how it can be both; or either, for that matter. In the case of Pacific mackerel, CUTOFF is only 18,200 tons, well below ½ B_{MSY} (the standard definition of an overfished stock).[9] Mackerel is an important forage species, yet there is no analysis to determine if this CUTOFF value is adequate to protect its role as prey in the ecosystem, or if it is adequate, by what measure.

Council members and members of the public have requested a re-evaluation of the CPS harvest control rules to determine how they comply with provisions of the NS1 Guidelines in general and, in particular, how they incorporate ecological factors into the specification of ABC and ACL (OY). Until such an analysis has been performed and made available to the public, the council should withhold action on an amendment that purports to fully integrate new provisions of the Magnuson-Stevens Act and NS1 Guidelines into CPS management.

Thank you for your consideration.

Sincerely,

Ken Hinman

Ken Hinman
President

[9] Dorval et al. Pacific Mackerel Stock Assessment for U.S. Management in the 2008-9 Fishing Season. NOAA Fisheries Service. June 2008. Page 70.

EXEMPTED FISHING PERMITS (EFP) FOR 2010

At its November 2009 meeting, the Council adopted harvest specifications and management measures for the 2010 Pacific sardine fishery. As part of the management measures the Council set aside 5,000 metric tons (mt) of the 2010 harvest guideline (HG) as a research set aside. The intent of the research set aside is to continue and expand on aerial surveys that were conducted in 2008 and 2009 by industry representatives. The Coastal Pelagic Species (CPS) Advisory Bodies advised improving and expanding the research in 2010 by setting aside a portion of the 2010 HG for research that can be conducted, at least in part, outside of the directed fishery. Because all or part of this activity may happen during an otherwise closed period, an exempted fishing permit (EFP) from the National Marine Fisheries Service (NMFS) will be required.

The pilot survey conducted in 2008 was limited to areas in the Pacific Northwest. The 2009 survey expanded into areas off California. Expanding the scope of the survey is of interest to both the scientific and fishing industry representatives who have expressed an interest in expanding the geographic coverage of the survey as well as exploring the use of new survey technologies such as hydroacoustics and satellite imagery. A primary intent of this research is to better inform the assessment of Pacific Sardine abundance. Survey methods used in 2009 have been reviewed and approved for use in the 2010 update of the Pacific sardine assessment, but any new research employed during 2010 will require a thorough peer review before being used in the next full assessment scheduled for 2011. The current proposal for an EFP, submitted by representatives of the fishing industry, is attached as Agenda Item H.3.a, Attachment 1.

At the March meeting the Council is tasked with adopting a proposal for 2010 Pacific sardine research for public review. The Council is scheduled to make final recommendations on EFPs for 2010 at its April 2010 meeting in Portland, Oregon. Should the EFPs be denied and the proposed research not occur, the 5,000 mt set aside is scheduled to be reallocated to the third period (September 15-December 31) of the directed fishery as adopted by the Council in November 2009 and implemented in regulation by NMFS.

Council Action:

Adopt Exempted Fishing Permit for Public Review.

Reference Materials:

1. Agenda Item H.3.a, Attachment 1: West Coast Aerial Sardine Survey 2010 Application for Exempted Fishing Permit.
2. Agenda Item H.3.c, Public Comment.

Agenda Order:

a. Agenda Item Overview — Mike Burner
b. Reports and Comments of Agencies and Advisory Bodies
c. Public Comment
d. **Council Action**: Adopt EFP proposals for Public Review

PFMC
2/16/2010

West Coast Aerial Sardine Survey

2010

Application for Exempted Fishing Permit

Applicants:

Northwest Sardine Survey, LLC
(Jerry Thon, Principal)

and

California Wetfish Producers Association
(Diane Pleschner-Steele, Principal)

Science Advisors:

Tom Jagielo, MSc
Tom Jagielo, Consulting

and

Doyle Hanan, PhD
Hanan and Associates, Inc.

DRAFT

February 17, 2010

Introduction

Advisory bodies of the Pacific Fishery Management Council (PFMC), including the Coastal Pelagic Species Advisory Subpanel (CPSAS), Coastal Pelagic Species Management Team (CPSMT) and the Scientific and Statistical Committee (SSC), have recommended that additional fishery-independent indices of abundance be developed for the assessment of Pacific Sardine.

To meet the stated need for a credible index of sardine abundance, an aerial survey methodology was developed and successfully tested in 2008 by the Northwest Sardine Survey (NWSS), an industry group based in the Pacific Northwest (Wespestad et al. 2009). A stock assessment review (STAR) panel approved the approach in May, 2009, and recommended that it be applied in a coastwide, synoptic survey. The PFMC subsequently approved an Exempted Fishing Permit (EFP) application to conduct a coastwide aerial sardine survey in the summer of 2009, submitted by an industry consortium formed by the Northwest Sardine Survey and the California Wetfish Producers Association (CWPA). Work conducted under the 2009 sardine EFP resulted in a survey that extended from Cape Flattery, WA to Monterey Bay, CA. The results from this survey were reviewed by a STAR panel in September, 2009 and were approved for use in the 2009 Pacific sardine stock assessment. The 2009 Pacific sardine stock assessment, which included the aerial survey index, was subsequently approved by the SSC and the PFMC for use in 2010 management.

The present EFP application is for survey work proposed in 2010. It uses the methodology employed in the 2009 aerial sardine survey, and proposes to extend the coverage area further southward in California, and potentially further northward into Canada -- if Canadian governmental approvals can be obtained. As in 2009, the 2010 application is submitted by two regional industry groups (NWSS and CWPA) who again propose to collaborate to conduct a coastwide survey.

The purpose of this application is to document how the proposed survey meets the NMFS requirements for the approval of an EFP. Specifically, it provides: 1) the scientific study design, analytical methodologies, and a description of the overall logistics (in the main document that follows), 2) a detailed Fieldwork Operational Plan (Appendix I), 3) a point by point discussion of how this EFP application follows the NMFS guidelines for preparation of an EFP application (Appendix II), and 3) documentation supporting the analysis of sample size requirements (Appendix III).

This EFP application is submitted to NMFS to obtain access to the 5,000 mt approved by the PFMC and withheld from the directed fishery management measures for the West Coast sardine OY for the purpose of conducting research surveys in 2010. The two components of the EFP are: 1) the primary coastwide “Summer Aerial Sardine Survey” -- a request for 4,200 mt to repeat the 2009 Summer survey over a larger spatial scale, and 2) the supplemental “Fall Southern California Pilot Study” -- a request for 800 mt to conduct a localized study in the Southern California Bight to evaluate alternative methods

for measuring and potentially improving survey methods to document the sardine biomass.

Sardine harvested under this EFP will be used to help fund the survey research. For the 2010 Summer Aerial Sardine Survey, we propose to apportion the set-aside amount of 4,200 mt equally between the northern and southern regions. The CWPA will conduct aerial survey work and purse seine vessel point sets at-sea from the Oregon-California border southward into the Southern California Bight (Southern region). Likewise, the NWSS-LLC will conduct aerial survey work and point sets from the Canadian border to the Oregon-California border (Northern region). Additional aerial survey work may be conducted by the NWSS-LLC in Canada if approval from the Canadian government is obtained in time to do so. For the Fall California Pilot Study, we propose to apportion the additional set-aside amount of 800 mt to the CWPA, who will be responsible for funding and conducting this activity.

Scientific accountability for the 2010 Summer Aerial Sardine Survey will be provided by Mr. Tom Jagielo for the Northern region, and by Dr. Doyle Hanan for the southern region. Dr. Hanan will also oversee day to day activities for the Southern region, in daily communication and cooperation with Northwest principals. Under the direction of Mr. Jagielo, Mr. Ryan Howe will oversee the day to day activities of the Northern region. Mr. Howe will also coordinate coastwide consistency in data collection, data archiving, and data reduction. Mr. Jagielo will have the primary responsibility to analyze the coastwide data from the Coastwide Summer Aerial Sardine Survey and will report the results to Dr. Kevin Hill, NMFS, SFSC, in a form suitable for input to the stock assessment model. Dr. Hanan and Mr. Howe will be available to help with data analysis as requested.

To comply with NMFS requirements for this project, Dr. Hanan will serve as the West Coast Aerial Survey project Single Point of Contact (SPC) (858)518-2233, drhanan@cox.net).

The CWPA will administer the 2010 Fall California Pilot Study. Dr. Hanan will be solely responsible for providing scientific leadership and operational oversight for this activity, and Tom Jagielo will be available to provide advice and help with analysis as requested.

A. Coastwide Summer Aerial Sardine Survey (July-August, 2010)

I. Survey Design – Coastwide Summer Aerial Sardine Survey

The coastwide Summer Aerial Sardine Survey employs a two-stage sampling design. Stage 1 consists of aerial transect sampling to estimate the surface area (and ultimately the biomass) of individual sardine schools from quantitative aerial photogrammetry; Stage 2 involves at-sea sampling to quantify the relationship between individual school surface area and biomass. Sampling will be conducted in July (following closure of the directed fishery), through August, and potentially into early September of 2010 by NWSS

in the Northern region, and by CWPA in the Southern region. Logistical details of the survey are provided in Appendix I (West Coast Aerial Sardine Survey - 2010 Field Operational Plan).

Stage 1: Aerial Transect Survey

Logistics

The 2010 aerial survey employs the belt transect method using a systematic random sampling design, with each transect comprising a single sampling unit (Elzinga et al. 2001). Parallel transects will be conducted in an east-west orientation, generally parallel to the gradient of sardine schools distributed along the coast. Three alternative fixed starting points five miles apart were established, and from these points, three SETs of 66 transects were delineated for the survey. The order of conducting the three replicate SETs will be chosen by randomly picking one SET at a time without replacement. The east and west endpoints of each transect and corresponding shoreline position are given in Appendix I, Tables 1a-c and are mapped in Appendix I, Figures 1a-c for each of the three replicates (SET A, SET B, and SET C, respectively). Transects start at 3 miles from shore and extend westward for 35 statute miles in length; they are spaced 15 nautical miles (15 minutes) apart in latitude. In addition to the 35 statute mile transect, the 3 statute mile segment directly eastward of each transect to the shore will be flown and photographed. Survey biomass will be estimated from the 3-35 mile transect data; analysis will also be conducted for the distance 0-3 mile segment and biomass estimated to evaluate the potential need for future modification of the survey design.

Time and weather permitting, additional opportunistic scouting may be conducted longitudinally (in a north/south orientation in the area offshore of the established 35 mile long east/west transects), for the purpose of locating sardine schools westward of the established survey area. If the westward distribution of sardine is found to extend substantially beyond the established east/west transects, future modification of the survey design will made, accordingly.

Details regarding the airplanes and pilots participating in the survey, a description of the order in which transects will be flown to avoid “double counting”, and other operational specifics are described in Appendix I.

Data Collection and Reduction

Each survey plane will be equipped with the same photogrammetric aerial digital camera mounting system and data acquisition system that was used in the 2009 aerial sardine survey (Aerial Imaging Solutions; Appendix I, Adjunct 1). This integrated system will be used again to acquire digital images and to log transect data. The system records altitude, GPS position, and spotter observations, which are directly linked to the time stamped quantitative digital imagery. At the nominal survey altitude of 4,000 feet, the approximate width-swept by the camera with a 24 mm lens is 1,829 m (1.13 mi). Digital images will be collected with 60% overlap to ensure seamless photogrammetric coverage along transects.

A Transect Flight Log Form will be kept during the sampling of each transect for the purpose of documenting the observations of the pilot and/or onboard observers (Appendix I, Adjunct 2). Key notations will include 1) observations of school species identified and 2) documentation of any special conditions that could have an influence on interpreting the photographs taken on the transect.

In order to provide ground truth information and a cross comparison between survey aircraft, digital imagery of certain land-based features of known size (e.g. an airplane hangar, a football field, or a set of tennis courts) will again be collected at a series of altitudes ranging from 500 ft. to 4,000 ft. The observed vs. actual sizes of the objects will subsequently be compared to validate camera performance and to evaluate photogrammetric error.

Digital images from the survey will be analyzed to determine the number, size, and shape of sardine schools on each transect. Adobe *Photoshop Lightroom 2.0* software will be used to bring the sardine schools into clear resolution. Measurements of sardine school size (m^2) and shape (circularity) will be made using Adobe *Photoshop CS3-Extended*. Transect width will be determined from the digital images using the basic photogrammetric relationship:

$$\frac{I}{F} = \frac{GCS}{A}$$

and solving for *GCS*:

$$GCS = \frac{I}{F}A$$

where I = Image width of the camera sensor (e.g. 36 mm), F = the focal length of the camera lens (e.g. 24mm), A = altitude, and GCS = "ground cover to the side" or width of the field of view of the digital image. Transect width will be obtained by taking the average of *GCS* for all images collected on transect. Transect length will be obtained from the distance between start and stop endpoints using the GPS data logged by the data acquisition system.

Data Analysis

Estimation of total sardine biomass for the survey area will be accomplished in a 3 step process, requiring: 1) measurement of individual school surface area on sampled transects, 2) estimation of individual school biomass (from measured school surface area and estimated school density), and 3) transect sampling design theory for estimation of a population total.

Individual school surface area (a_i) will be measured on the photo-documented transects using the measurement tool feature of *Adobe Photoshop,* employing the photogrammetric relationships described above. Individual school density (d_i) is specific to school size and will be determined from the empirical relationship between surface area and biomass obtained from Stage 2 (point-set) sampling (described below). Individual school biomass (b_i) is estimated as the product of school density and surface area ($b_i = d_i a_i$). The sum of individual school biomass (b_u) will then be determined for each transect (u). The mean sampled biomass for the study area ($\bar{b}$) is computed as:

$$\bar{b} = \sum_{u=1}^{n} b_u \ / \ n \ .$$

Total biomass for the study area $\left(\hat{B}\right)$ will be estimated using the unbiased estimator for a population total (Stehman and Salzer 2000),

$$\hat{B} = N\bar{b} \ ,$$

with estimated variance

$$\hat{V}\left(\hat{B}\right) = \frac{N^2\left(1 - \frac{n}{N}\right)s_e^2}{n}$$

where N = the total number of transects possible in the region, *n* = the number of transects sampled in the region, and s_e^2 is the sample variance of $\bar{b}$ (Cochran, 1977). The total number of transects possible in the region (N) is calculated by dividing the width of the entire region (W) by the average transect width (w).

The variance of the biomass estimate will also be determined by using the method of bootstrapping to propagate error from Stage 1 and Stage 2 sampling, as described below under the heading "Evaluation of Sample Size Requirements for Stage 1 and Stage 2 Sampling". This estimate of variance will be provided, along with the point estimate of biomass, to the NMFS/SWFCS for use in the 2010 Pacific sardine stock assessment.

Stage 2: At-Sea Point Set Sampling

Logistics

Empirical measurements of biomass will again be obtained by conducting research hauls or "point sets" at sea. Point sets are the means used to determine the relationship between

individual school surface area (as documented with quantitative aerial photographs, described above) and the biomass of individual fish schools. Four purse seine vessels will participate in the survey in the Northern region (NWSS) under the direction of Mr. Thon. Eight vessels will participate in the Southern region (CWPA) under the direction of Dr. Hanan; 4 from Monterey and 4 from S.CA. Considering the broad area to be covered, we request 4 vessels to operate in each area per 24-hour period. The identification and gear configuration of the participating vessels is given in Appendix I, Adjunct 3.

For the purposes of the aerial survey, a valid point set is defined as a sardine school first identified by a survey pilot and subsequently captured in its entirety by a survey purse seine vessel. Before setting by the purse seine vessel, a target sardine school will be identified by the spotter pilot at an altitude of 4,000 ft, which is the nominal altitude specified for survey transects. The criteria that will be used for determining the acceptability of point sets for the school density analysis are given in Appendix I, Adjunct 4. Attempts will be made to conduct point sets over as wide an area as feasible; however, point sets may occur in any area covered by aerial transects where sardine schools of the desired size are found. Additional details on the logistics of point set sampling are provided in Appendix I.

Data Collection and Reduction

For fully captured schools, the 1) total weight of the school, 2) numbers per unit weight, and 3) species composition will be determined from biological sampling of the point set hauls (see below). Additionally, school height in the water column will be recorded from vessel sonar and down-sounder equipment.

The point set sampling design is based on school size, with the goals of: 1) obtaining a range of sizes representative of schools photographed on the transects, and 2) keeping within a size range consistent with the safe operation of the vessels participating in the survey. Thus, point sets will generally not be attempted for schools larger than approximately 130 mt. Point set sampling will be distributed between the Northern and Southern regions, with 2,100 mt available for point sets for each area in 2010. A total of 56 point sets are planned for the north, and 56 for the south (Appendix I, Table 2).

In developing the recommendation for the number of point set samples needed for the aerial sardine survey in 2010, consideration was given to obtaining more data points for the area-biomass regression in the region between 2,000 and 10,000 m^2 (Figure 1). The purpose of getting more data points in this size range is to better determine the asymptote of the relationship and thus to better estimate the biomass of the largest schools observed. In order to distribute the samples across the full range of size categories, and to sample the larger schools with an adequate sample size (e.g., n = 32 for the 2,000-10,000 m^2 size range), an overall sample size of n=56 point sets was proposed. This sampling schedule will make efficient use of 2,100 mt per region; a total EFP set-aside of 4,200 mt coastwide for the Summer Survey.

An evaluation of sample size requirements, derived from a simulation analysis using 2009 survey data, is discussed below. While it is clear that a larger sample size would be beneficial, the proposed sample size of n = 56 point sets per region is a realistic request with the resources available.

Data Analysis

The relationship between school surface area and biomass will be determined by fitting the three parameter Michaelis-Menten model assuming log-normal error, i.e., ln(Density) = (a + b*Area)/(c+Area) to the observations of school surface area and biomass obtained from the valid point sets.

Biological Sampling of Point Sets

Fishermen participating in the survey will keep the point set hauls in separate holds upon capture so the tonnage of each aerially photographed and measured haul can be determined separately upon landing. Fish will be collected at fish processing plants upon landing. Samples will be collected from the unsorted catch while being pumped from the vessels. Fish will be taken systematically at the start, middle, and end of each set as it is pumped. The three samples will then be combined and a random subsample of fish (n = 50) will be taken from the pooled sample. Length, weight, sex, and maturity data will be collected for each sampled fish. Sardine weights will be taken using an electronic scale accurate to 0.5 gm; lengths will be taken using a millimeter length strip provided attached to a measuring board. Standard length is determined by measuring from sardine snout to the last vertebrae. Sardine maturity will be documented by referencing maturity codes (female- 4 point scale, male- 3 point scale) supplied by Beverly Macewicz NMFS, SWFSC (Appendix I, Table 3). A subsample of 25 fish from each point set sample will be frozen and retained for collection of otoliths.

Evaluation of Sample Size Requirements for Stage 1 and Stage 2 Sampling

In order to develop sample size recommendations for the Coastwide Summer Aerial Sardine Survey, an analysis of the data collected in 2009 was conducted to evaluate the effect of varying the number of transects (from Stage 1 sampling) and point sets (from Stage 2 sampling) on the variability of the final estimate of sardine population biomass from the survey.

A stochastic simulation algorithm was coded using *R (version 2.10.1)* statistical analysis software, for the purpose of estimating the variance of the survey biomass estimator. Sampling error from Stage 1 and Stage 2 sampling was propagated through to determination of the final biomass estimate. The simulation proceeded as follows: 1) bootstrap re-sampling was conducted on the transect data from the 2009 survey, 2) a variance co-variance matrix for the three parameter Michaelis-Menten function was derived for the 2008-2009 survey point set data using the method of Markov-Switching, Bayesian, Vector Autoregression *(MSBVAR, version 0.4.0)* (Appendix III, Adjunct 1), and 3) a distribution of the Michaelis-Menten parameters was generated, sampled, fitted with the regression function, and used to generate a distribution of new biomass

estimates. The process was repeated for 10,000 bootstrap replicates. The *R* code developed for this purpose is presented in Appendix III, Adjunct 2. An example of 20 randomly drawn parameter fits to the point set data is given in Figure 2, and the distribution of biomass from 10,000 bootstrap runs is given in Figure 3, below.

The simulation described above was also used to generate simulated data sets of varying size, to evaluate how the variance on the final biomass estimate varies as the number of point sets increases. The simulated data sets ranged in size from n = 23 to n = 189. For each data set size, at least 100 data sets were generated and used to calculate an average CV of the simulated biomass estimates. An additional set of simulations was run with the number of transects doubled from the actual number (41) to 82. Examples of the *R* code developed for these simulations are presented in Appendix III, Adjuncts 3 and 4, respectively. An example of 20 randomly drawn parameter fits to three different generated data sets, where n = 95 point sets, is given below in Figures 4a, 4b, and 4c.

The results of the sample size simulations are presented in Table 1 and Figure 5, below. For n = 41 transects, the biomass CV ranged from 0.74 to 0.54, and leveled out around n = 125 point sets. A similar trend was observed for n = 82 transects; CV declined from 0.55 to 0.39 at the sample sizes of 23 vs.189 point sets, respectively.

These results show the value of obtaining additional point sets to reduce the uncertainty of the survey biomass estimate. They also illustrate that improving the level of transect sampling can also be expected to reduce the overall variance of the biomass estimate. As noted above, the proposed sample size of n = 56 point sets per region, totaling 112 point sets, is a realistic request given the time constraints and resources available.

II. Survey Logistics - Coastwide Summer Aerial Sardine Survey

A description of: 1) the roles and responsibilities of project personnel, 2) EFP purse seine vessel selection, 3) the disposition of fish harvested under the EFP, and 4) the project budget, are provided below. Additionally, a detailed Field Operational Plan is presented in Appendix I, and a point by point discussion of NMFS EFP guidelines and requirements is presented in Appendix II.

Project Personnel: Roles and Responsibilities

Industry Coordinators (Applicants):

Name:	Ms. Diane Pleschner-Steele
Affiliation:	Executive Director, California Wetfish Producers Association
Address:	PO Box 1951, Buellton, CA 93427
Email:	dplesch@earthlink.net
Phone:	(805) 693-5430

Role: Industry EFP Co-Applicant: CWPA (Southern region)

Responsibilities: Coordinate sale of EFP sardine from Southern region with participating processors. Administrate EFP funds collected in Southern region; direct funds as required to accomplish the projects scientific objectives in the Southern region. Contract with scientists, vessels, pilots, and others as needed to execute the project in the Southern region under direction of Dr. Hanan (Science Advisor).

Name: Mr. Jerry Thon
Affiliation: Principal, Northwest Sardine Survey, LLC
Address: 12 Bellwether Way, Suite 209, Bellingham, WA 98225
Email: jthon2@msn.com
Phone: (360) 201-8449

Role: Industry EFP Co-Applicant: NWSS-LLC (Northern region)

Responsibilities: Coordinate sale of EFP sardine from the Northern region with participating processors. Administrate EFP funds collected in Northern region; direct funds as required to accomplish the projects scientific objectives in the Northern region. Contract with scientists, vessels, pilots, and others as needed to execute the project in the Northern region under direction of Mr. Jagielo (Science Advisor).

Scientific Advisors (see Appendix II, Adjunct 1 for Resumes and Curriculums Vitae):

Name: Mr. Tom Jagielo, MSc
Affiliation: Tom Jagielo, Consulting
Email: TomJagielo@msn.com
Phone: (360) 791-9089

Role: Science Advisor, Coastwide Summer Aerial Sardine Survey

Responsibilities: Develop, and modify as needed, the Coastwide Summer Survey design. Provide scientific guidance and oversight for project execution. Analyze Coastwide Summer Survey data. Prepare final report. Provide survey results in a form suitable for use by NMFS/SWFSC in the Pacific sardine stock assessment. Represent the project in public fora (e.g. PFMC, STAR panels, SSC) to present and interpret scientific results from the Coastwide Summer Survey. Assist with data analysis of Fall California Pilot Study as requested.

Name: Dr. Doyle Hanan, PhD
Affiliation: Hanan & Associates, Inc.
Email: drhanan@cox.net
Phone: (858) 518-2233

Role: Single Point of Contact (SPC) for 2010 EFP Field Work
Scientific Field Lead, Southern region, Coastwide Summer Survey
Science Advisor, Fall California Pilot Study

Responsibilities: Provide daily Field Reports as SPC for the coastwide summer survey as required by NMFS under the EFP. Coordinate collection and ensure scientific validity of Field Data from the coastwide summer survey specific to the Southern region. Provide field data collected in the Southern region to Mr. Howe and Mr. Jagielo for compilation into the coastwide summer survey data analysis. Assist with data analysis and preparation of final report. Present project results as appropriate and/or required. Additionally, provide scientific direction and leadership to the Fall California Pilot study.

Scientific staff:

Name: Mr. Ryan Howe, BSc
Affiliation: Consultant
Email: ryanhowe9@yahoo.com

Role: Scientific Field Lead, Northern region, Coastwide Summer Survey
Coastwide Data Coordinator, Coastwide Summer Survey

Responsibilities: Under direction of Mr. Jagielo, coordinate collection and ensure scientific validity of Field Data from the coastwide summer survey specific to the Northern region. Additionally, compile data collected in both the Northern and Southern regions for coastwide summer survey data analysis, working with Dr. Hanan to coordinate consistency of data collection coastwide. Provide scientific direction and leadership of photogrammetric analysis staff. Assist with coastwide summer survey data analysis and preparation of final report. Present project results as appropriate and/or required. Assist with data analysis of Fall California Pilot Study as requested.

EFP Purse Seine Vessel Selection

Our priorities for selecting vessels to participate under this EFP include: 1) vessels having the ability to separate the point sets into different hatches, 2) vessels committing to follow scientific protocol as directed during this study period, and 3) vessels that have installed or have the capacity to install or carry any electronic equipment necessary.

With the narrow time window for sampling it is desirable to have a field of boats we can draw on. The main reason to have several boats in this period is to maximize the number of point sets we can bring in during optimum weather and sea conditions. These boats will only be used for point sets. Some vessels do not have recording sounders, but all vessels do have sonar's that can measure school height and log it. Having a slate of potential vessels to draw from removes the possibility of losing operational days from problems like engine failure. Being able to pick vessels from the list of available boats, and reporting the vessels that will be operating at any given time to local enforcement will help to meet the EFP goals efficiently and cost-effectively. We request approval to deploy eight vessels per 24 hour period in the south (four in Monterey and four in S.CA.) and up to four vessels per 24 hour period in the north.

Disposition of fish harvested under the EFP

Fish harvested under this EFP will be sold to help fund the sardine research described above. Participating processors receiving point set EFP product in California from sardine quota set-aside to CWPA and in the Northwest from sardine quota set-aside to NWSS-LLC will be identified prior to any fish deliveries made under this EFP, and they will process the fish by bid. Fish Tickets will be tabulated to verify that the sardine harvested under the EFP do not exceed the amount of harvest allocated for the research set-aside to the recipients, and that the amounts harvested correspond to the total of the amounts harvested while conducting the point set research.

Budget

An itemized budget is provided as Appendix II, Adjunct 2. The amount of funds that will be available to the project from the sale of sardine harvested and sold under the EFP is of necessity a rough estimate; this number will be refined as bids for processing are received and the amount of funds potentially available can be established. On the cost side, we have detailed components of the project that will be required to complete the work proposed. Field work always includes uncertainty (weather, fish availability, etc.) and contingency amounts have been included to attempt to address some of this uncertainty.

The financial structure of the project is as follows:

1. Funds derived from the capture and sale of the sardine research set-aside will be used to pay for the research to be conducted under this proposed EFP. The costs of the project in California will be the responsibility of the CWPA from their 2,100 mt portion and in the Northwest will be the responsibility of the NWSS-LLC from their 2,100 mt portion. Costs will be paid for by the sale of the fish captured during the point sets.

2. Fishing vessels will be chartered by NWSS-LLC and CWPA to catch the sardines during point sets and conduct echo soundings of fish schools with ES-60 or other suitable electronic equipment.

3. Participating processors will not profit on the sale of the EFP sardine quota; rather, they will process the fish at cost. The NW processor(s) for this project will be chosen after submitting bids. The lowest bids will be accepted. CWPA has identified processors who have volunteered to participate in this research according to the provisions of this EFP.

4. Airplanes conducting the photo surveys and assisting in point set captures will work under hourly rates or by contract to CWPA and/or NWSS-LLC.

5. Equipment needs, and operational costs including scientific support will be paid for by the CWPA and the NWSS-LLC from the sale of their individual 2,100 mt research quotas. Joint expenses of Mr. Jagielo (Science Advisor) to design the research plan, attend STAR panel and Scientific Team Meetings before during and after the survey period will be borne by each side equally. Costs incurred by the Science Advisors and Scientific Staff to deal specifically with CWPA or the NWSS-LLC will be billed directly to that group only. We anticipate the revenue from the fish sales will be sufficient to cover the costs to capture, process, and conduct the survey. In addition, CWPA has established a special sardine assessment on its membership to offset any expenses not covered by the sale of EFP research fish.

B. Fall Southern California Pilot Sardine Survey EFP Application as a supplement to the summer sardine aerial survey

1. Applicant Information (see cover sheet)

2. Justification for inclusion of this pilot study in the EFP

Under the proposed EFP, the West Coast Sardine Survey (a consortium of Pacific Northwest and California sardine industry participants) plans to conduct, for the second year, a semi-synoptic survey of the sardine biomass along the U.S. West Coast, employing the methodology approved by STAR panels and the SSC in 2009. The summer survey is conducted during daylight, collecting aerial photographic data in conjunction with fishing vessel observation, biological and 'point set' volume data, which is used to calibrate aerial photos.

Repeating the summer aerial survey in 2010 is important to reduce uncertainty. Sardines are visible seasonally during daylight hours in California as in the Pacific Northwest, however, these fish are also observed and may be more readily measured at night in California. Sardine abundance peaks in California during fall and winter months (historically California's peak fishing season). Thus industry and participating scientists request a small portion of this EFP, not to exceed 800 mt, be designated to permit scientists to investigate and further improve survey methodology by evaluating the use of lidar, acoustics, and night-time bioluminescence photography in addition to daylight photography methods used in the summer survey to estimate sardine abundance.

This pilot study allows identified vessels to catch Pacific sardine, both day and/or night as directed by the principal investigator (Dr. Doyle Hanan), during October-November 2010, a time when the directed fishery is typically closed. The aerial component of the

study consists of transects placed in a designated area of southern CA along and adjacent to the fall CalCOFI cruise tracks, extending out 75 miles from the mainland, and will be conducted in conjunction with the fall CalCOFI survey. The goal is to develop and refine survey methodology for review by STAR panel in 2011, for potential inclusion in future sardine stock assessments.

3. Broader significance of the EFP

This EFP pilot study builds on existing aerial survey methods by linking aerial surveys with ship-based acoustic assessments performed during the fall 2010 CalCOFI cruise, and evaluating additional survey techniques, e.g. lidar, and night vs. day photography, to improve survey methodology with a goal to provide additional fishery-independent data to enhance and improve sardine school detection. For example, lidar techniques detect schools at deeper depths from the surface than photographic optics.

By allowing for sardine research harvest during the fall closed period, this addition to the EFP will facilitate expansion of both the geographical area and time of survey coverage in 2010, including a period when sardines are most abundant in southern CA. Due to the very short fall directed fishing period (the directed fishery closed before the end of September in 2008 and 2009), this research cannot be accomplished at the desired time without an Experimental Fishing Permit. By approving a small portion of the research set aside for this pilot, it will be possible to achieve the scientific objective of conducting point sets to calibrate aerial, lidar and acoustic measurements as detailed in the operational plan for the fall pilot project (Appendix I). Moreover, the research to be conducted under this EFP will further test new, scientifically rigorous methods to survey the Pacific sardine resource, and will potentially provide valuable Pacific sardine stock assessment data to the Council and to NOAA Fisheries. This type of information is considered a high priority research and data need by NOAA Fisheries.

4. Description and quantity of species to be harvested under the EFP

At its November 2009 meeting, the Council approved 5,000 mt of the 2010 Pacific sardine Harvest Guideline for sardine research to be conducted under an EFP. In recommending 5,000 mt be set aside for research, participating scientists proposed to allocate 2,100 mt each to PNW and CA for the summer aerial survey (a table recommending distribution of the point sets, totaling 4,200 mt, was included in the 2009 EFP final report). The remaining 800 mt were proposed for a fall pilot project in S.CA. The total amount of sardines designated for harvest under this pilot will not exceed 800 mt. A table illustrating distribution of point sets is included in the Study Design for this element. This recommendation is awaiting final Council and NMFS approval of the EFP application and NMFS rulemaking.

5. Description of mechanism to ensure that harvest limits for targeted and incidental species are not exceeded

Under this EFP, all species caught will be retained, documented and reported. The most common incidental catches in the sardine fishery are other CPS species, i.e. Pacific mackerel, jack mackerel, market squid and northern anchovy. The PFMC website notes that, according to NMFS Biological Opinion, "… fishing activities conducted under the

CPS FMP are not likely to jeopardize the continued existence of any endangered or threatened species." It is not expected that any fishing under this EFP would have any effect on any endangered or threatened species. We do not expect more than a nominal amount of incidental species to be landed.
As in the summer survey, individual point set catches in the fall study will be kept in separate vessel holds and will be individually weighed at the dock upon landing. Participating vessels will deliver all species to identified processing/freezing facilities within the survey area. It is anticipated that deliveries will occur into southern California ports, i.e. San Pedro, during the fall pilot. Each participating vessel and processing facility will be responsible for collecting and recording catch data for each species delivered. Each participating processor will be responsible for issuing and reporting fish tickets to State authorities, as required by law. Each participant will also be required to report all catch and fish ticket data to the Dr. Hanan on a daily basis.
Individual point set sardine catch weights will be tallied by Dr. Hanan to monitor the attainment of the project sample size goals, which specify that point sets are to be collected in specific size categories (small and large) required under the survey design. Any bycatch of other species will be retained and a tally of the catch by species will also be maintained by Dr. Hanan. Daily reporting is necessary to achieve the project objectives as specified in the Survey Design section of the main document. This detailed accounting of daily and incidental catches will allow for detailed daily reporting to NMFS authorities and will ensure that the 800 mt sardine set aside reserved for this pilot project will not be exceeded. Participating processing facility [ies] will process and sell EFP sardines at cost, as with the summertime aerial survey. These sales, along with contributions from industry participants, will be used to aid in funding the research.

6. Expected total duration of the EFP
This portion of EFP will be valid during October and November, 2010, allowing for catching of Pacific sardine after the expected closure of the fall period directed fishery.

7. Number of vessels covered under the EFP
Four purse seine vessels are identified from the Southern California area on the list of EFP vessels and will be operating under the direction of the principal investigator. The CalCOFI research vessel (on its regularly scheduled transect lines) and a small NMFS or industry-contracted research boat will perform hydroacoustic assessments on and/or near CalCOFI track lines.

9. Description of data collection and analysis methodology
This information is described in detail in the Survey Design section below and in the main summer survey document.

10. Description of how participating vessels will be chosen for this study
Our priorities for selecting vessels to participate under this portion of the EFP include: 1) vessels having the ability to separate the point sets into different hatches; 2) vessels committing to follow scientific protocol as directed during this study period, 3) vessels that have installed or have the capacity to install or carry any electronic equipment

necessary. Additionally, vessels must meet the PFMC eligibility requirements for participating in an EFP fishery as described in Council Operating Procedure No. 19, and must also hold necessary State and Federal permits required for the fishing of Pacific sardine/Coastal Pelagic Species.

11. Approximate times and places fishing will occur and description of gear to be used for each participating vessel

Under this EFP supplement, participating vessels will have the opportunity to catch a total not to exceed 800 mt of Pacific sardine under the Council recommended 5000 mt set-aside for dedicated sardine research during the closed period. Fishing will take place in the southern California Bight around and adjacent to established aerial transect lines and CalCOFI cruise tracks, under the direction of the principal investigator. Participating vessels will use purse seine gear. Please see attached transect locations. All EFP fishing will be conducted within the range of the proposed transects. Primary ports of landing will be San Pedro and/or Port Hueneme, California. All fishing by participating vessels will be done in compliance with state and federal regulations, including the conditions and exemptions granted by this EFP

C. Exempted Fishery Permit Application - Conclusion

In summary, the proposed EFP will contribute substantially toward improving the data available to assess the sardine stock for management on the Pacific Coast. Building on the successful survey work conducted and used in the 2009 stock assessment, the EFP research study in 2010 will enable us to obtain a second coastwide biomass estimate. In addition, the fall pilot survey will assess alternative survey methods and develop protocol for review in the 2011 sardine STAR panel. These additional methods, such as lidar and acoustics, are proven biomass survey techniques employed in other fisheries and may improve and facilitate expansion of future biomass estimates for sardine. The research set-aside of OY under the EFP will provide a reliable source of funds and will allow us to conduct our work in a controlled, methodical manner, separate from the race for fish which ensues during the directed fishery. This will enable us to obtain a larger and more representative sample of point sets to more precisely and accurately estimate sardine school density – an important parameter needed for sardine biomass estimation using the aerial survey method.

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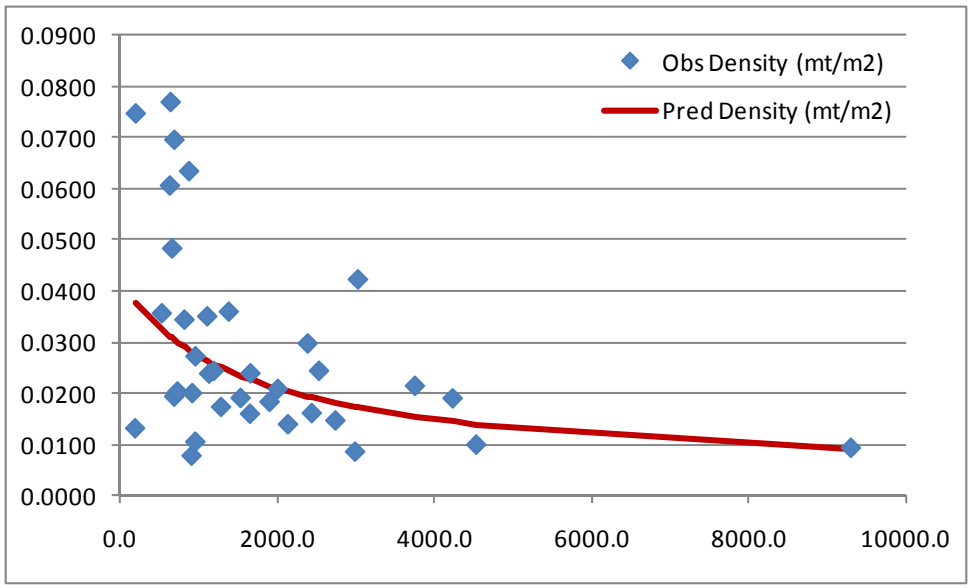
Figure 1. Relationship of surface area (m^2) (x axis) vs. density (y axis) determined from point sets sampled in 2008 and 2009. Obs: actual point-set data; Pred: model-estimate of density.



Tom
Sticky Note

Figure 2. Plot of 20 point set bootstraps to the 2008 and 2009 point set data.

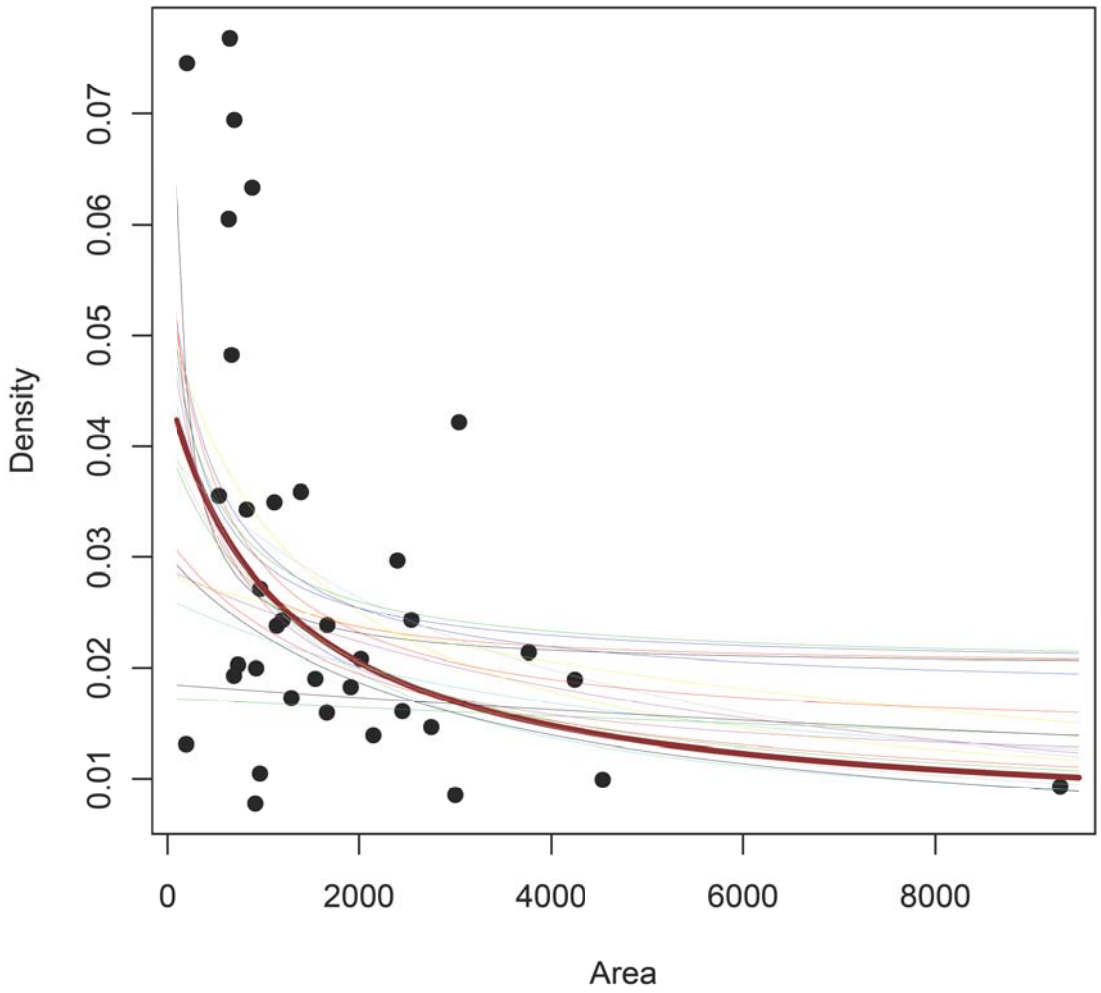


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Figure 3. Distribution of sardine biomass from 10,000 bootstrap replicates.

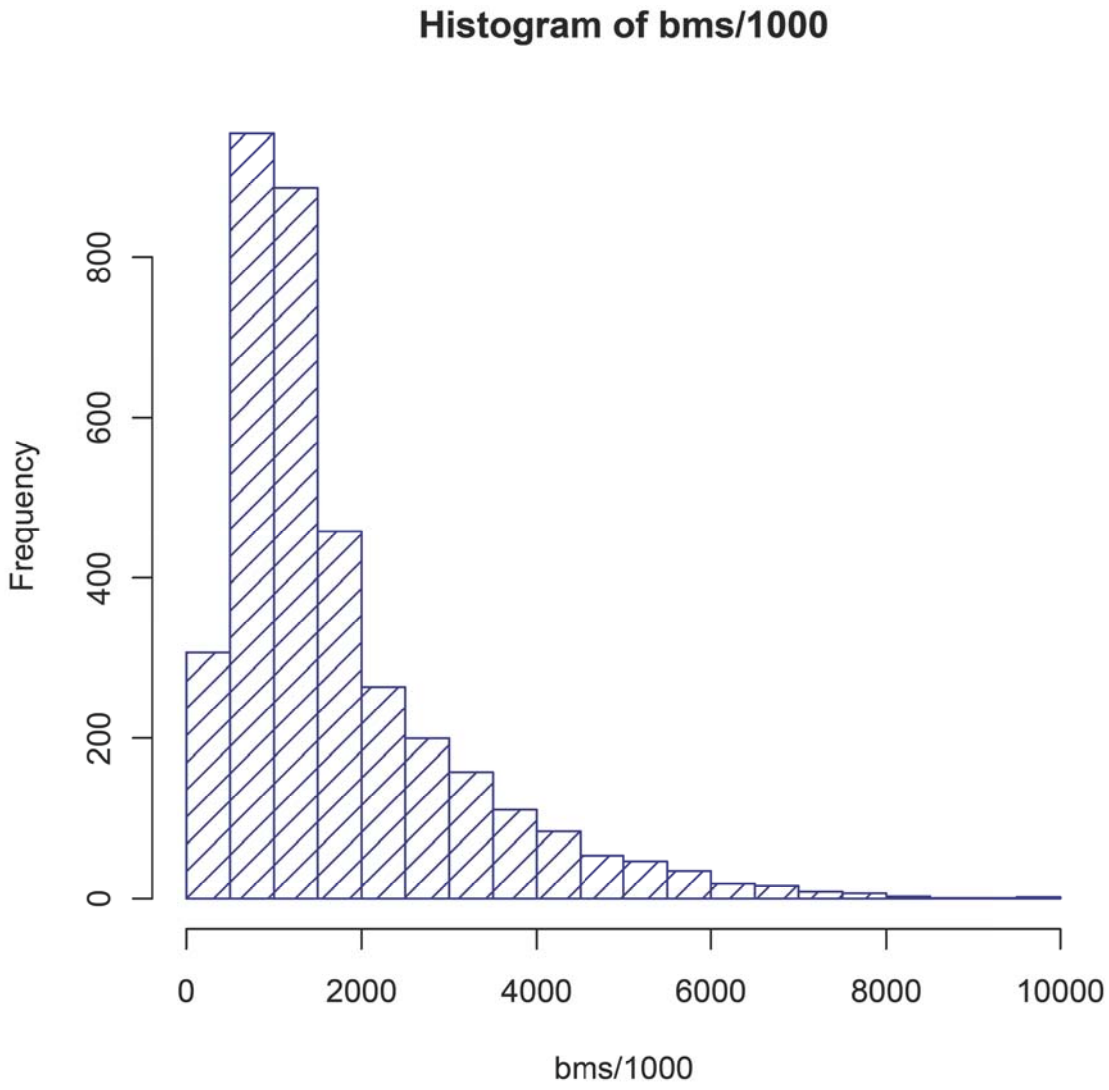

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Figure 4a. Example of regression fit to generated point set data; n = 95 point sets.

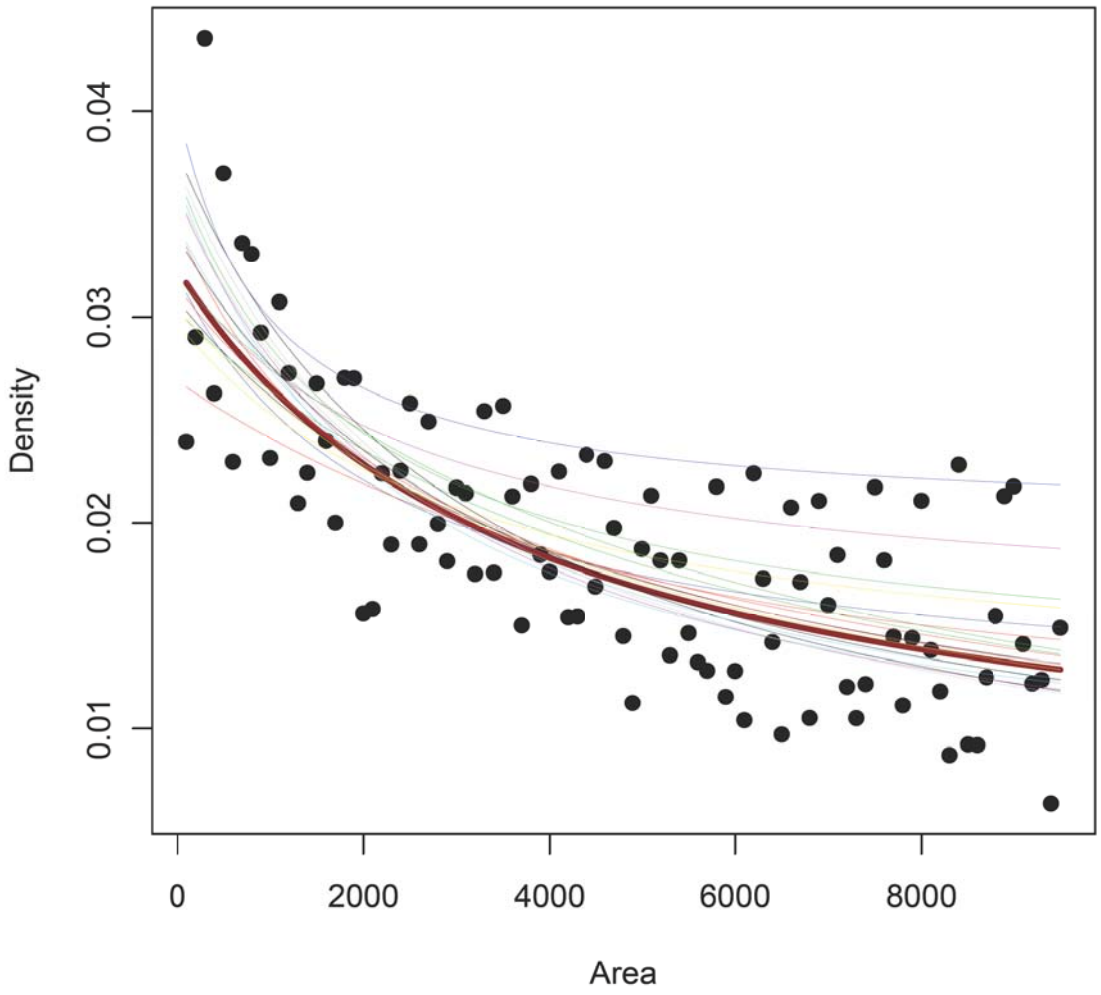

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Figure 4b. Example of regression fit to generated point set data; n = 95 point sets.

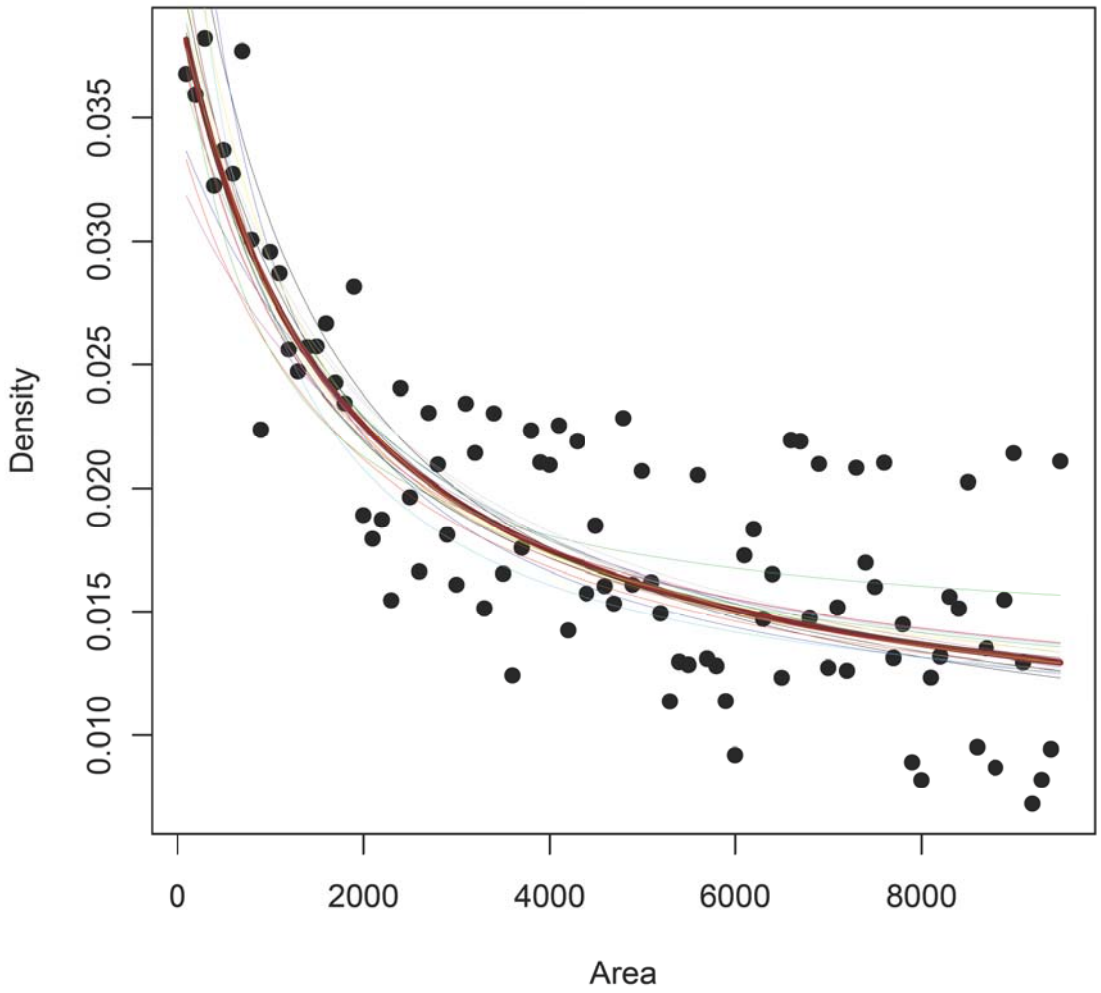

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Figure 4c. Example of regression fit to generated point set data; n = 95 point sets.

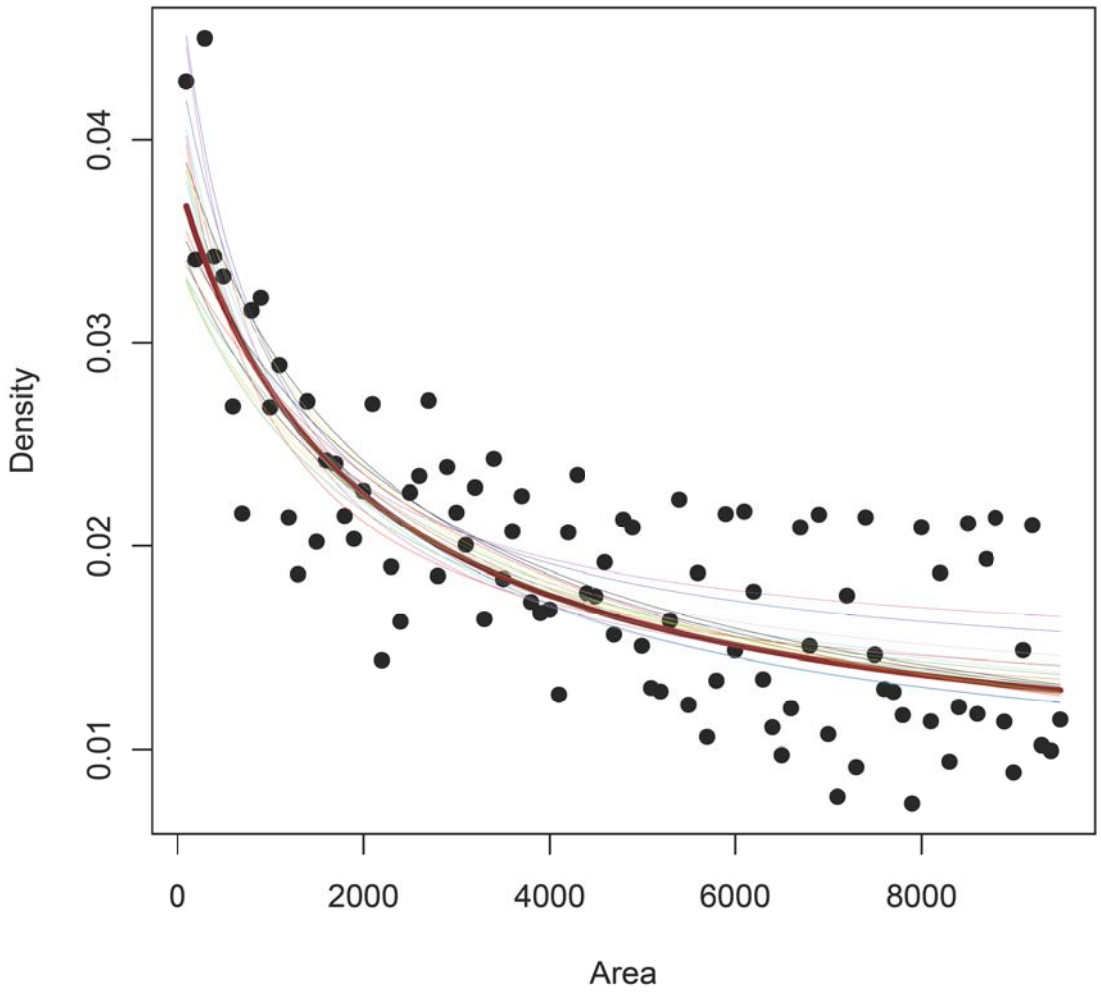
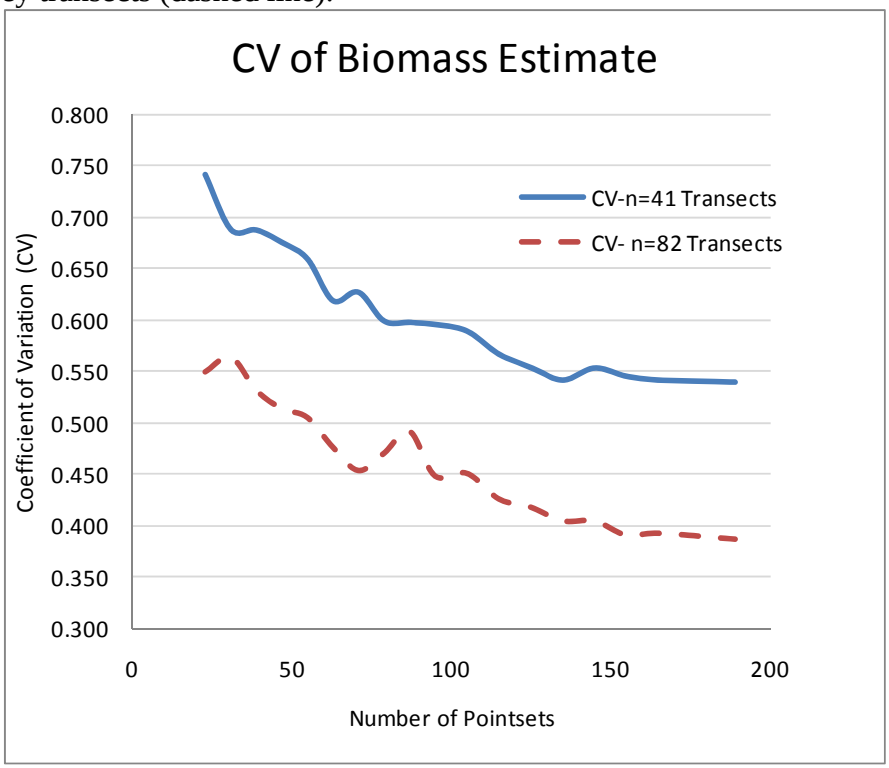


Figure 5. CV as a function of point set sample size for n = 41 (solid line), and n = 82 aerial survey transects (dashed line).



mt	Number of Pointsets	CV-n=41 Transects	CV- n=82 Transects
1077	23	0.741	0.550
1811	31	0.688	0.564
2528	39	0.687	0.532
3275	47	0.675	0.514
3901	55	0.659	0.505
4645	63	0.619	0.476
5362	71	0.627	0.454
6038	79	0.599	0.470
6616	87	0.597	0.492
7423	95	0.595	0.448
8150	105	0.589	0.451
8927	115	0.567	0.426
9683	125	0.554	0.418
10445	135	0.541	0.405
11196	145	0.553	0.405
11933	155	0.545	0.391
12663	165	0.541	0.393
13356	189	0.539	0.387

Table 1. Biomass CV as a function of point set sample size for n = 41, and n = 82 aerial survey transects.

Appendix I

West Coast Aerial Sardine Survey

2010

Field Operational Plan

Industry Coordinators:

Northwest Sardine Survey, LLC
(Jerry Thon, Principal)

and

California Wetfish Producers Association
(Diane Pleschner-Steele, Principal)

Science Advisors:

Tom Jagielo, MSc
Tom Jagielo, Consulting

and

Doyle Hanan, PhD
Hanan and Associates, Inc.

February 17, 2010

A. Coastwide Summer Aerial Sardine Survey (July-August, 2010)

I. Aerial Transect Survey

Overall Aerial Survey Design

To ensure clear communications among participants and other interested parties, the Single Point of Contact (SPC) person for 2010 survey field work will be Dr. Doyle Hanan.

Field work will be directed in Washington and Oregon by Mr. Ryan Howe with Mr. Jerry Thon (Northern Region Field Project Leaders), and in California by Dr. Hanan (Southern Region Field Project Leader), with daily communications and cooperation among the two regions. Mr. Howe will lead the digital photograph analysis and will archive all photographic and biological data for both regions.

Mr. Jagielo will have the primary responsibility to analyze the coastwide data from the Coastwide Summer Aerial Sardine Survey and will report the results to Dr. Kevin Hill, NMFS, SFSC, in a form suitable for input to the stock assessment model. Dr. Hanan and Mr. Howe will be available to help with data analysis as requested.

The 2010 coastwide aerial survey design consists of 66 transects spanning the area from Cape Flattery in the north to and including the Channel Islands in the southern California Bight (Table 1, Figure 1). Each 66-transect series will be conducted as a SET, and will make up one replicate. The 2010 survey will strive to complete three replicate SETS, or 198 transects in total.

Location of Transects

The east and west endpoints of each transect and corresponding shoreline position are given in Tables 1a-c and are mapped in Figures 1a-c for each of the three replicates (SET A, SET B, and SET C, respectively). Transects start at 3 miles from shore and extend westward for 35 statute miles in length; they are spaced 15 nautical miles (15 minutes) apart in latitude. In addition to the 35 statute mile transect, the 3 statute mile segment directly eastward of each transect to the shore will be flown and photographed. Survey biomass will be estimated from the 3-35 mile transect data. Analysis will also be conducted (and sardine surface area estimated) for the distance 0-3 mile segment to evaluate the potential need for future modification of the survey design.

Time and weather permitting, additional opportunistic scouting may be conducted longitudinally (in a north/ south orientation in the area offshore of the established 35 mile long east/west transects), for the purpose of locating sardine schools westward of the established survey area. If the westward distribution of sardine is found to extend substantially beyond the established east/west transects, future modification of the survey design will made, accordingly.

Aerial Resources
In the Northern region, a Piper Super Cub and a Cessna 337 will be used to conduct survey transects and point sets. In the Southern region, two Partenavia 68 airplanes operated by the California Department of Fish and Game will be used to conduct transects, and two additional planes, a Cessna 172 and/or a Cessna182, will be used to conduct point sets. Spotter pilots familiar with Southern California and Monterey will be contracted to participate in the survey, which will include flying transect replicates and conducting point sets in their respective regions. All survey airplanes will be equipped with a Canon EOS 1Ds in an Aerial Imaging Solutions FMC mount system (Adjunct 1), installed either inside the fuselage of the plane, or mounted externally in a pod.

Use of Aerial Resources
Aerial resources in the two regions will be coordinated by the regional Field Project Leaders (Dr. Hanan and Mr. Thon). To conduct a SET, survey pilots in the Northern region will begin with transect number 1 at Cape Flattery in the north and will proceed to transect number 26 off the Southern Oregon coast. Pilots operating in the southern region will begin with transect number 27 and will proceed southward to transect number 66, south of the Channel Islands, in southern California. Within each region, pilots will operate as a coordinated team, communicating via radio or cell phone. They will take a "Leap-Frog" approach: for example -- plane 1 will fly transects 1-5 while plane 2 is flying transects 6-10; then plane 1 will fly transects 11-15 while plane 2 flies Transects 16-20, and so on. The actual number of transects flown in a day by each plane will be determined jointly by the survey pilots and Field Project Leaders and may be more or less than the example of five per plane given above.

Conditions Acceptable for Surveying
At the beginning of each potential survey day, the survey pilots will confer with the Field Project Leaders and will jointly judge if conditions will permit safe and successful surveying that day. Considering local conditions, they will also jointly determine the optimal time of day for surveying the area slated for coverage that day. Factors will include sea condition, time of day for best sardine visibility, presence of cloud or fog cover, and other relevant criteria.

Transect Sampling
Prior to beginning a survey flight, the Pre-Flight Survey Checklist will be completed for each aircraft. This will ensure that the camera system settings are fully operational for data collection. For example, it is crucial to have accurate GPS information in the log file. It is also crucial that the photograph number series is re-set to zero. Transects flown without the necessary survey data are not valid and cannot be analyzed.

The decision of when to start a new SET of transects will be determined jointly by the regional Field Project Leaders with input from Mr. Jagielo as requested. Transects will be flown at the nominal survey altitude of 4,000 ft whenever possible. If conditions require a lower altitude for acceptable ocean surface visibility, transects (or portions of transects) may be flown at a lower altitude, when necessary. Transects may be flown starting at either the east end or the west end.

A Transect Flight Log Form will be kept during the sampling of each transect for the purpose of documenting the observations of the pilot and/or onboard observers. Key notations will include

observations of school species ID and documentation of any special conditions that could have an influence on interpreting photographs taken during transects.

Sardine are believed to migrate from California, northward during the summer. Thus, to avoid the possibility of "double counting", it is important that transects are conducted in a North-to-South progression. Once a transect (or a portion of a transect) has been flown, neither that transect, nor any transects to the north of that transect, may be flown again during that transect SET (66-transect series) in progress. It will be acceptable to skip transects or portions of transects if conditions require it (e.g. if better weather is available to the south of an area), but transects may not be "made up" once skipped during the sampling of a transect SET. Once begun, the goal is to cover the full 66-transect SET in as few days as possible.

For each transect SET, Transects 1-26 (Northern region) will be executed under the direction of the Northern region Field Project Leaders (Mr. Howe and Mr. Thon). Transects 27-66 will be executed under the direction of the Southern Region Field Project Leader (Dr. Hanan). Ideally, the first transect of the southern region (transect 27) will commence immediately following completion of the last transect in the northern region (transect 26), to maintain a seamless and orderly southward progression to sample all 66 transects without "double counting". In the event that logistics should require beginning transect sampling in the Southern region before completion of transect sampling in the Northern region, between-region coordination will be necessary to avoid "double counting". This will be accomplished by dropping an appropriate number of transects from the analysis. Transects will be dropped from either: 1) the most southerly transects in the Northern region, 2) the most northerly transects in the Southern region, or 3) both of the above. The number of transects to be dropped will be determined by 1) the transect spacing (i.e. 15 nm) and 2) the number of days that fish photographed on transects in the Southern region would have the opportunity to move into the Northern region. A nominal northward migration rate of 15 nm/day will be assumed for this calculation. Thus, for every day sampling occurs in the Southern region prior to completion of the Northern region, one transect will be dropped from the analysis, accordingly.

Data Transfer

Photographs and FMC log files will be downloaded and forwarded for analysis and archival at the end of each survey day. At the end of each flight, the Field Project Leaders will verify that the camera and data collection system operated properly and that images collected are acceptable for analysis. Dr. Hanan will 1) fly onboard the Cessna 182 and/or Cessna 172 to operate the FMC system and record observations, 2) train pilots in proper use of camera systems ,and 3) collect and forward data from pilots in the Southern region. Mr. Howe will 1) collect data from the pilots in the Northern region, and 2) coordinate the transfer and archival of all coastwide aerial survey data.

II. Point Set Sampling

Location, number, and size of Point Sets

Point sets are fully captured sardine schools landed by purse seiners approved and permitted for this research. Each set by a purse seiner will be directed by one of the survey pilots. Attempts

will be made to conduct point sets over as wide an area as feasible; however, point sets may occur in any area covered by aerial transects where sardine schools of the desired size are found.

Point sets will be collected over a range of sizes from each region, as set out in Table 2. The goal is to obtain 56 valid point sets in each region.

Aerial Photography of Point Sets

Sardine schools to be captured for point sets will be first selected by the survey pilot and photographed at the nominal survey altitude of 4,000 ft. Following a discrete school selection, the pilot will descend to a lower altitude to better photograph the approach of the seiner to the school and set the seiner for capture of the school. Photographs will be taken before and during the vessels approach to the school for the point set capture. Each school selected by the pilot and photographed for a potential point set will be logged on the survey pilot's Point Set Flight Log Form. The species identification of the selected school will be verified by the Captain of the purse seine vessel conducting the point set and will be logged on the Fisherman's Log Form. These records will be used to determine the rate of school mis-identification by spotter pilots in the field and by analysts viewing photographs taken at the nominal survey altitude of 4,000 ft.

Vessel Point Set Capture

The purse seine vessel will encircle (wrap) and fully capture the school selected by the survey pilot for the point set. Any school not "fully" captured will not be considered a valid point set for analysis. If a school is judged to be "nearly completely" captured (i.e. over 90% captured), it will be noted as such and will be included for analysis. Both the survey pilot and the purse seine captain will independently make note of the "percent captured" on their survey log forms for this purpose. Upon capture, sardine point sets will be held in separate holds for separate weighing and biological sampling of each set after landing.

Biological Sampling

Biological samples of individual point sets will be collected at the landing docks or at the fish processing plants upon landing. Fish will be systematically taken at the start, middle, and end of a delivered set. The three samples will then be combined and a random subsample of fish will be taken. The sample size will be n = 50 fish for each point set haul.

Length, weight, maturity, and otoliths will be sampled for each point set haul and will be documented on the Biological Sampling Form. Sardine weights will be taken using an electronic scale accurate to 0.5 gm. Sardine lengths will be taken using a millimeter length strip attached to a measuring board. Standard length will be determined by measuring from sardine snout to the last vertebrae. Sardine maturity will be established by referencing maturity codes (female- 4 point scale, male- 3 point scale) supplied by Beverly Macewicz NMFS, SWFSC. A subsample of 25 fish from each point set sample will be frozen and retained for collection of otoliths.

Hydroacoustic Sounding of School Height

School height will be measured for each point set. This may be obtained by using either the purse seine or other participating research vessels' hydroacoustic gear. The school height measurements to be recorded on the Fisherman's Log Form are: 1) depth in the water column of the top of the school, and 2) depth in the water column of the bottom of the school. Simrad ES-

60 sounders will be installed on three purse seine vessels. Data collected by the ES-60 sounders will be backed-up daily and archived onshore.

Number and Size of Point Sets to be Captured
Point sets will be conducted for a range of school sizes (Table 2). Each day, spotter pilots will operate with an updated list of remaining school sizes needed for analysis. Each spotter pilot will use his experience to judge the biomass of sardine schools from the air, and will direct the purse seine vessel to capture schools of appropriate size. Following landing of the point sets at the dock, the actual school weights will be determined and the list of remaining school sizes needed from Table 2 will be updated accordingly for the next day of fishing. If schools are not available in the designated size range, point sets will be conducted on schools as close to the designated range as possible. Mr. Howe will oversee the gathering of point set landing data and will update the list daily for the northern area; Dr. Hanan will oversee the gathering of point set landing data and will update the list daily for the southern area. The total landed weight of point sets sampled in each area (north and south) will not exceed 2,100 mt per area.

Landing Reporting Requirements
Cumulative point set landings will be updated by Principals Ms. Pleschner-Steele (Southern region) and Mr. Thon (Northern region). Dr. Hanan will report the coastwide total daily to NMFS, as per the terms of the Exempted Fishing Permit. Also included in this daily report will be an estimate of the weight of all by-catch by species.

Other EFP Reporting Requirements
To ensure clear communications among participants and other interested parties, the single point of contact (SPC) person during 2010 survey field work will be Dr. Doyle Hanan.

Principals Mr. Thon (Northern region) and Ms. Pleschner-Steele or Dr. Hanan (Southern region) will also be responsible for providing the other required reporting elements (as specified in the EFP permit) to NMFS. For example, a daily notice will be provided for enforcement giving 24 hour notice of vessels to be conducting point sets on any given day and will include vessel name, area to be fished, estimated departure time, estimated return time.

III. Calibration and Validation

Aerial Measurement Calibration
Each survey year, routine calibration is conducted to verify aerial measurements. For each area (north and south) a series of photographs will again be collected from a feature of known size (e.g. a football field or tennis court) on the ground, from the altitudes of 1,000 ft, 2,000 ft, 3,000 ft, and 4,000 ft. For each altitude series, an aerial pass will be made to place the target onto the right, middle, and left portions of the photographic image.

Aerial Photographs and Sampling for Species Validation
The collection of reference photographs is updated each survey year. For each area (north and south) a set of reference photographs will again be compiled which will be taken at the nominal survey altitude of 4,000 ft for the purpose of species identification. The spotter pilots will find and photograph schooling fish other than sardine (e.g. mackerel, herring, smelt, anchovy, etc).

For the actual schools photographed, a vessel at sea will collect a jig sample to document the species identification. The collection of reference photographs is used by the team of photograph analysts to continue to learn how to discern between sardine and other species as they appear on the aerial transect photographs.

Tables 1a -1i Summer Survey, Transect SETs A, B, and C.

Table 1a. SET A Northern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Washington	N	A1	48	20.00	125	28.49	A1w	124	42.91	A1e	124	39.0	A1s
Washington	N	A2	48	5.00	125	29.24	A2w	124	43.89	A2e	124	40.0	A2s
Washington	N	A3	47	50.00	125	17.01	A3w	124	31.87	A3e	124	28.0	A3s
Washington	N	A4	47	35.00	125	8.78	A4w	124	23.85	A4e	124	20.0	A4s
Washington	N	A5	47	20.00	125	4.55	A5w	124	19.83	A5e	124	16.0	A5s
Washington	N	A6	47	5.00	124	57.32	A6w	124	12.81	A6e	124	9.0	A6s
Washington	N	A7	46	50.00	124	53.09	A7w	124	8.80	A7e	124	5.0	A7s
Washington	N	A8	46	35.00	124	50.87	A8w	124	6.78	A8e	124	3.0	A8s
Washington	N	A9	46	20.00	124	49.66	A9w	124	5.76	A9e	124	2.0	A9s
Oregon	N	A10	46	5.00	124	42.44	A10w	123	58.75	A10e	123	55.0	A10s
Oregon	N	A11	45	50.00	124	43.22	A11w	123	59.73	A11e	123	56.0	A11s
Oregon	N	A12	45	35.00	124	42.02	A12w	123	58.71	A12e	123	55.0	A12s
Oregon	N	A13	45	20.00	124	43.81	A13w	124	0.70	A13e	123	57.0	A13s
Oregon	N	A14	45	5.00	124	45.61	A14w	124	2.68	A14e	123	59.0	A14s
Oregon	N	A15	44	50.00	124	49.41	A15w	124	6.66	A15e	124	3.0	A15s
Oregon	N	A16	44	35.00	124	49.20	A16w	124	6.65	A16e	124	3.0	A16s
Oregon	N	A17	44	20.00	124	52.00	A17w	124	9.63	A17e	124	6.0	A17s
Oregon	N	A18	44	5.00	124	52.81	A18w	124	10.62	A18e	124	7.0	A18s
Oregon	N	A19	43	50.00	124	54.62	A19w	124	12.60	A19e	124	9.0	A19s
Oregon	N	A20	43	35.00	124	57.43	A20w	124	15.59	A20e	124	12.0	A20s
Oregon	N	A21	43	20.00	125	7.25	A21w	124	25.57	A21e	124	22.0	A21s
Oregon	N	A22	43	5.00	125	10.06	A22w	124	28.56	A22e	124	25.0	A22s
Oregon	N	A23	42	50.00	125	16.88	A23w	124	35.54	A23e	124	32.0	A23s
Oregon	N	A24	42	35.00	125	7.70	A24w	124	26.53	A24e	124	23.0	A24s
Oregon	N	A25	42	20.00	125	9.52	A25w	124	28.51	A25e	124	25.0	A25s
Oregon	N	A26	42	5.00	125	1.35	A26w	124	20.50	A26e	124	17.0	A26s

Table 1b. SET B Northern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Washington	N	B1	48	15.00	125	30.40	B1w	124	44.90	B1e	124	41.0	B1s
Washington	N	B2	48	0.00	125	28.17	B2w	124	42.88	B2e	124	39.0	B2s
Washington	N	B3	47	45.00	125	12.94	B3w	124	27.86	B3e	124	24.0	B3s
Washington	N	B4	47	30.00	125	7.70	B4w	124	22.84	B4e	124	19.0	B4s
Washington	N	B5	47	15.00	125	0.47	B5w	124	15.83	B5e	124	12.0	B5s
Washington	N	B6	47	0.00	124	57.24	B6w	124	12.81	B6e	124	9.0	B6s
Washington	N	B7	46	45.00	124	52.02	B7w	124	7.79	B7e	124	4.0	B7s
Washington	N	B8	46	30.00	124	49.80	B8w	124	5.77	B8e	124	2.0	B8s
Washington	N	B9	46	15.00	124	48.58	B9w	124	4.76	B9e	124	1.0	B9s
Oregon	N	B10	46	0.00	124	42.37	B10w	123	58.74	B10e	123	55.0	B10s
Oregon	N	B11	45	45.00	124	43.16	B11w	123	59.72	B11e	123	56.0	B11s
Oregon	N	B12	45	30.00	124	42.94	B12w	123	59.71	B12e	123	56.0	B12s
Oregon	N	B13	45	15.00	124	42.74	B13w	123	59.69	B13e	123	56.0	B13s
Oregon	N	B14	45	0.00	124	46.54	B14w	124	3.67	B14e	124	0.0	B14s
Oregon	N	B15	44	45.00	124	48.33	B15w	124	5.66	B15e	124	2.0	B15s
Oregon	N	B16	44	30.00	124	49.14	B16w	124	6.64	B16e	124	3.0	B16s
Oregon	N	B17	44	15.00	124	50.94	B17w	124	8.63	B17e	124	5.0	B17s
Oregon	N	B18	44	0.00	124	52.75	B18w	124	10.61	B18e	124	7.0	B18s
Oregon	N	B19	43	45.00	124	55.55	B19w	124	13.60	B19e	124	10.0	B19s
Oregon	N	B20	43	30.00	125	0.37	B20w	124	18.58	B20e	124	15.0	B20s
Oregon	N	B21	43	15.00	125	8.24	B21w	124	26.57	B21e	124	23.0	B21s
Oregon	N	B22	43	0.00	125	12.00	B22w	124	30.55	B22e	124	27.0	B22s
Oregon	N	B23	42	45.00	125	14.82	B23w	124	33.54	B23e	124	30.0	B23s
Oregon	N	B24	42	30.00	125	8.64	B24w	124	27.52	B24e	124	24.0	B24s
Oregon	N	B25	42	15.00	125	7.46	B25w	124	26.51	B25e	124	23.0	B25s
Oregon	N	B26	42	0.00	124	55.29	B26w	124	14.50	B26e	124	11.0	B26s

Table 1c. SET C Northern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Washington	N	C1	48	10.00	125	31.33	C1w	124	45.89	C1e	124	42.0	C1s
Washington	N	C2	47	55.00	125	25.09	C2w	124	39.88	C2e	124	36.0	C2s
Washington	N	C3	47	40.00	125	9.85	C3w	124	24.86	C3e	124	21.0	C3s
Washington	N	C4	47	25.00	125	6.62	C4w	124	21.84	C4e	124	18.0	C4s
Washington	N	C5	47	10.00	124	58.40	C5w	124	13.82	C5e	124	10.0	C5s
Washington	N	C6	46	55.00	124	55.17	C6w	124	10.80	C6e	124	7.0	C6s
Washington	N	C7	46	40.00	124	50.95	C7w	124	6.79	C7e	124	3.0	C7s
Washington	N	C8	46	25.00	124	49.73	C8w	124	5.77	C8e	124	2.0	C8s
Washington	N	C9	46	10.00	124	44.51	C9w	124	0.75	C9e	123	57.0	C9s
Oregon	N	C10	45	55.00	124	44.29	C10w	124	0.73	C10e	123	57.0	C10s
Oregon	N	C11	45	40.00	124	41.09	C11w	123	57.72	C11e	123	54.0	C11s
Oregon	N	C12	45	25.00	124	42.88	C12w	123	59.70	C12e	123	56.0	C12s
Oregon	N	C13	45	10.00	124	43.67	C13w	124	0.68	C13e	123	57.0	C13s
Oregon	N	C14	44	55.00	124	46.47	C14w	124	3.67	C14e	124	0.0	C14s
Oregon	N	C15	44	40.00	124	48.27	C15w	124	5.65	C15e	124	2.0	C15s
Oregon	N	C16	44	25.00	124	50.07	C16w	124	7.64	C16e	124	4.0	C16s
Oregon	N	C17	44	10.00	124	51.88	C17w	124	9.62	C17e	124	6.0	C17s
Oregon	N	C18	43	55.00	124	53.68	C18w	124	11.61	C18e	124	8.0	C18s
Oregon	N	C19	43	40.00	124	56.49	C19w	124	14.59	C19e	124	11.0	C19s
Oregon	N	C20	43	25.00	125	3.31	C20w	124	21.58	C20e	124	18.0	C20s
Oregon	N	C21	43	10.00	125	9.12	C21w	124	27.56	C21e	124	24.0	C21s
Oregon	N	C22	42	55.00	125	14.93	C22w	124	33.55	C22e	124	30.0	C22s
Oregon	N	C23	42	40.00	125	8.76	C23w	124	27.53	C23e	124	24.0	C23s
Oregon	N	C24	42	25.00	125	8.58	C24w	124	27.52	C24e	124	24.0	C24s
Oregon	N	C25	42	10.00	125	5.40	C25w	124	24.51	C25e	124	21.0	C25s
Oregon	N	C26	41	55.00	124	54.23	C26w	124	13.49	C26e	124	10.0	C26s

Table 1d. SET A Southern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
California	S	A27	41	50.00	124	56.17	A27w	124	15.49	A27e	124	12.0	A27s
California	S	A28	41	35.00	124	49.00	A28w	124	8.47	A28e	124	5.0	A28s
California	S	A29	41	20.00	124	46.84	A29w	124	6.46	A29e	124	3.0	A29s
California	S	A30	41	5.00	124	51.67	A30w	124	11.45	A30e	124	8.0	A30s
California	S	A31	40	50.00	124	53.50	A31w	124	13.43	A31e	124	10.0	A31s
California	S	A32	40	35.00	125	2.34	A32w	124	22.42	A32e	124	19.0	A32s
California	S	A33	40	20.00	125	2.18	A33w	124	22.41	A33e	124	19.0	A33s
California	S	A34	40	5.00	124	46.02	A34w	124	6.40	A34e	124	3.0	A34s
California	S	A35	39	50.00	124	31.87	A35w	123	52.38	A35e	123	49.0	A35s
California	S	A36	39	35.00	124	26.71	A36w	123	47.37	A36e	123	44.0	A36s
California	S	A37	39	20.00	124	29.56	A37w	123	50.36	A37e	123	47.0	A37s
California	S	A38	39	5.00	124	22.41	A38w	123	43.35	A38e	123	40.0	A38s
California	S	A39	38	50.00	124	17.26	A39w	123	38.34	A39e	123	35.0	A39s
California	S	A40	38	35.00	124	2.11	A40w	123	23.32	A40e	123	20.0	A40s
California	S	A41	38	20.00	123	44.97	A41w	123	6.31	A41e	123	3.0	A41s
California	S	A42	38	5.00	123	37.83	A42w	122	59.30	A42e	122	56.0	A42s
California	S	A43	37	50.00	123	10.68	A43w	122	32.29	A43e	122	29.0	A43s
California	S	A44	37	35.00	123	10.55	A44w	122	32.28	A44e	122	29.0	A44s
California	S	A45	37	20.00	123	3.40	A45w	122	25.27	A45e	122	22.0	A45s
California	S	A46	37	5.00	122	56.27	A46w	122	18.26	A46e	122	15.0	A46s
California	S	A47	36	50.00	122	27.13	A47w	121	49.25	A47e	121	46.0	A47s
California	S	A48	36	35.00	122	38.00	A48w	122	0.24	A48e	121	57.0	A48s
California	S	A49	36	20.00	122	31.87	A49w	121	54.23	A49e	121	51.0	A49s
California	S	A50	36	5.00	122	16.74	A50w	121	39.22	A50e	121	36.0	A50s
California	S	A51	35	50.00	122	3.61	A51w	121	26.21	A51e	121	23.0	A51s
California	S	A52	35	35.00	121	46.48	A52w	121	9.20	A52e	121	6.0	A52s
California	S	A53	35	20.00	121	32.36	A53w	120	55.19	A53e	120	52.0	A53s
California	S	A54	35	5.00	121	16.24	A54w	120	39.18	A54e	120	36.0	A54s
California	S	A55	34	50.00	121	16.11	A55w	120	39.17	A55e	120	36.0	A55s
California	S	A56	34	35.00	121	17.99	A56w	120	41.16	A56e	120	38.0	A56s
California	S	A57	34	20.00	120	2.87	A57w	119	26.15	A57e	119	23.0	A57s
California	S	A58	34	20.00	120	57.71	A58w	120	20.99	A58e			
California	S	A59	34	5.00	119	40.76	A59w	119	4.14	A59e	119	1.0	A59s
California	S	A60	34	5.00	120	35.43	A60w	119	58.82	A60e			
California	S	A61	33	50.00	119	2.64	A61w	118	26.13	A61e	118	23.0	A61s
California	S	A62	33	50.00	119	57.16	A62w	119	20.65	A62e			
California	S	A63	33	35.00	118	28.53	A63w	117	52.12	A63e	117	49.0	A63s
California	S	A64	33	35.00	119	22.89	A64w	118	46.48	A64e			
California	S	A65	33	20.00	118	8.41	A65w	117	32.11	A65e	117	29.0	A65s
California	S	A66	33	20.00	119	2.62	A66w	118	26.32	A66e			

Table 1e. SET B Southern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
California	S	B27	41	45.00	124	53.12	B27w	124	12.48	B27e	124	9.0	B27s
California	S	B28	41	30.00	124	46.95	B28w	124	6.47	B28e	124	3.0	B28s
California	S	B29	41	15.00	124	48.78	B29w	124	8.46	B29e	124	5.0	B29s
California	S	B30	41	0.00	124	49.61	B30w	124	9.44	B30e	124	6.0	B30s
California	S	B31	40	45.00	124	56.45	B31w	124	16.43	B31e	124	13.0	B31s
California	S	B32	40	30.00	125	5.29	B32w	124	25.42	B32e	124	22.0	B32s
California	S	B33	40	15.00	125	2.12	B33w	124	22.40	B33e	124	19.0	B33s
California	S	B34	40	0.00	124	41.97	B34w	124	2.39	B34e	123	59.0	B34s
California	S	B35	39	45.00	124	30.82	B35w	123	51.38	B35e	123	48.0	B35s
California	S	B36	39	30.00	124	28.66	B36w	123	49.37	B36e	123	46.0	B36s
California	S	B37	39	15.00	124	28.51	B37w	123	49.36	B37e	123	46.0	B37s
California	S	B38	39	0.00	124	22.36	B38w	123	43.34	B38e	123	40.0	B38s
California	S	B39	38	45.00	124	12.21	B39w	123	33.33	B39e	123	30.0	B39s
California	S	B40	38	30.00	123	53.07	B40w	123	14.32	B40e	123	11.0	B40s
California	S	B41	38	15.00	123	37.92	B41w	122	59.31	B41e	122	56.0	B41s
California	S	B42	38	0.00	123	40.77	B42w	123	2.30	B42e	122	59.0	B42s
California	S	B43	37	45.00	123	9.64	B43w	122	31.29	B43e	122	28.0	B43s
California	S	B44	37	30.00	123	7.50	B44w	122	29.28	B44e	122	26.0	B44s
California	S	B45	37	15.00	123	3.36	B45w	122	25.27	B45e	122	22.0	B45s
California	S	B46	37	0.00	122	50.22	B46w	122	12.25	B46e	122	9.0	B46s
California	S	B47	36	45.00	122	28.09	B47w	121	50.24	B47e	121	47.0	B47s
California	S	B48	36	30.00	122	34.96	B48w	121	57.23	B48e	121	54.0	B48s
California	S	B49	36	15.00	122	28.82	B49w	121	51.22	B49e	121	48.0	B49s
California	S	B50	36	0.00	122	8.70	B50w	121	31.21	B50e	121	28.0	B50s
California	S	B51	35	45.00	121	58.57	B51w	121	21.20	B51e	121	18.0	B51s
California	S	B52	35	30.00	121	41.44	B52w	121	4.19	B52e	121	1.0	B52s
California	S	B53	35	15.00	121	32.32	B53w	120	55.18	B53e	120	52.0	B53s
California	S	B54	35	0.00	121	17.19	B54w	120	40.17	B54e	120	37.0	B54s
California	S	B55	34	45.00	121	16.07	B55w	120	39.16	B55e	120	36.0	B55s
California	S	B56	34	30.00	121	7.95	B56w	120	31.15	B56e	120	28.0	B56s
California	S	B57	34	15.00	119	54.83	B57w	119	18.14	B57e	119	15.0	B57s
California	S	B58	34	15.00	120	49.62	B58w	120	12.93	B58e			B58s
California	S	B59	34	0.00	119	27.72	B59w	118	51.14	B59e	118	48.0	B59s
California	S	B60	34	0.00	120	22.34	B60w	119	45.76	B60e			B60s
California	S	B61	33	45.00	119	3.60	B61w	118	27.13	B61e	118	24.0	B61s
California	S	B62	33	45.00	119	58.07	B62w	119	21.59	B62e			B62s
California	S	B63	33	30.00	118	23.49	B63w	117	47.12	B63e	117	44.0	B63s
California	S	B64	33	30.00	119	17.80	B64w	118	41.43	B64e			B64s
California	S	B65	33	15.00	118	4.38	B65w	117	28.11	B65e	117	25.0	B65s
California	S	B66	33	15.00	118	58.53	B66w	118	22.26	B66e			B66s

Table 1f. SET C Southern Region

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
California	S	C27	41	40.00	124	50.06	C27w	124	9.48	C27e	124	6.0	C27s
California	S	C28	41	25.00	124	45.89	C28w	124	5.46	C28e	124	2.0	C28s
California	S	C29	41	10.00	124	50.72	C29w	124	10.45	C29e	124	7.0	C29s
California	S	C30	40	55.00	124	50.55	C30w	124	10.44	C30e	124	7.0	C30s
California	S	C31	40	40.00	124	59.40	C31w	124	19.43	C31e	124	16.0	C31s
California	S	C32	40	25.00	125	4.23	C32w	124	24.41	C32e	124	21.0	C32s
California	S	C33	40	10.00	124	54.08	C33w	124	14.40	C33e	124	11.0	C33s
California	S	C34	39	55.00	124	36.91	C34w	123	57.39	C34e	123	54.0	C34s
California	S	C35	39	40.00	124	28.76	C35w	123	49.38	C35e	123	46.0	C35s
California	S	C36	39	25.00	124	29.61	C36w	123	50.36	C36e	123	47.0	C36s
California	S	C37	39	10.00	124	24.46	C37w	123	45.35	C37e	123	42.0	C37s
California	S	C38	38	55.00	124	23.31	C38w	123	44.34	C38e	123	41.0	C38s
California	S	C39	38	40.00	124	7.16	C39w	123	28.33	C39e	123	25.0	C39s
California	S	C40	38	25.00	123	46.01	C40w	123	7.32	C40e	123	4.0	C40s
California	S	C41	38	10.00	123	37.87	C41w	122	59.31	C41e	122	56.0	C41s
California	S	C42	37	55.00	123	23.73	C42w	122	45.29	C42e	122	42.0	C42s
California	S	C43	37	40.00	123	9.59	C43w	122	31.28	C43e	122	28.0	C43s
California	S	C44	37	25.00	123	5.45	C44w	122	27.27	C44e	122	24.0	C44s
California	S	C45	37	10.00	123	2.31	C45w	122	24.26	C45e	122	21.0	C45s
California	S	C46	36	55.00	122	31.18	C46w	121	53.25	C46e	121	50.0	C46s
California	S	C47	36	40.00	122	29.04	C47w	121	51.24	C47e	121	48.0	C47s
California	S	C48	36	25.00	122	32.91	C48w	121	55.23	C48e	121	52.0	C48s
California	S	C49	36	10.00	122	18.78	C49w	121	41.22	C49e	121	38.0	C49s
California	S	C50	35	55.00	122	6.66	C50w	121	29.21	C50e	121	26.0	C50s
California	S	C51	35	40.00	121	56.53	C51w	121	19.20	C51e	121	16.0	C51s
California	S	C52	35	25.00	121	31.40	C52w	120	54.19	C52e	120	51.0	C52s
California	S	C53	35	10.00	121	25.28	C53w	120	48.18	C53e	120	45.0	C53s
California	S	C54	34	55.00	121	19.15	C54w	120	42.17	C54e	120	39.0	C54s
California	S	C55	34	40.00	121	16.03	C55w	120	39.16	C55e	120	36.0	C55s
California	S	C56	34	25.00	121	6.91	C56w	120	30.15	C56e	120	27.0	C56s
California	S	C57	34	10.00	119	52.80	C57w	119	16.14	C57e	119	13.0	C57s
California	S	C58	34	10.00	120	47.53	C58w	120	10.87	C58e			C58s
California	S	C59	33	55.00	119	4.68	C59w	118	28.13	C59e	118	25.0	C59s
California	S	C60	33	55.00	119	59.25	C60w	119	22.70	C60e			C60s
California	S	C61	33	40.00	118	38.56	C61w	118	2.12	C61e	117	59.0	C61s
California	S	C62	33	40.00	119	32.98	C62w	118	56.54	C62e			C62s
California	S	C63	33	25.00	118	15.45	C63w	117	39.11	C63e	117	36.0	C63s
California	S	C64	33	25.00	119	9.71	C64w	118	33.37	C64e			C64s
California	S	C65	33	10.00	118	0.34	C65w	117	24.11	C65e	117	21.0	C65s
California	S	C66	33	10.00	118	54.44	C66w	118	18.21	C66e			C66s

Table 1g. SET A Canadian Transects

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Canada	CN	cnA1	48	35.00	125	30.73	cnA1w	124	44.93	cnA1e	124	41.0	cnA1s
Canada	CN	cnA2	48	50.00	125	56.98	cnA2w	125	10.95	cnA2e	125	7.0	cnA2s
Canada	CN	cnA3	49	5.00	126	43.23	cnA3w	125	56.97	cnA3e	125	53.0	cnA3s
Canada	CN	cnA4	49	20.00	126	52.48	cnA4w	126	5.99	cnA4e	126	2.0	cnA4s
Canada	CN	cnA5	49	35.00	127	23.74	cnA5w	126	37.01	cnA5e	126	33.0	cnA5s
Canada	CN	cnA6	49	50.00	127	29.00	cnA6w	126	42.03	cnA6e	126	38.0	cnA6s
Canada	CN	cnA7	50	5.00	128	40.27	cnA7w	127	53.05	cnA7e	127	49.0	cnA7s
Canada	CN	cnA8	50	20.00	128	48.54	cnA8w	128	1.07	cnA8e	127	57.0	cnA8s
Canada	CN	cnA9	50	35.00	129	5.81	cnA9w	128	18.09	cnA9e	128	14.0	cnA9s
Canada	CN	cnA10	50	50.00	129	3.08	cnA10w	128	15.11	cnA10e	128	11.0	cnA10s
Canada	CN	cnA11	51	5.00	128	29.37	cnA11w	127	41.13	cnA11e	127	37.0	cnA11s
Canada	CN	cnA12	51	20.00	128	39.65	cnA12w	127	51.16	cnA12e	127	47.0	cnA12s
Canada	CN	cnA13	51	35.00	128	41.94	cnA13w	127	53.18	cnA13e	127	49.0	cnA13s
Canada	CN	cnA14	51	50.00	128	45.23	cnA14w	127	56.20	cnA14e	127	52.0	cnA14s
Canada	CN	cnA15	52	5.00	128	30.53	cnA15w	127	41.23	cnA15e	127	37.0	cnA15s
Canada	CN	cnA16	52	20.00	129	13.83	cnA16w	128	24.25	cnA16e	128	20.0	cnA16s
Canada	CN	cnA17	52	35.00	129	7.13	cnA17w	128	17.27	cnA17e	128	13.0	cnA17s
Canada	CN	cnA18	52	50.00	129	22.44	cnA18w	128	32.30	cnA18e	128	28.0	cnA18s
Canada	CN	cnA19	53	5.00	129	26.76	cnA19w	128	36.32	cnA19e	128	32.0	cnA19s
Canada	CN	cnA20	53	20.00	129	47.08	cnA20w	128	56.35	cnA20e	128	52.0	cnA20s
Canada	CN	cnA21	53	35.00	130	33.40	cnA21w	129	42.37	cnA21e	129	38.0	cnA21s
Canada	CN	cnA22	53	50.00	130	53.73	cnA22w	130	2.40	cnA22e	129	58.0	cnA22s
Canada	CN	cnA23	54	5.00	131	0.07	cnA23w	130	8.43	cnA23e	130	4.0	cnA23s
Canada	CN	cnA24	54	20.00	131	24.41	cnA24w	130	32.45	cnA24e	130	28.0	cnA24s
Canada	CN	cnA25	54	35.00	131	21.75	cnA25w	130	29.48	cnA25e	130	25.0	cnA25s

Table 1h. SET B Canadian Transects

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Canada	CN	cnB1	48	30.00	125	29.65	cnB1w	124	43.92	cnB1e	124	40.0	cnB1s
Canada	CN	cnB2	48	45.00	125	56.90	cnB2w	125	10.94	cnB2e	125	7.0	cnB2s
Canada	CN	cnB3	49	0.00	126	28.15	cnB3w	125	41.96	cnB3e	125	38.0	cnB3s
Canada	CN	cnB4	49	15.00	126	50.40	cnB4w	126	3.98	cnB4e	126	0.0	cnB4s
Canada	CN	cnB5	49	30.00	127	23.66	cnB5w	126	37.00	cnB5e	126	33.0	cnB5s
Canada	CN	cnB6	49	45.00	127	26.92	cnB6w	126	40.02	cnB6e	126	36.0	cnB6s
Canada	CN	cnB7	50	0.00	128	3.18	cnB7w	127	16.04	cnB7e	127	12.0	cnB7s
Canada	CN	cnB8	50	15.00	128	40.45	cnB8w	127	53.06	cnB8e	127	49.0	cnB8s
Canada	CN	cnB9	50	30.00	129	0.72	cnB9w	128	13.08	cnB9e	128	9.0	cnB9s
Canada	CN	cnB10	50	45.00	129	15.99	cnB10w	128	28.10	cnB10e	128	24.0	cnB10s
Canada	CN	cnB11	51	0.00	128	23.27	cnB11w	127	35.13	cnB11e	127	31.0	cnB11s
Canada	CN	cnB12	51	15.00	128	36.55	cnB12w	127	48.15	cnB12e	127	44.0	cnB12s
Canada	CN	cnB13	51	30.00	128	37.84	cnB13w	127	49.17	cnB13e	127	45.0	cnB13s
Canada	CN	cnB14	51	45.00	128	45.13	cnB14w	127	56.19	cnB14e	127	52.0	cnB14s
Canada	CN	cnB15	52	0.00	128	32.43	cnB15w	127	43.22	cnB15e	127	39.0	cnB15s
Canada	CN	cnB16	52	15.00	128	46.73	cnB16w	127	57.24	cnB16e	127	53.0	cnB16s
Canada	CN	cnB17	52	30.00	129	7.03	cnB17w	128	17.27	cnB17e	128	13.0	cnB17s
Canada	CN	cnB18	52	45.00	129	1.34	cnB18w	128	11.29	cnB18e	128	7.0	cnB18s
Canada	CN	cnB19	53	0.00	129	25.65	cnB19w	128	35.31	cnB19e	128	31.0	cnB19s
Canada	CN	cnB20	53	15.00	129	42.97	cnB20w	128	52.34	cnB20e	128	48.0	cnB20s
Canada	CN	cnB21	53	30.00	130	27.29	cnB21w	129	36.37	cnB21e	129	32.0	cnB21s
Canada	CN	cnB22	53	45.00	130	46.62	cnB22w	129	55.39	cnB22e	129	51.0	cnB22s
Canada	CN	cnB23	54	0.00	131	1.96	cnB23w	130	10.42	cnB23e	130	6.0	cnB23s
Canada	CN	cnB24	54	15.00	131	10.29	cnB24w	130	18.44	cnB24e	130	14.0	cnB24s
Canada	CN	cnB25	54	30.00	131	22.64	cnB25w	130	30.47	cnB25e	130	26.0	cnB25s

Table 1i. SET C Canadian Transects

	Survey	Transect	Transect Latitude		West End			East End			Shoreline		
Location	Area	Number	Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Canada	CN	cnC1	48	25.00	125	29.57	cnC1w	124	43.91	cnC1e	124	40.0	cnC1s
Canada	CN	cnC2	48	40.00	125	41.82	cnC2w	124	55.93	cnC2e	124	52.0	cnC2s
Canada	CN	cnC3	48	55.00	126	19.06	cnC3w	125	32.95	cnC3e	125	29.0	cnC3s
Canada	CN	cnC4	49	10.00	126	34.31	cnC4w	125	47.97	cnC4e	125	44.0	cnC4s
Canada	CN	cnC5	49	25.00	127	24.57	cnC5w	126	37.99	cnC5e	126	34.0	cnC5s
Canada	CN	cnC6	49	40.00	127	16.83	cnC6w	126	30.01	cnC6e	126	26.0	cnC6s
Canada	CN	cnC7	49	55.00	128	2.09	cnC7w	127	15.03	cnC7e	127	11.0	cnC7s
Canada	CN	cnC8	50	10.00	128	41.36	cnC8w	127	54.05	cnC8e	127	50.0	cnC8s
Canada	CN	cnC9	50	25.00	128	46.63	cnC9w	127	59.08	cnC9e	127	55.0	cnC9s
Canada	CN	cnC10	50	40.00	129	13.90	cnC10w	128	26.10	cnC10e	128	22.0	cnC10s
Canada	CN	cnC11	50	55.00	128	9.18	cnC11w	127	21.12	cnC11e	127	17.0	cnC11s
Canada	CN	cnC12	51	10.00	128	39.46	cnC12w	127	51.14	cnC12e	127	47.0	cnC12s
Canada	CN	cnC13	51	25.00	128	30.74	cnC13w	127	42.16	cnC13e	127	38.0	cnC13s
Canada	CN	cnC14	51	40.00	128	46.03	cnC14w	127	57.19	cnC14e	127	53.0	cnC14s
Canada	CN	cnC15	51	55.00	128	42.33	cnC15w	127	53.21	cnC15e	127	49.0	cnC15s
Canada	CN	cnC16	52	10.00	128	19.63	cnC16w	127	30.23	cnC16e	127	26.0	cnC16s
Canada	CN	cnC17	52	25.00	129	7.93	cnC17w	128	18.26	cnC17e	128	14.0	cnC17s
Canada	CN	cnC18	52	40.00	129	4.24	cnC18w	128	14.28	cnC18e	128	10.0	cnC18s
Canada	CN	cnC19	52	55.00	129	24.55	cnC19w	128	34.31	cnC19e	128	30.0	cnC19s
Canada	CN	cnC20	53	10.00	129	30.87	cnC20w	128	40.33	cnC20e	128	36.0	cnC20s
Canada	CN	cnC21	53	25.00	129	48.19	cnC21w	128	57.36	cnC21e	128	53.0	cnC21s
Canada	CN	cnC22	53	40.00	130	38.51	cnC22w	129	47.38	cnC22e	129	43.0	cnC22s
Canada	CN	cnC23	53	55.00	131	0.84	cnC23w	130	9.41	cnC23e	130	5.0	cnC23s
Canada	CN	cnC24	54	10.00	131	6.18	cnC24w	130	14.44	cnC24e	130	10.0	cnC24s
Canada	CN	cnC25	54	25.00	131	23.52	cnC25w	130	31.46	cnC25e	130	27.0	cnC25s

Table 2. Distribution of point set sizes proposed for each region (Northern and Southern) for the 2010 Coastwide Summer Aerial Sardine Survey.

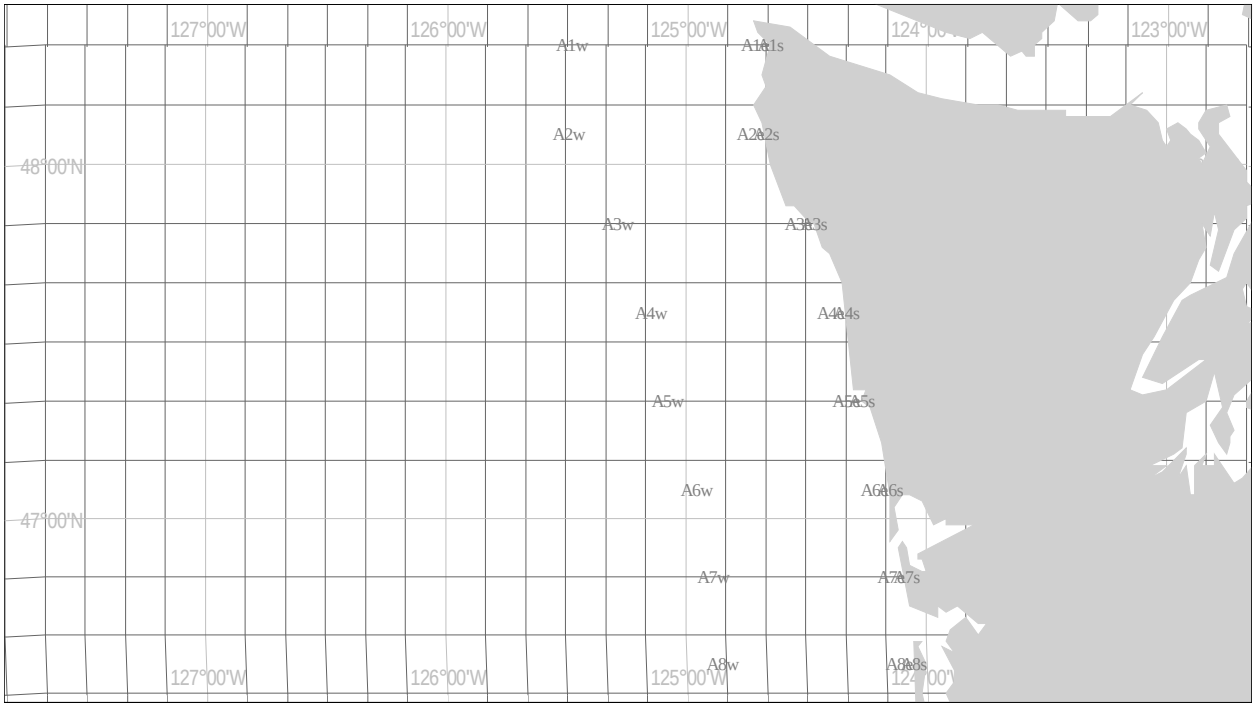
Size (m^2)	Weight (mt)	Total Weight	Number of Point Sets
100	3.8	31	8
500	10.6	85	8
1000	17.0	136	8
2000	26.5	212	8
4000	51.9	415	8
8000	70.5	564	8
10000	82.1	657	8
		2099	56

Table 3. Sardine maturity codes. Source: Beverly Macewicz NMFS, SWFSC.

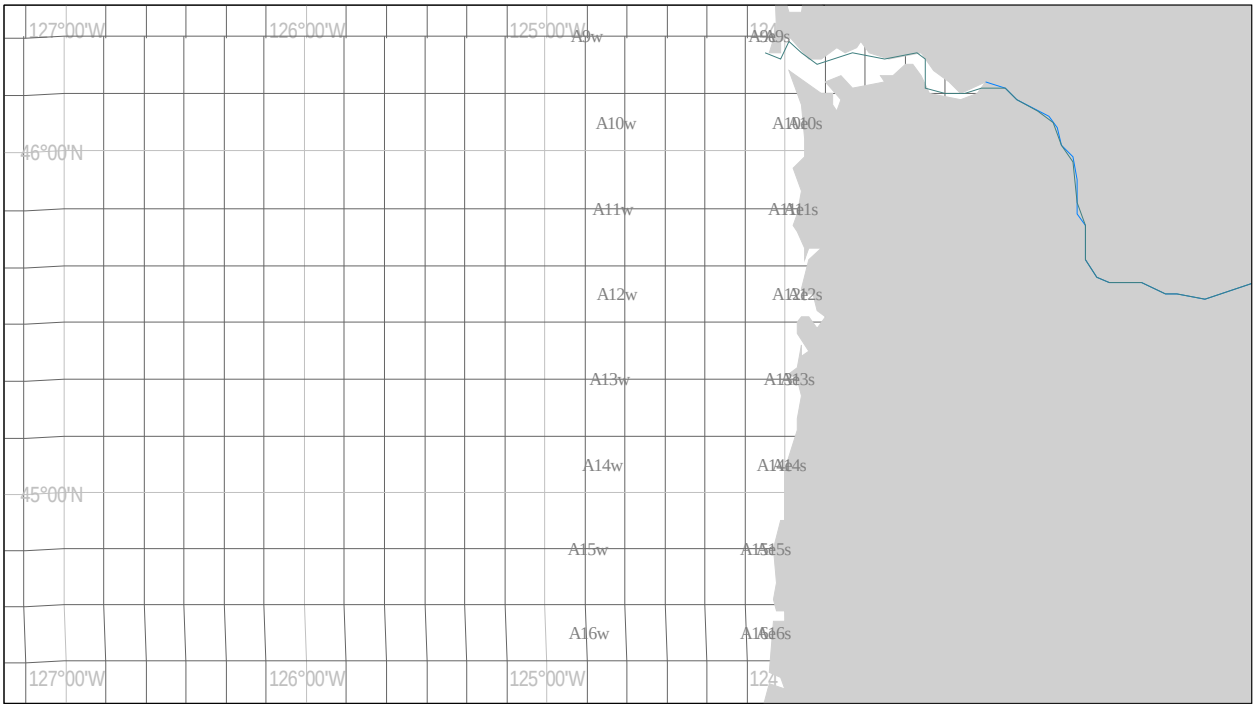
Female maturity codes	**Male maturity codes**
1. Clearly immature- ovary is very small; no oocytes present	1. Clearly immature- testis is very small thin, knifed-shaped with flat edge
2. Intermediate- individual oocytes not visible but ovary is not clearly immature; includes maturing and regressed ovaries	2. Intermediate- no milt evident and is not a clear immature; includes maturing or regressed testis
3. Active- yolked oocytes visible; any size or amount as long as you can see them with the unaided eye in ovaries	3. Active- milt is present; either oozing from pore, in the duct, or when testis is cut with knife.
4. Hydrated oocytes present; yolked oocytes may be present	

Figure 1a. Maps showing locations of transects comprising Replicate SET A

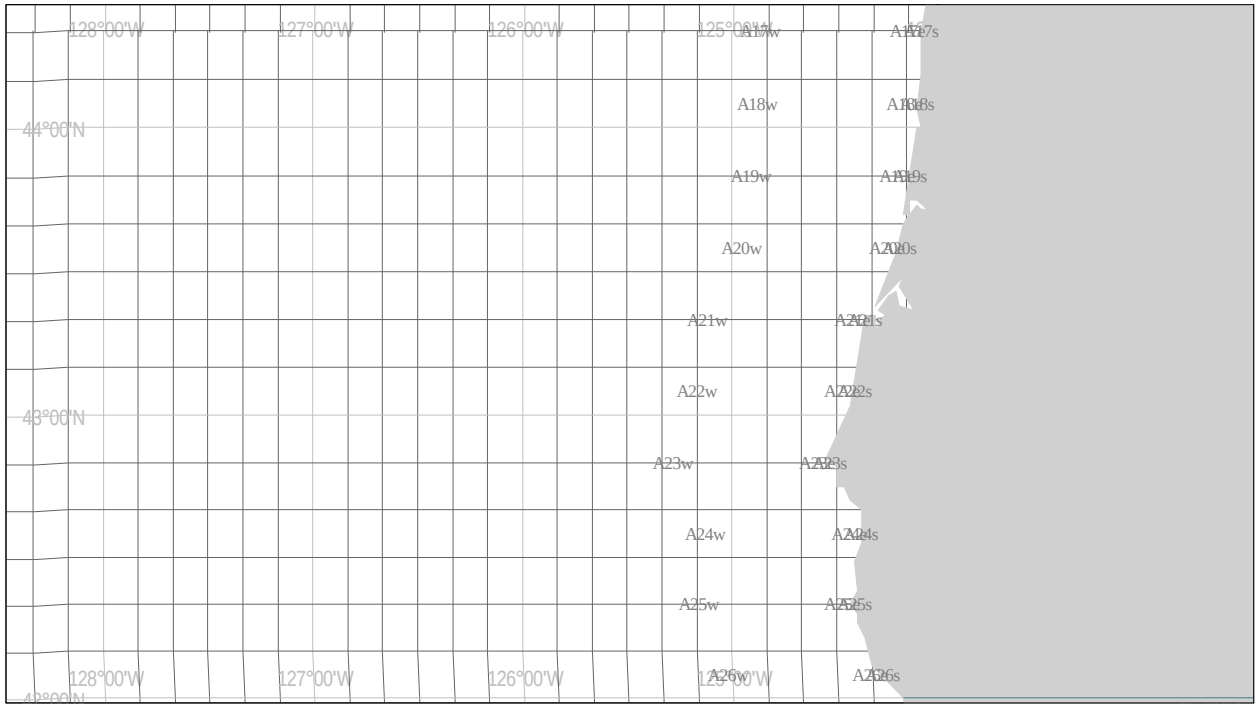
SET A Northern Region: Transects 1-8



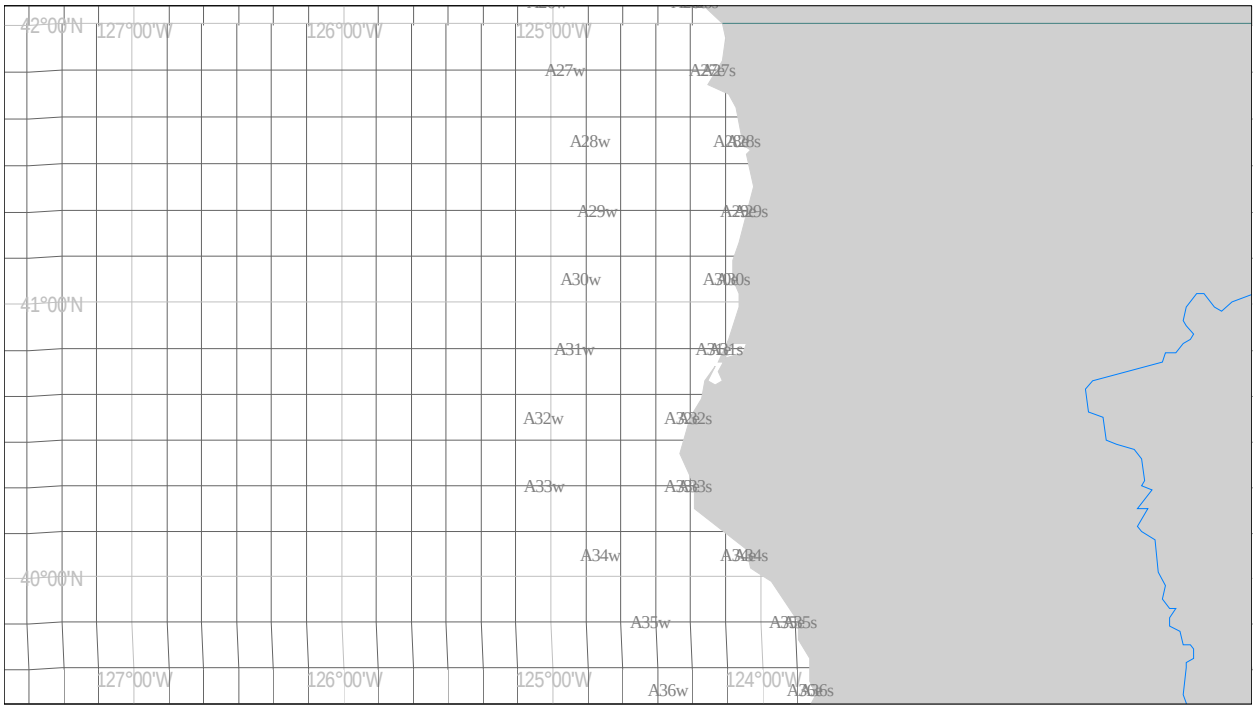
SET A Northern Region: Transects 9-16



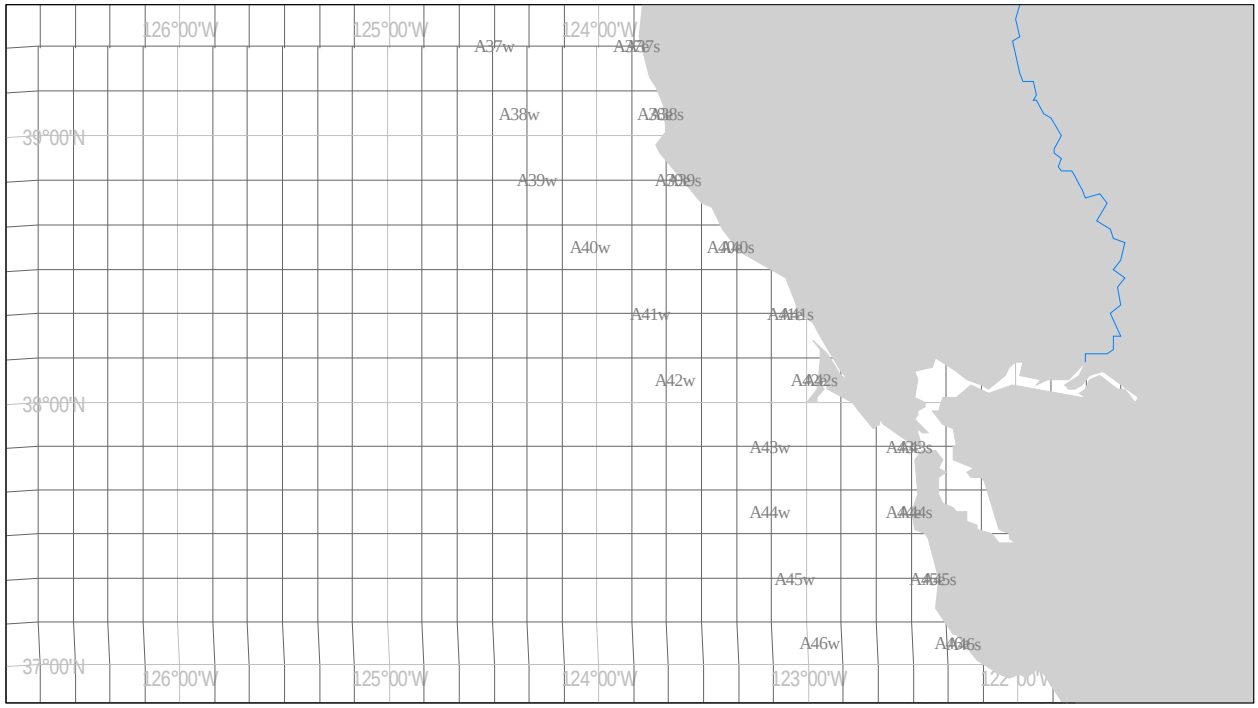
SET A Northern Region: Transects 17-26



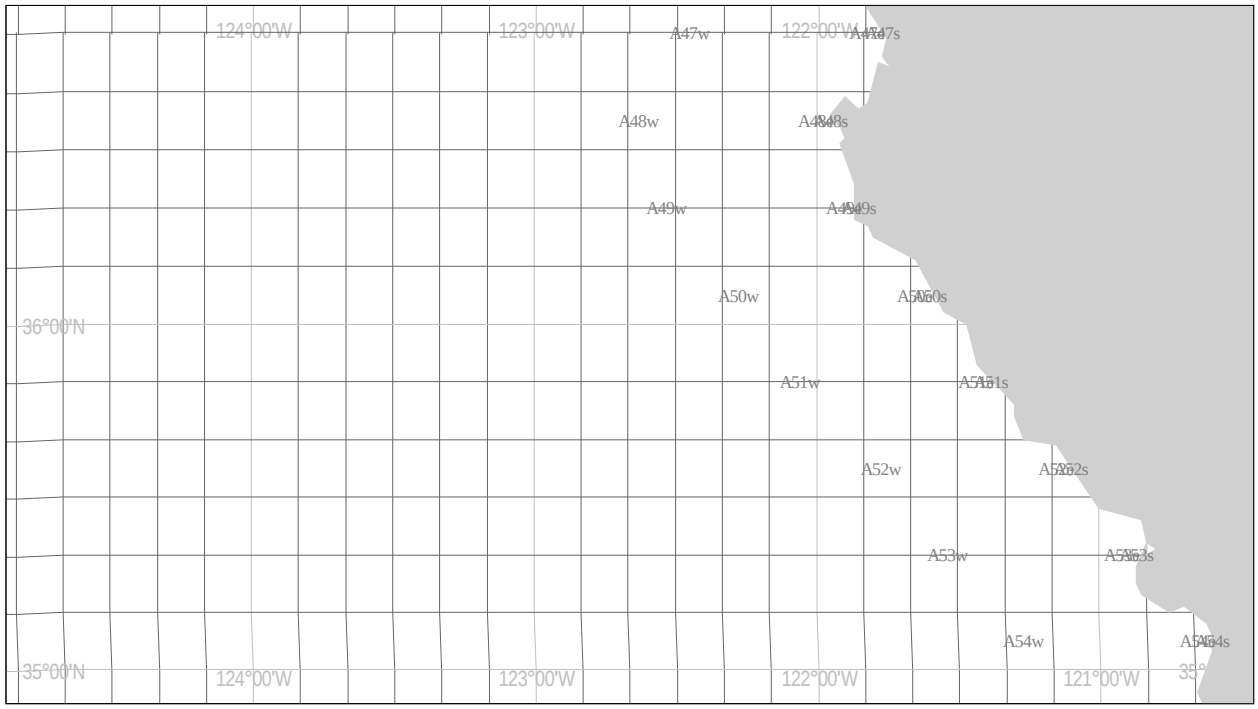
SET A Southern Region: Transects 27-36



SET A Southern Region: Transects 37-46



SET A Southern Region: Transects 47-54



SET A Southern Region: Transects 55-66

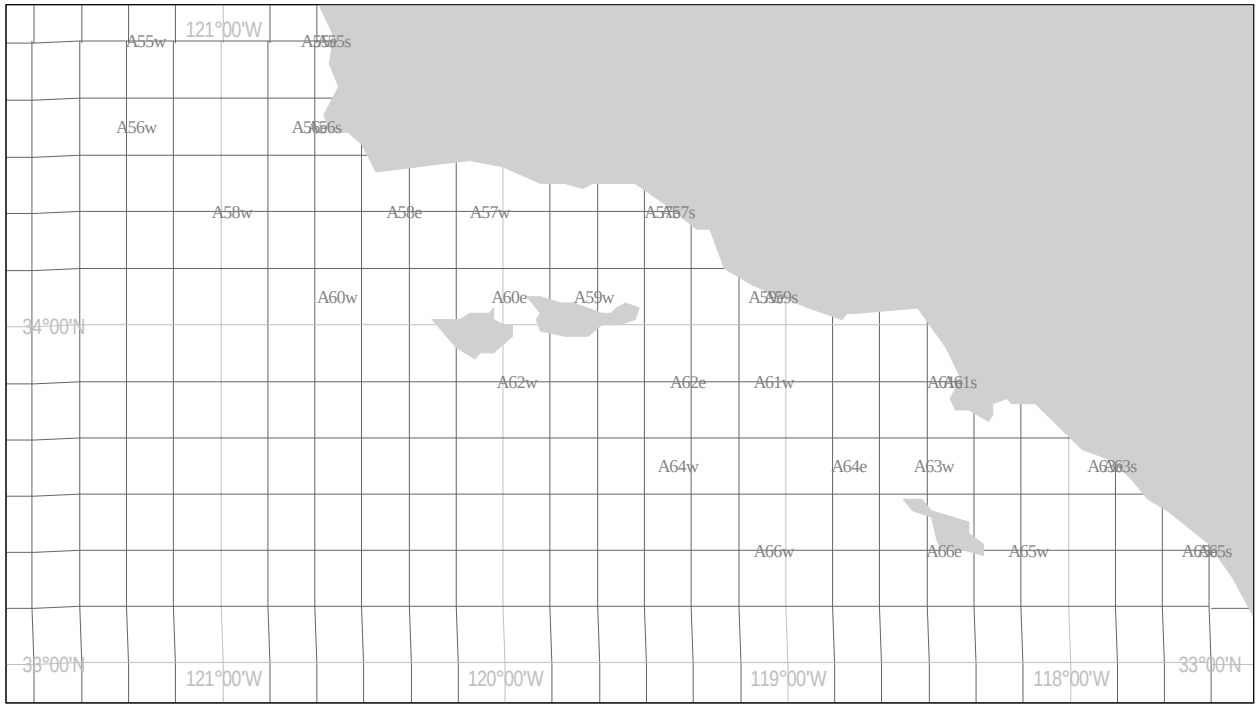
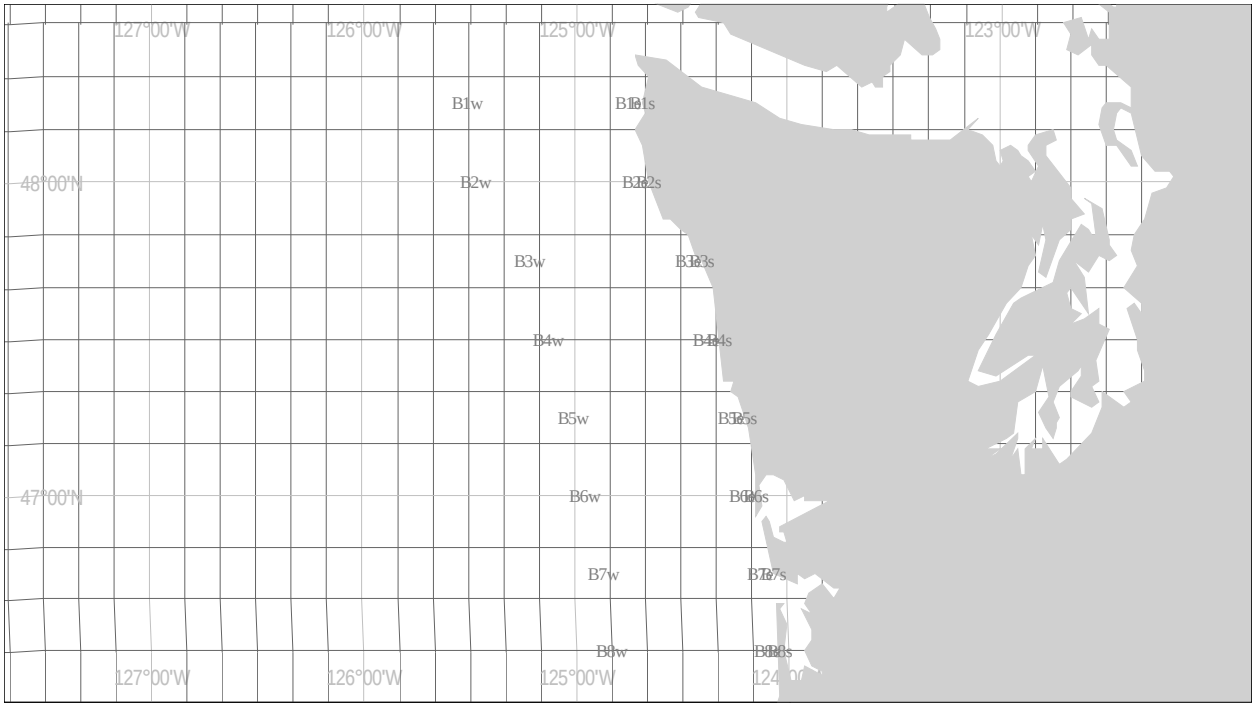
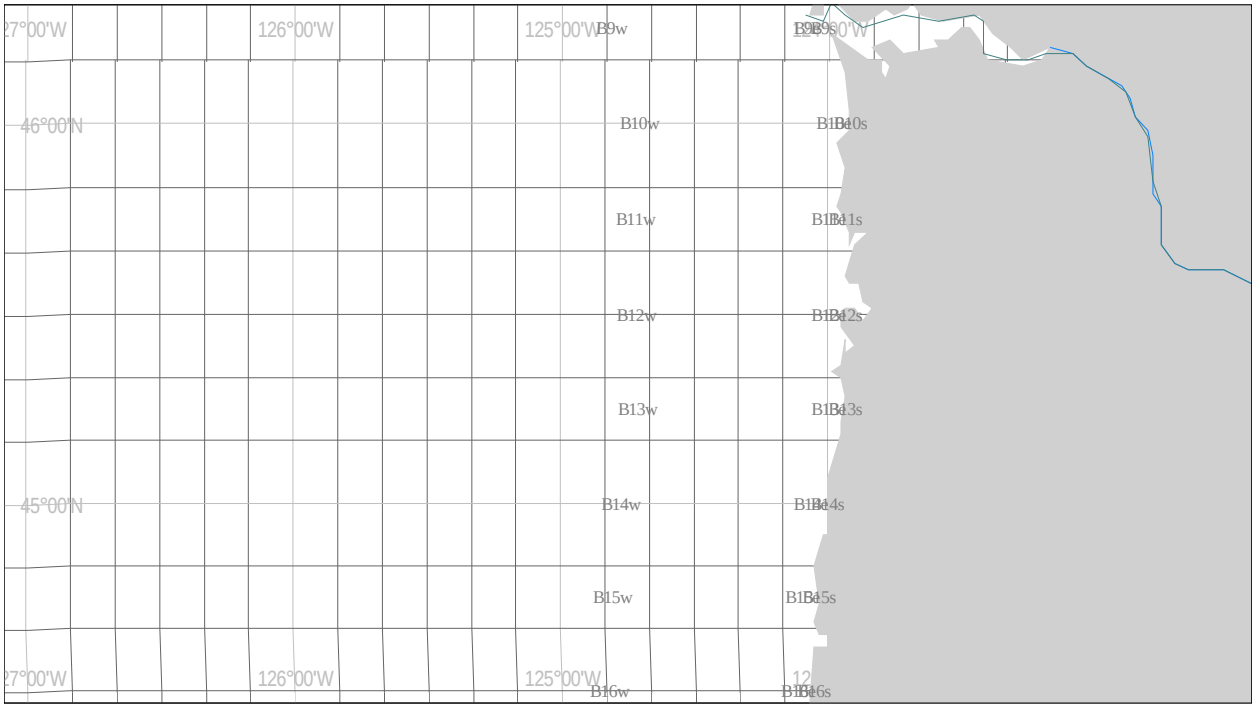


Figure 1b. Maps showing locations of transects comprising Replicate SET B

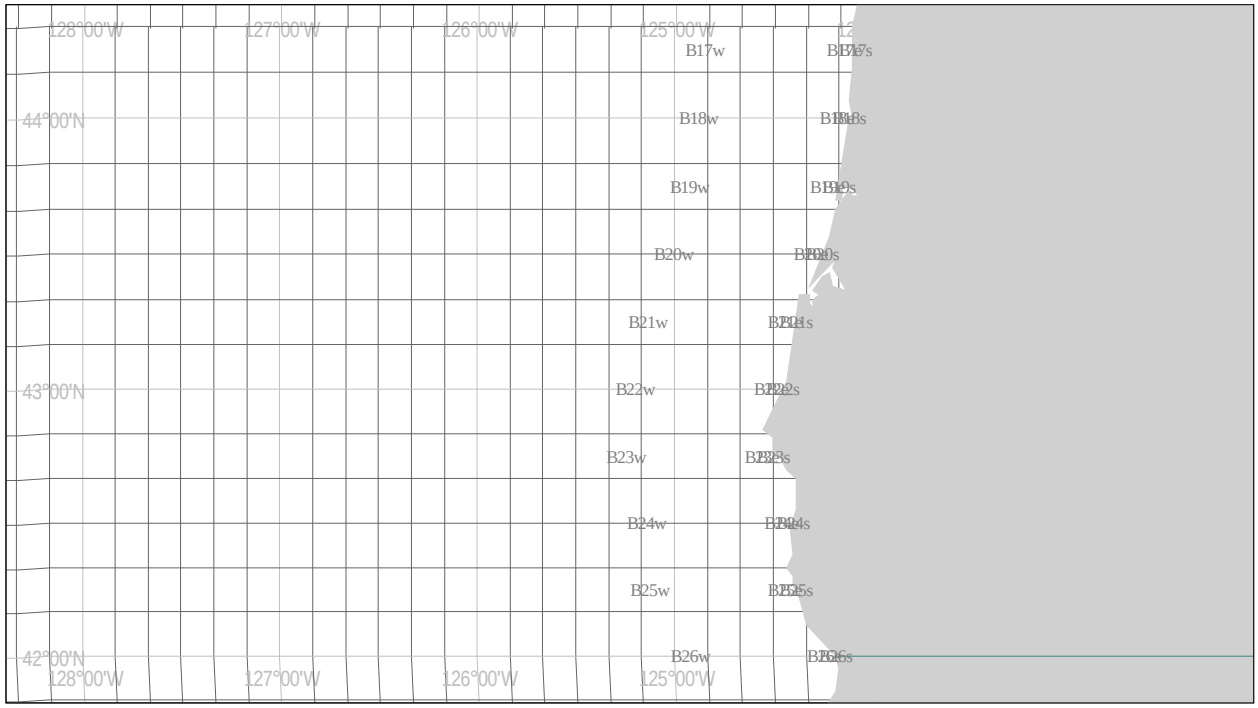
SET B Northern Region: Transects 1-8



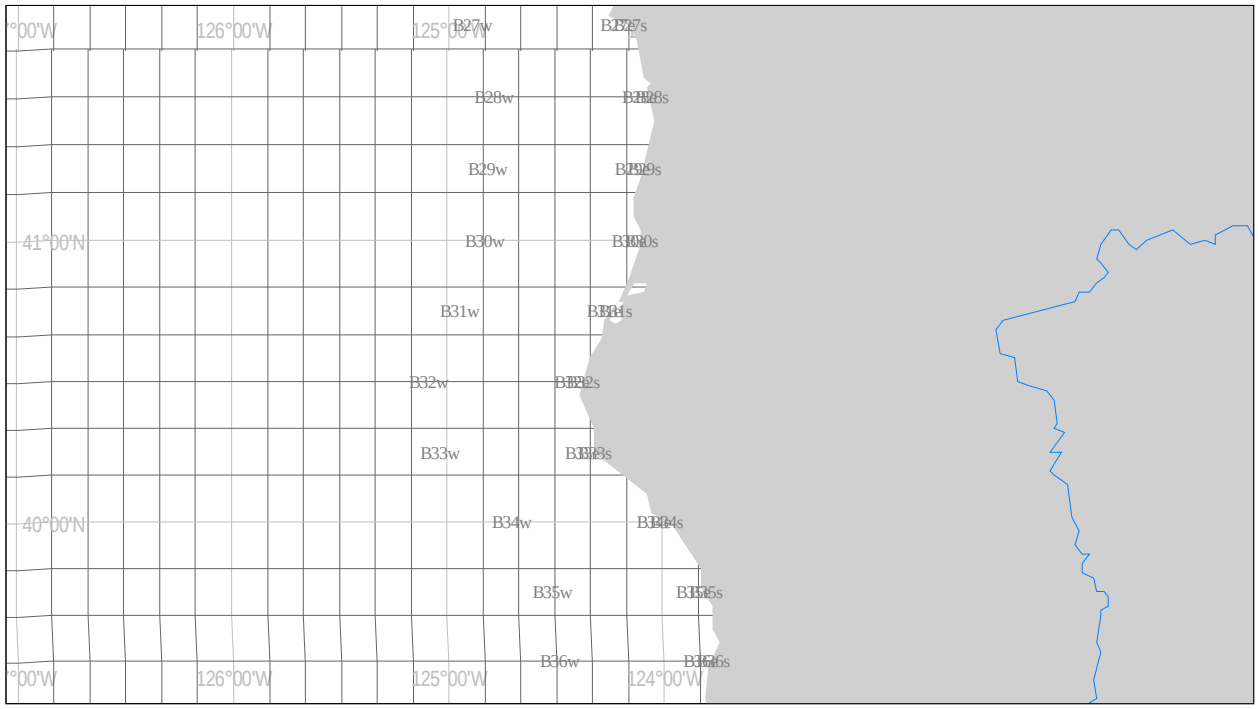
SET B Northern Region: Transects 9-16



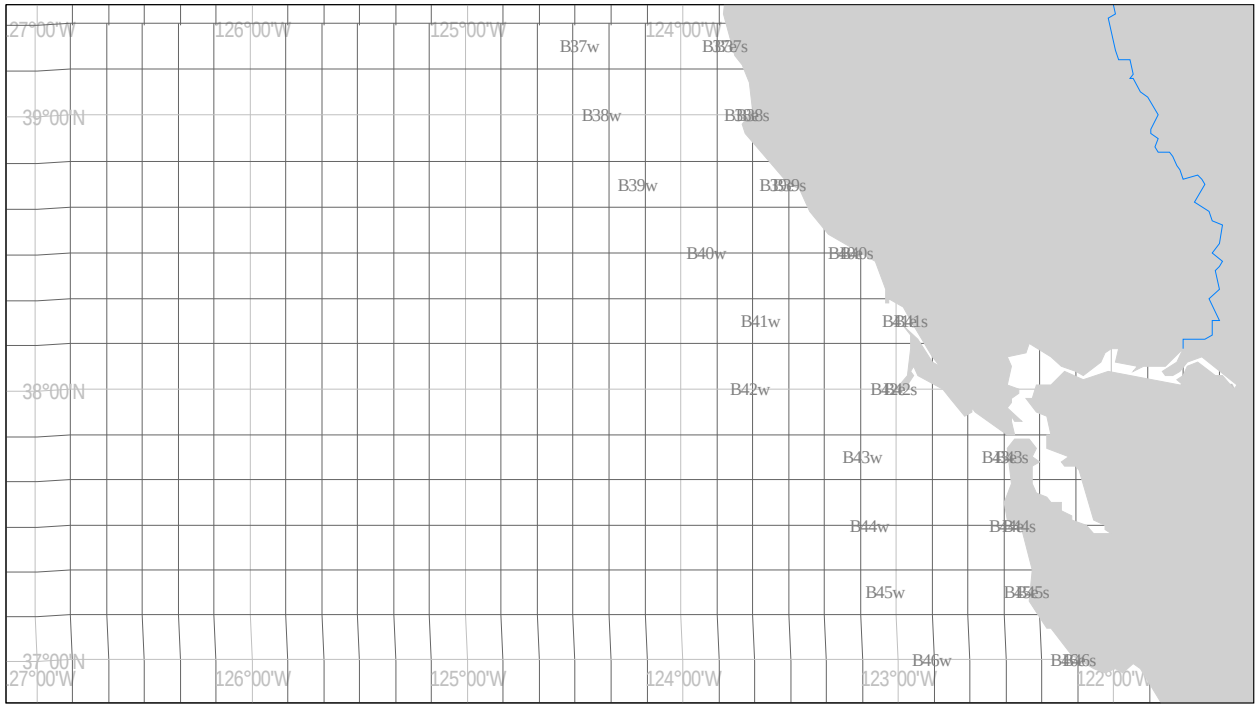
SET B Northern Region: Transects 17-26



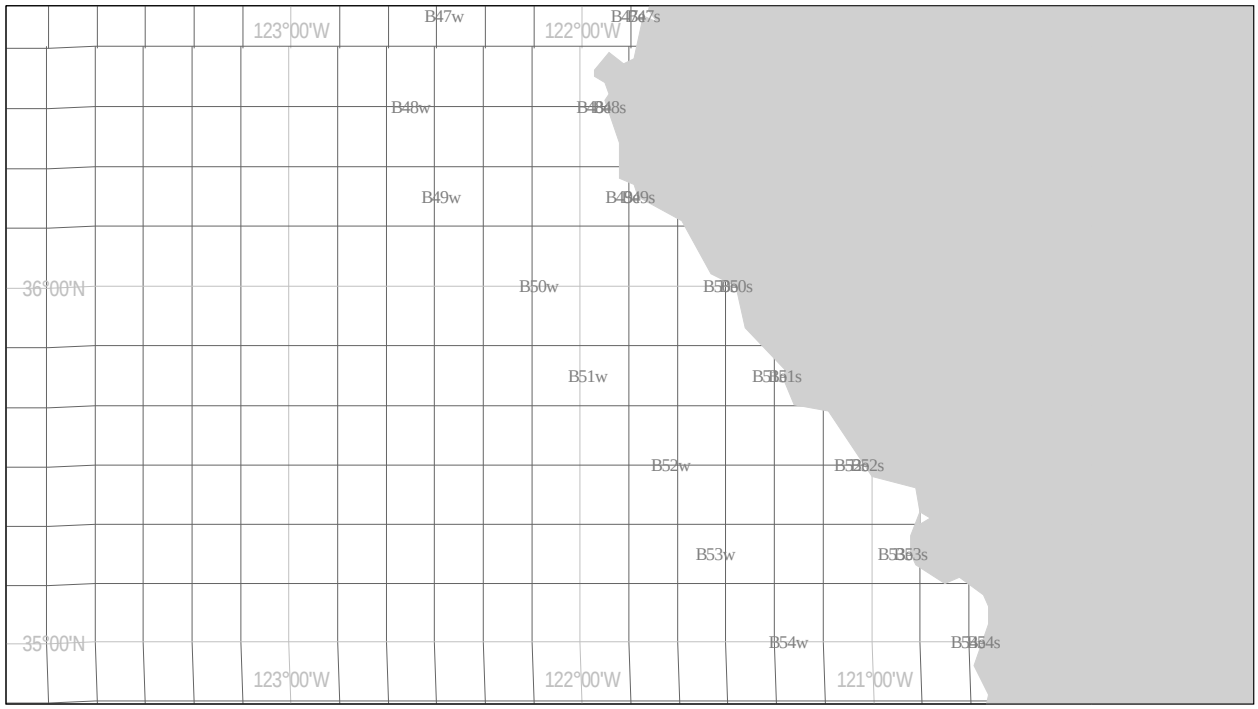
SET B Southern Region: Transects 27-36



SET B Southern Region: Transects 37-46



SET B Southern Region: Transects 47-54



SET B Southern Region: Transects 55-66

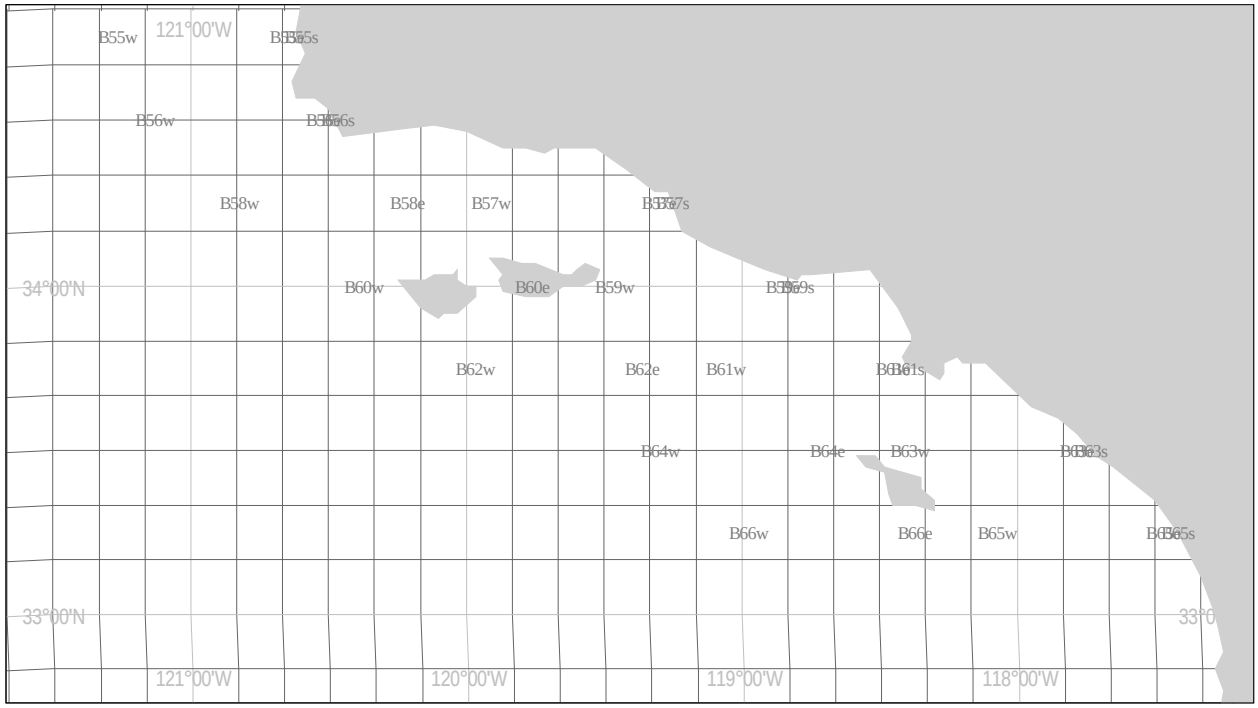
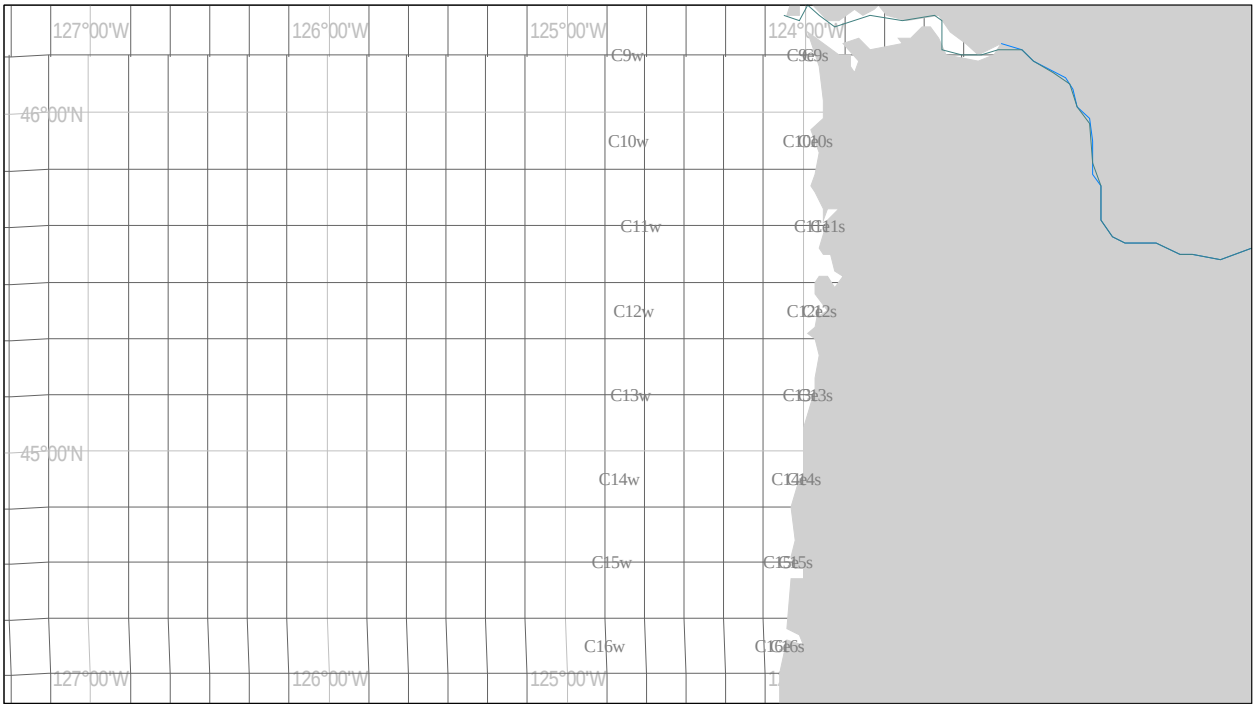


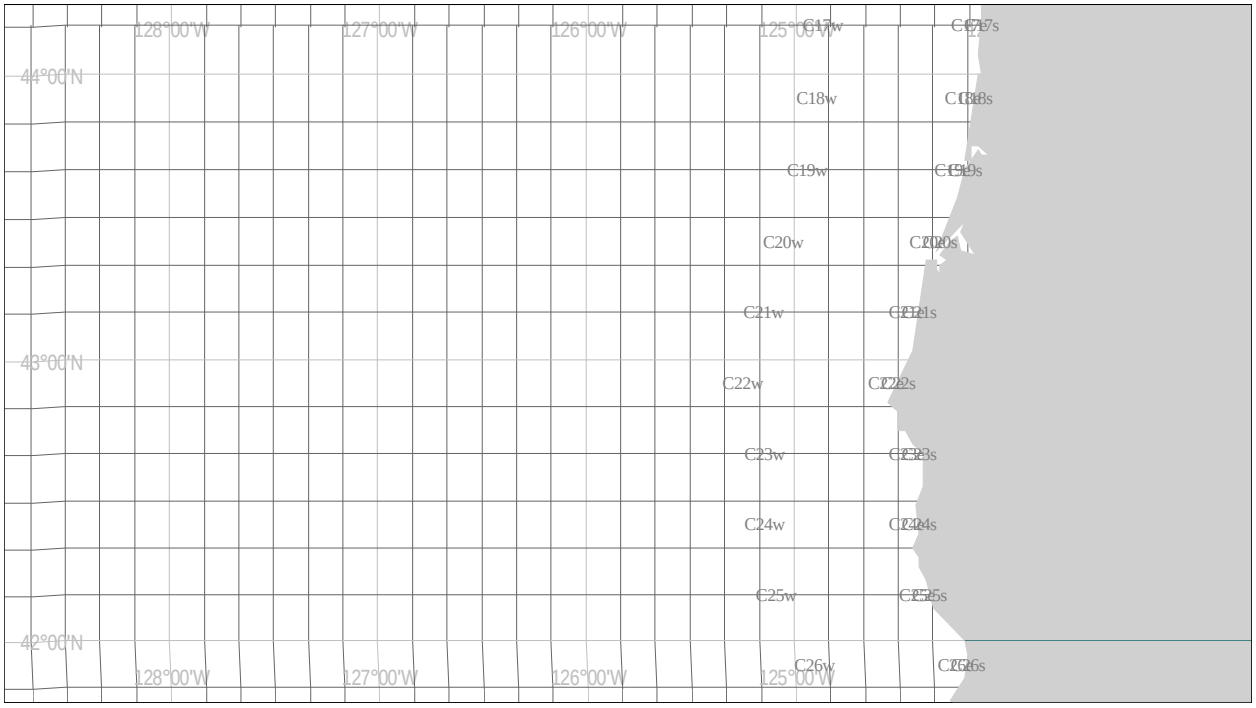
Figure 1c. Maps showing locations of transects comprising Replicate SET C

SET C Northern Region: Transects 1-8

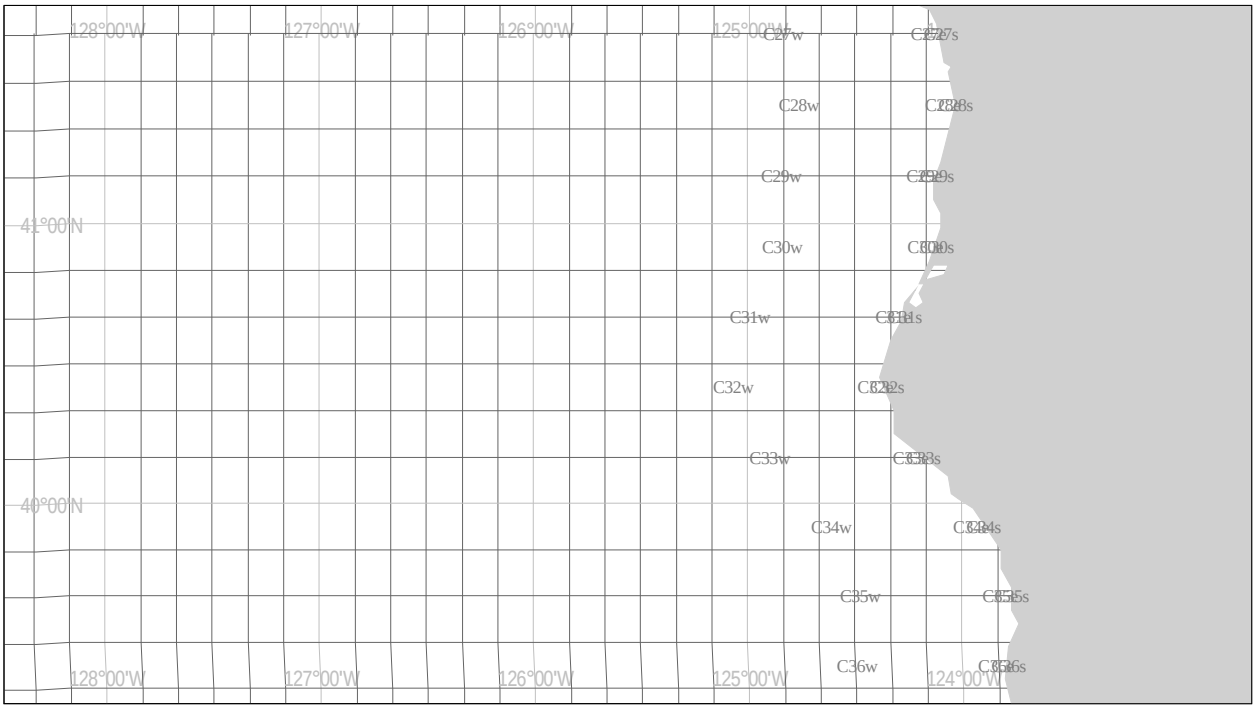
SET C Northern Region: Transects 9-16



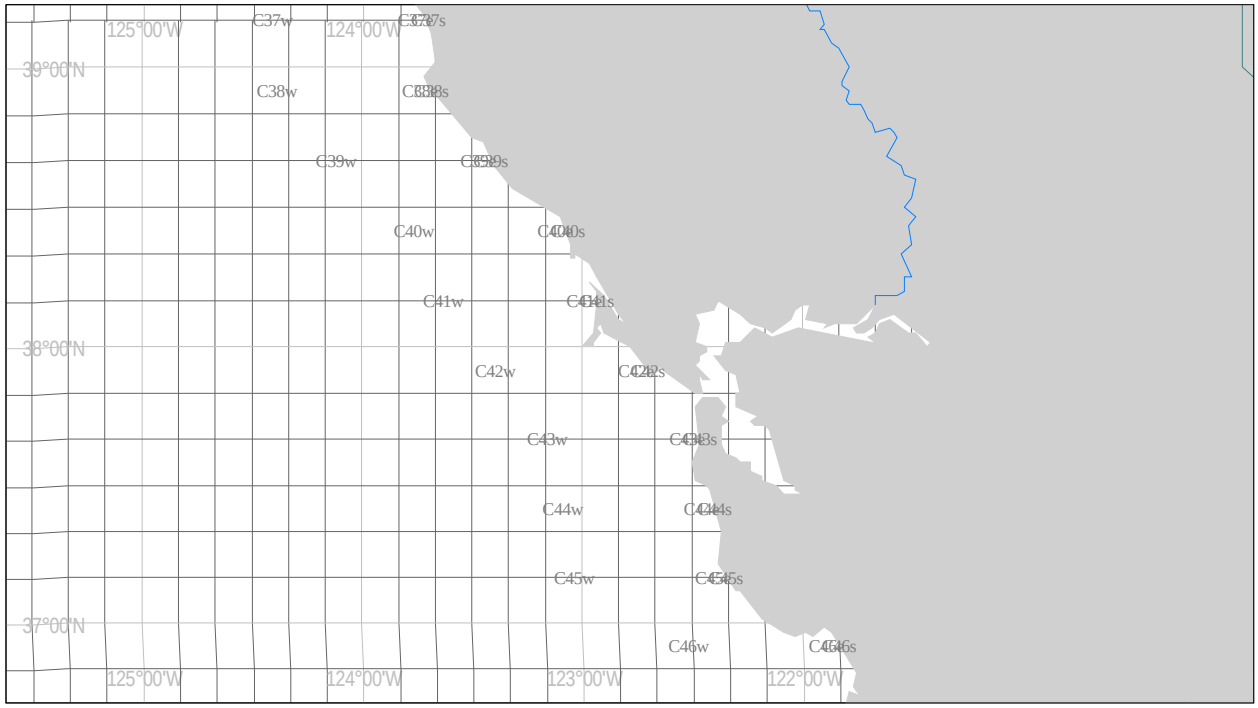
SET C Northern Region: Transects 17-26



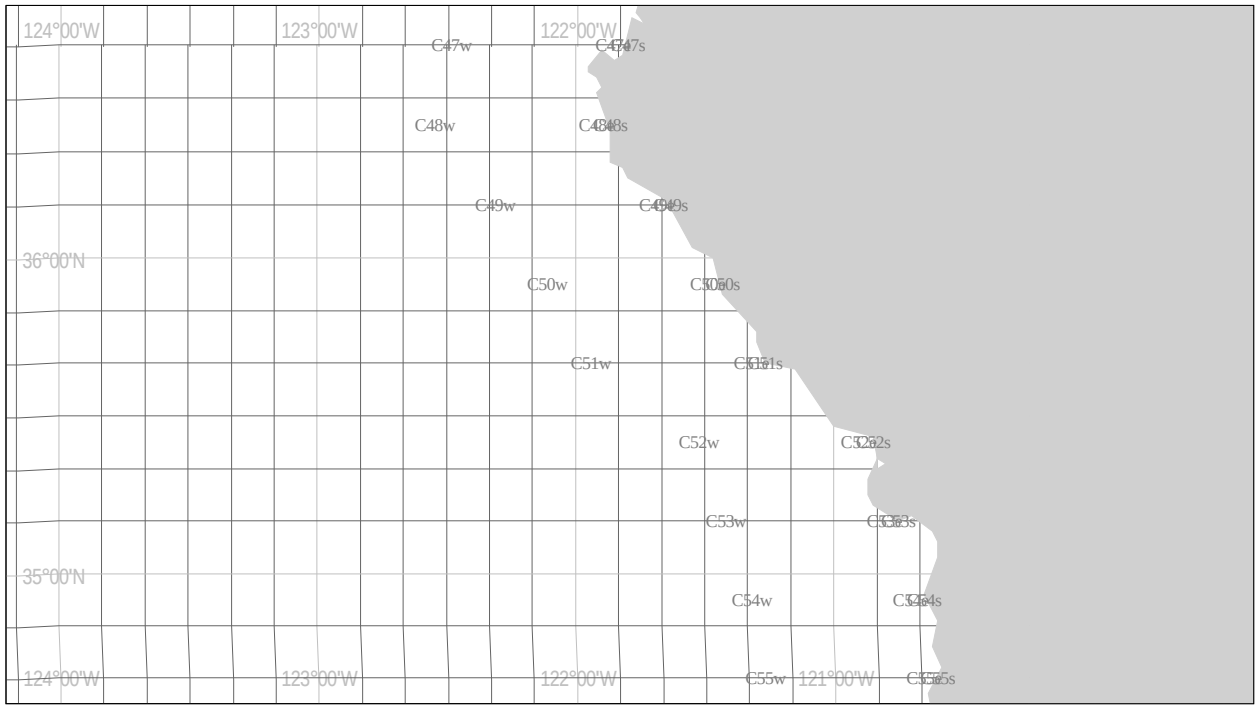
SET C Southern Region: Transects 27-36



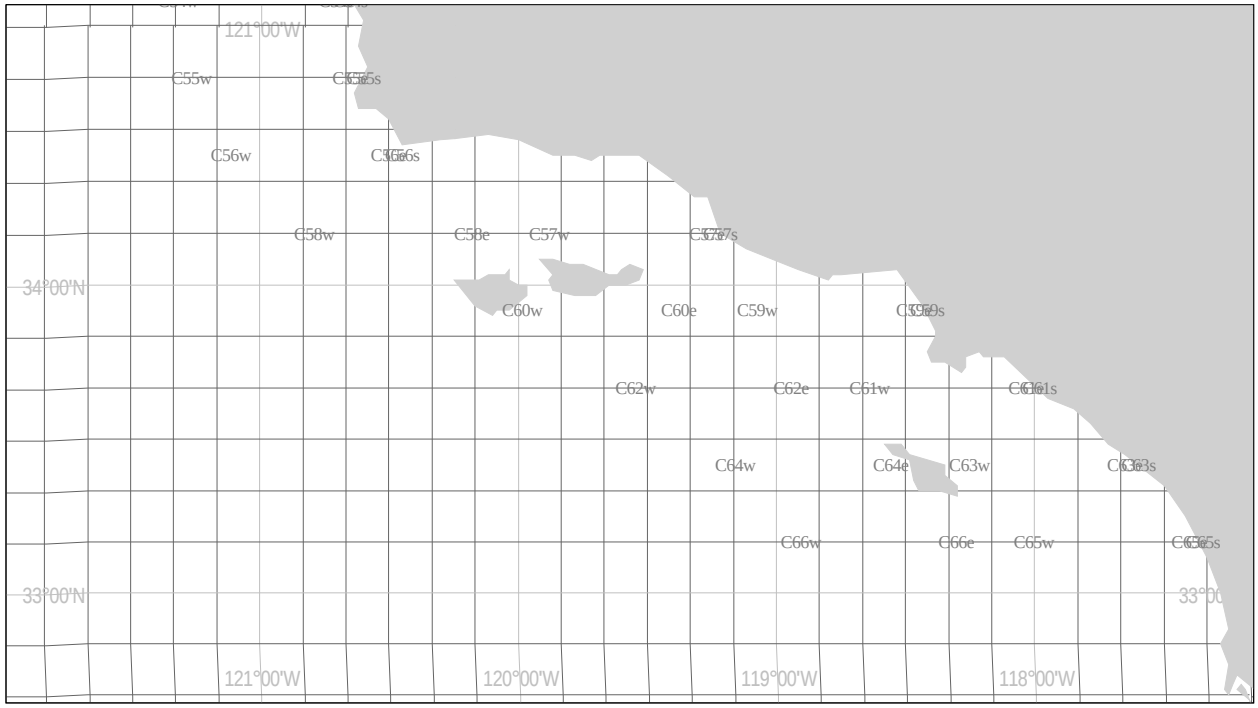
SET C Southern Region: Transects 37-46



SET C Southern Region: Transects 47-55

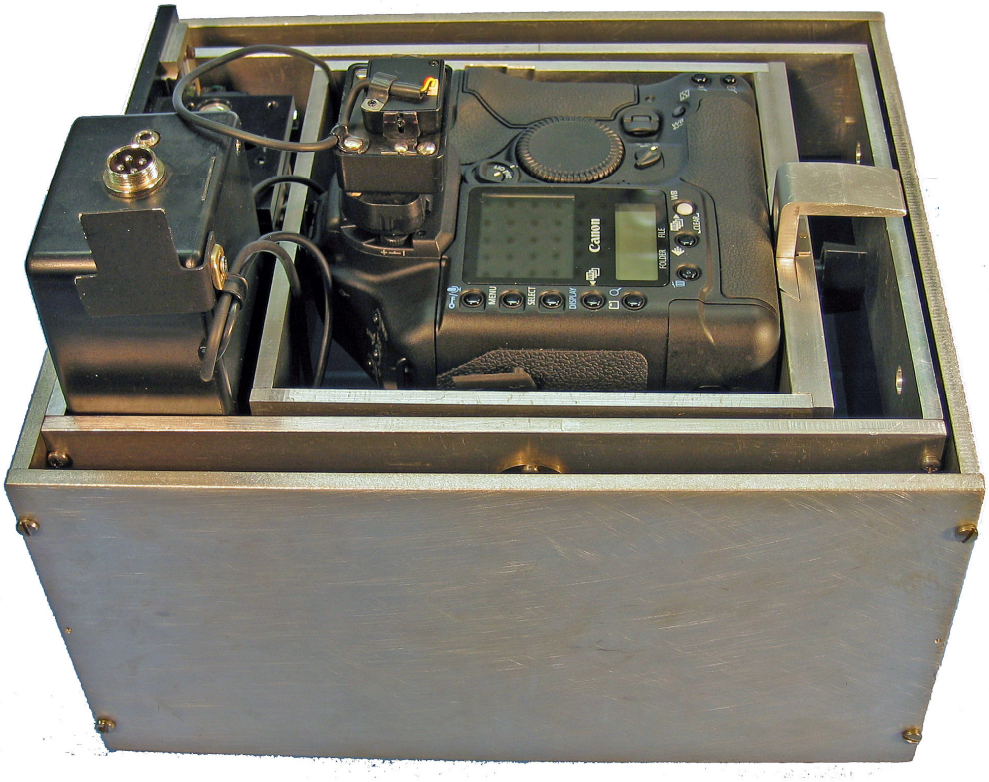


SET C Southern Region: Transects 55-66



Appendix I, Adjunct 1. Aerial Imaging Solutions FMC System

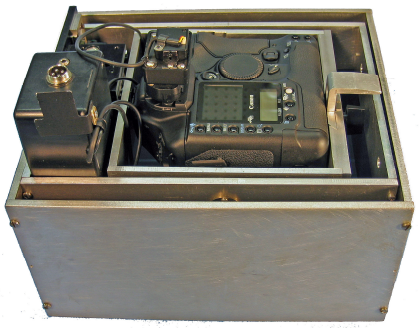
AERIAL IMAGING SOLUTIONS
FMC MOUNT SYSTEM

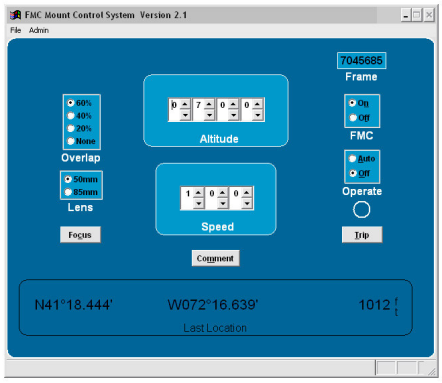


DESCRIPTION

An aerial mount system for digital cameras that reduces image blur caused by the forward motion of the aircraft while the shutter is open. The mount and camera are connected to, and remotely controlled by, a program running on a customer-supplied (Windows-based) computer. Flight and camera parameters entered by the computer's operator determine the required forward motion compensation (FMC) and camera firing interval. The system also takes inputs from the customer-supplied GPS and radar altimeter and will, optionally, use these data to automatically determine the required FMC and firing interval. The system includes a remote viewfinder that displays the image seen through the camera's eyepiece on a small monitor to permit the computer operator to observe camera operation to ensure successful coverage of sites. It also includes a data acquisition system that interfaces with the camera, GPS, radar altimeter, and computer to record position and altitude readings as each frame is collected.

AERIAL IMAGING SOLUTIONS
FMC MOUNT SYSTEM





TECHNICAL SPECIFICATIONS

Cameras Accepted

- Canon EOS-1Ds (Standard)
- Any small or medium format digital camera (Custom)

- **FMC Drive**
  - Servo motor with closed-loop control circuit
- **Weight and Dimensions (Approximate)**
  - Weight w/Camera and cables: 15 lbs (6.8 kg)
  - Length: 11.3” (287 mm)
  - Width: 9.8” (250 mm)
  - Height: 9.3” (237 mm)
- **Environmental**
  - 32° F to 113° F (0° C to 45° C)
- **Power**
  - 28 V DC @ 3A
- **Setup and Pre-flight Testing Time**
  - Approximately 2 hours

Contents of System

- Mount
- Mount Controller
- Control Program
- Data Logger
- Cables
- Transportation Box

Appendix I, Adjunct 2. Field data forms – Coastwide Summer Aerial Sardine Survey

West Coast Sardine Survey 2010

Biological Sampling Form

Date: Vessel: Sample No.

Sampler: Processor: Total Sample Wt (kg)

Fish #	Weight (g)	Std. Length (mm)	Sex (M/F)	Maturity Code	Otolith vial #
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Fish #	Weight (g)	Std. Length (mm)	Sex (M/F)	Maturity Code	Otolith vial #
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					

Comments:

West Coast Sardine Survey 2010

Fisherman's Log Form

Date: _____ **Captain:** _____

Vessel: _____ **Processor:** _____

Hydroacoustic Gear

Type	Manufact.	Model	Frequency
Sounder			
Sonar			

Net Dimensions

Length	Depth	Mesh Size

School and Ocean Data

Point Set	Time	Latitude	Longitude	Depth to Top of School (fath)	Depth to Bottom of School (fath)	Ocean Depth (fath)	Temp.	*Weather Condition
1								
2								
3								
4								
5								
6								

Captains Estimate

Point Set	% of school captured	Estimated Tonnage at Sea
1		
2		
3		
4		
5		
6		

Delivery Information

Point set	Fish Hold	Other Vessel utilized	Delivered Weight (lbs)	Fish Ticket Number
1				
2				
3				
4				
5				
6				

Comments: _____

*Weather Codes: 1= calm, clear; 2= light wind, good visibility; 3= moderate wind, fair visibility; 4= poor fishing conditions.

West Coast Sardine Survey 2010

Point Set Flight Log Form

Date: _____ **Processor:** _____

Pilot: _____ **Observer:** _____

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
1									

Comments:

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
2									

Comments:

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
3									

Comments

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
4									

Comments:

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
5									

Comments:

Set #	Time	Photo #	Latitude	Longitude	Altitude	Vessel	Species Observed	% of School Captured	Estimated Tonnage
6									

Comments:

West Coast Sardine Survey 2010

Transect Flight Log Form

Transect: ____________ **Date:** ____________ **Pilot:** ____________

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Time	Photo #	Latitude	Longitude	Altitude	Species Observed	Estimated Tonnage

Comments:

Appendix I, Adjunct 3. Identification and gear configuration of participating vessels

Vessels: Northern region

The NWSS-LLC will have the option to draw upon the following vessels during the EFP work:

1. Vessel: Pacific Pursuit
   Skipper: Keith Omey
   Owner: Pacific Pursuit, LLC
   OR Reg#: OR873ABY
   OR Sardine Permit#: 30920
   Length: 73’

2. Vessel: Lauren L. Kapp
   Skipper: Ryan Kapp
   Owner: Daryll Kapp
   OR Reg#: OR072ACX
   OR Sardine Permit #: 57008
   Length: 72’

3. Vessel: Pacific Knight
   Skipper: Mike Hull
   Owner: Dulcich, Inc.
   OR Reg#: OR155ABZ
   OR Sardine Permit#: 57011
   Length: 62’

4. Vessel: Pacific Raider
   Skipper: Nick Jerkovich
   Owner:
   OR Reg#: 972638
   OR Sardine Permit#: 57010
   Length: 58’

Vessels: Southern region

The CWPA will have the option to draw upon the following vessels during the EFP work:

Vessel Name	Skipper	Owner	USCG #	CPS Permit #
Monterey				
Sea Wave	Andy Russo	Sea Wave Corp-Sal Tringali	D951443	10
King Philip	Anthony Russo	Sea Wave Corp-Sal Tringali	D1061827	9
El Dorado	Frank Aliotti	Aliotti Brothers Inc.	D690849	32
Aliotti Bros.	Dominic Aliotti	Joseph D. Aliotti	D685870	48
Southern CA				
Eileen	Nick Jurlin	South Sound Fisheries Inc.	D252749	38
Trionfo	(Neil) Guglielmo	Aniello Guglielmo	D625449	45
Endurance	Vince Lauro	Vincent Lauro	D613302	35
Maria T	Robert Terzoli	Vito Terzoli	D509632	25

Appendix I, Adjunct 4. Aerial Survey Point Set Protocol

1) Sardine schools to be captured for point sets will first be selected by the spotter pilot and photographed at the nominal survey altitude of 4,000 ft. After selection, the pilot may descend to a lower altitude to continue photographing the school and setting the fishing vessel.
2) It is essential that any school selected for a point set is a discrete school and is of a size that can be captured in its entirety by the purse seine vessel; point set schools may not be a portion of a larger aggregation of fish.
3) To ensure standardization of methodology, the first set of point sets taken by each participating pilot will be reviewed to ascertain that they meet specified requirements. From that point forward, point set photos will be reviewed routinely to ensure that requirements are met.
4) A continuous series of photographs will be taken before and during the vessels approach to the school to document changes in school surface area before and during the process of point set capture. The photographs will be collected automatically by the camera set at 60% overlap.
5) Each school selected by the spotter pilot and photographed for a potential point set will be logged on the spotter pilots' Point Set Flight Log Form. The species identification of the selected school will be verified by the Captain of the purse seine vessel conducting the point set, and will be logged on the Fishermans' Log Form. These records will be used to determine the rate of school mis-identification by spotter pilots in the field and by analysts viewing photographs taken at the nominal survey altitude of 4,000 ft.
6) The purse seine vessel will wrap and fully capture the school selected by the spotter pilot for the point set. Any schools not "fully" captured will not be considered a valid point set for analysis.
7) If a school is judged to be "nearly completely" captured (i.e. over 90% captured), it will be noted as such and will be included for analysis. Both the spotter pilot and the purse seine vessel captain will independently make note of the "percent captured" on their survey log forms for this purpose.
8) Upon capture, sardine point sets will be held in separate holds for separate weighing and biological sampling at the dock.
9) Biological samples of individual point sets will be collected at fish processing plants upon landing. Samples will be collected from the unsorted catch while being pumped from the vessels. Fish will be systematically taken at the start, middle, and end of a delivery as it is pumped. The three samples will then be combined and a random subsample of fish will be taken. The sample size will be n = 50 fish for each point set haul.
10) Length, weight, maturity, and age structures will be sampled for each point set haul and will be documented on the Biological Sampling Form. Sardine weights will be taken using an electronic scale accurate to 0.5 gm. Sardine lengths will be taken using a millimeter length strip provided attached to a measuring board. Standard length will be determined by measuring from sardine snout to the last vertebrae. Sardine maturity will be established by referencing maturity codes (female- 4 point scale, male- 3 point scale). Otolith samples will be collected from n = 25 fish selected at random from each n = 50

fish point set sample for future age reading analysis. Alternatively, the 25 fish subsample may be frozen and sampled for otoliths at a later date.

11) School height will be measured for each point set. This may be obtained by using either the purse seine or other participating research vessels' hydroacoustic gear. The school height measurements to be recorded on the Fishermans' Log Form are: 1) depth in the water column of the top of the school, and 2) depth in the water column of the bottom of the school. Simrad ES-60 sounders will be installed on three purse seine vessels. Data collected by the ES-60 sounders will be backed-up daily and archived onshore.
12) Point sets will be conducted for a range of school sizes. Each day, the spotter pilot will operate with an updated list of remaining school sizes needed for analysis. The spotter pilot will use his experience to judge the surface area of sardine schools from the air, and will direct the purse seine vessel to capture schools of the appropriate size. Following landing of the point sets at the dock, the actual school weights will be determined and the list of remaining school sizes needed will be updated accordingly for the next day of fishing. If schools are not available in the designated size range, point sets will be conducted on schools as close to the designated range as possible.
13) The field director will oversee the gathering of point set landing data and will update the list of point sets needed (by size) daily for use by the spotter pilot.
14) Photographs and FMCdatalogs of point sets will be forwarded from the field for lab analysis daily.
15) The total landed weight of point sets sampled will not exceed the EPF allotment per area.
16) The following criteria will be used to exclude point sets from the density analysis (reasons used to deem a point set "unacceptable"). Mr. Ryan Howe will make the final determination of point set acceptability.

1	Percent captured	School is judged to be less than 90% captured
2	No photograph -1	No photograph of vessel was documented (camera off)
3	No photograph -2	No photograph of vessel was documented (camera on)
4	No photograph -3	Photograph available, but late (vessel is already pursing the catch)
5	School not discrete	Sardine captured was only a portion of a larger school ("cookie cutter")
6	Mixed hauls	Multiple point sets were mixed in one hold

Appendix I, Adjunct 5

Fall Southern California Pilot Sardine Survey

2010 Operational Plan

By

Dr. Doyle Hanan, PhD
Principal Investigator / Project Director

February 17, 2010

I. Transect Survey

Overall Aerial Survey Design
The 2010 Southern California Pilot Sardine Survey design consists of 6 transects spanning the area from 15 miles north of CalCOFI line 86.7 in the north to 15 miles south of CalCOFI line 90 in the southern California Bight (Figures 1 and 2). These transects will extend on or parallel to the CalCOFI lines and run from shore to 75 miles offshore. Each 6-transect series will be conducted as a SET, and will make up one replicate. We intend to fly two transect SETS during day and two transect SETS during night to determine optimum observation time for sardines, thus 24 transects in total.

Location of Transects
Transects and corresponding shoreline positions are mapped in Figure 2. The transects start at shore and extend westward for 75 statute miles in length; they are spaced approximately 15 nautical miles (15 minutes) apart in latitude.

Aerial Resources Available
The airplane used for this survey will be equipped with a Canon EOS 1Ds camera with laptop control computer and lidar equipment ((1) laser and beam-control optics, 2) receiver optics and detector, and 3) data collection and display computer))[1] to survey the transects. The camera will be mounted in an *Aerial Imaging Solutions* FMC mount system installed inside the fuselage and utilizing one of the downward ports (belly port). The lidar will use a 2nd downward viewing port.

Use of Aerial Resources
The survey pilot will begin with the most northerly transect, surveying from shore to the offshore end, then move to the next transect and survey from offshore to shore. The pilot will repeat this pattern until each transect is surveyed and the SET is completed.

Use of Acoustic Resources
We propose to estimate a function which relates aerially-observed fish school area to fish biomass, including error bounds; and estimate the target strength of sardine (and perhaps other fish species) versus acoustic frequency and fish length, including error bounds.

Conditions Acceptable for Aerial Surveying
At the beginning of each potential survey day, the survey pilot will confer with Dr. Hanan; they will jointly judge if conditions will permit safe and successful surveying that day. Considering local conditions, they will also jointly determine the optimal time of day for surveying the area slated for coverage that day. Factors will include sea condition, time of day for best sardine visibility, presence of cloud or fog cover, and other relevant criteria.

[1] Churnside, J. H., J. J. Wilson, and V. V. Tatarskii. 2001. Airborne lidar for fisheries applications. Opt. Eng. 40:406-414.

Transect Sampling
Prior to beginning a survey flight, the Pre-Flight Survey Checklist will be completed. This will ensure that the camera system settings and lidar equipment are fully operational for data collection. For example, it is crucial to have accurate GPS information in the log file. It is also crucial that the photograph number series is re-set to zero. Transects flown without the necessary survey data are not valid and cannot be analyzed.

The decision of when to start a new SET of transects will be determined jointly by the pilot and the principal investigator. Transects will be flown at the nominal survey altitude of 2,000 ft whenever possible. If conditions require a lower altitude for acceptable ocean surface visibility, transects (or portions of transects) may be flown at a lower altitude, when necessary. Transects may be flown starting at either the east end or the west end.

A Transect Flight Log Form will be kept during the sampling of each transect for the purpose of documenting the observations of the pilot and/or onboard observers. Key notations will include observations of school species ID and documentation of any special conditions that could have an influence on interpreting photographs taken during transects.

It will be acceptable to skip portions of transects as conditions require (e.g. fog covering a small transect portion). The goal is to cover a full 6-transect SET in one day or night and an additional replicate SET of transects in as few days and nights as possible.

Data Transfer
Photographs and FMC camera log files will be downloaded and forwarded for analysis and archival as soon as practicable. Dr. Hanan will collect photographic data and send to Mr. Ryan Howe to archive and analyze. He will also coordinate collection of the lidar data and provide to Dr. James Churnside, NOAA Environmental Technology Laboratory Boulder, CO, to archive and analyze.

II. Point Set Sampling

Purse Seine Vessels
For 2010 Southern California Pilot Sardine Survey point set sampling, we are requesting extension of permits for four of the eight summer purse seine vessels from the EFP list, vessels located in S.CA. We further request that up to 4 vessels be allowed to fish and land fish each 24 hour period. Dr. Hanan will notify NMFS and responsible enforcement individuals of those vessels to be fishing 24 hours prior to fishing. The four S.CA. vessels are identified Adjunct 3 of this appendix, above.

Location of Point Sets
Point sets are the actual capture of fish by purse seiners approved and permitted for this research. Each set by a purse seiner will be directed by the spotter pilot. Attempts will be made to conduct point sets day and night over as wide an area as feasible; however, point sets may occur in any area covered by aerial or acoustic transects that are not restricted to purse seine fishing and where sardine schools of the desired size are found or previously identified by aerial or acoustic survey.

Aerial Photography of Point Sets
Sardine schools to be captured for point sets will be first selected by the spotter pilot and photographed at the nominal survey altitude of 2,000 ft. This is an approved altitude for the summer aerial survey and is being used in this fall survey to enhance our ability to see and identify sardines at night and by lidar during the daytime. Following selection, the spotter pilot will descend to a lower altitude to better photograph the approach of the seiner to the school and set the seiner for capture of the school. The camera system will be running with no manual firing during the entire point set, thus allowing photographs before and during the vessels approach to the school for the point set capture. Each school selected by the spotter pilot and photographed for a potential point set will be logged on the spotter pilot's Point Set Flight Log Form. The species identification of the selected school will be verified by the captain of the purse seine vessel conducting the point set and will be logged on the Fisherman's Log Form. These records will be used to determine the rate of school mis-identification by the spotter pilot in the field and by analysts viewing photographs taken at the nominal survey altitude of 2,000 ft.

Vessel Point Set Capture
The purse seine vessel will encircle (wrap) and fully capture the school selected by the spotter pilot for the point set. Any schools not "fully" captured will not be considered a valid point set for analysis. If a school is judged to be "nearly completely" captured (i.e. over 90% captured), it will be noted as such and will be included for analysis. Both the spotter pilot and the purse seine captain will independently make note of the "percent captured" on their survey log forms for this purpose. Upon capture, sardine point sets will be held in separate holds for separate weighing and biological sampling of each set after landing.

Biological Sampling
Biological samples of individual point sets will be collected at the landing docks or at the fish processing plants upon landing. Fish will be systematically taken at the start, middle, and end of a delivered set. The three samples will then be combined and a random subsample of fish will be taken. The sample size will be n = 50 fish for each point set haul.

Length, weight, maturity, and otoliths will be sampled for each point set haul and will be documented on the Biological Sampling Form. Sardine weights will be taken using an electronic scale accurate to 0.5 gm. Sardine lengths will be taken using a millimeter length strip attached to a measuring board. Standard length will be determined by measuring from sardine snout to the last vertebrae. Sardine maturity will be established by referencing maturity codes (female- 4 point scale, male- 3 point scale) supplied by Beverly Macewicz NMFS, SWFSC. Twenty five fish will be selected at random and frozen from each n = 50 fish point set sample for future age reading analysis.

Hydroacoustic Sounding of School Height
School height will be measured for each point set. This may be obtained by using either the purse seine or other participating research vessels' hydroacoustic gear. The school height measurements to be recorded on the Fisherman's Log Form are: 1) depth in the water column of the top of the school, and 2) depth in the water column of the bottom of the school.

Number and Size of Point Sets
Point sets will be conducted for a range of school sizes (Table 1). Each day or night, the spotter pilot will operate with an updated list of remaining school sizes needed for analysis. The spotter pilot will use his experience to judge the biomass of sardine schools from the air, and will direct the purse seine vessel to capture schools of appropriate size. Following landing of the point sets at the dock, the actual school weights will be determined and the list of remaining school sizes needed from Table 1 will be updated accordingly for the next day of fishing. If schools are not available in the designated size range, point sets will be conducted on schools as close to the designated range as possible. Dr. Hanan will oversee the gathering of point set landing data and will update the list daily. The total landed weight of point sets sampled will not exceed 800 mt.

Landing Reporting Requirements
Cumulative point set landings will be maintained and updated by Dr. Hanan and will be reported daily to NMFS, as per the terms of the Exempted Fishing Permit. Also included in this daily report will be an estimate of the weight of all by-catch by species.

Other EFP Reporting Requirements
Dr. Hanan will be responsible for providing the other required reporting elements (as specified in the EFP permit) to NMFS. For example, a daily notice will be provided for enforcement giving 24 hour notice of vessels to be conducting point sets on any given day and will include vessel name, area to be fished, estimated departure time, estimated return time.

III. Calibration and Validation

Aerial Measurement Calibration
A series of photographs will be collected from a feature of known size (e.g. a football field or tennis court) on the ground, from the altitude of 2,000 ft. An aerial pass will be made to place the target onto the right, middle, and left portions of the photographic image.

Aerial Photographs and Sampling for Species Validation
A set of reference photographs will be compiled which will be taken at the nominal survey altitude of 2,000 ft for the purpose of species identification. The spotter pilot will find and photograph schooling fish other than sardine (e.g. mackerel, herring, smelt, anchovy, etc). For the actual schools photographed, a vessel at sea will collect a jig sample to document the species identification. This set of reference photographs will be used by the photograph analysts to learn how to discern between sardine and other species as they appear on the aerial transect photographs.

IV. Photograph Data Reduction and Analysis

Digital images will be analyzed by Mr. Ryan Howe and his staff to determine the number, size, and shape of sardine schools on each transect. Mr. Howe will use the techniques employed during the 2008 and 2009 sardine aerial transect projects.[2] We are assuming these same methods

[2] Jagielo, T., D. Hanan, and R. Howe. 2009. West Coast Aerial Sardine Survey Sampling Results in 2009. Final report presented to California Wetfish Producers Association and Northwest Sardine Survey, LLC. 13 pages. D.

are applicable to the nighttime photographs which will focus on detecting and photographing the bioluminescence created when the sardines swim through phytoplankton and we will be testing photographic techniques to capture those images. Adobe *Photoshop Lightroom 2.0* software will be used to bring the sardine schools into clear resolution and measurements of sardine school size (m^2) and shape (circularity) will be made using Adobe *Photoshop CS3-Extended*. Photogrammetric school analysis will follow the methods used in the Coastwide summer Aerial Sardine Survey, as described on page 5 of the Main Document.

Data Analysis

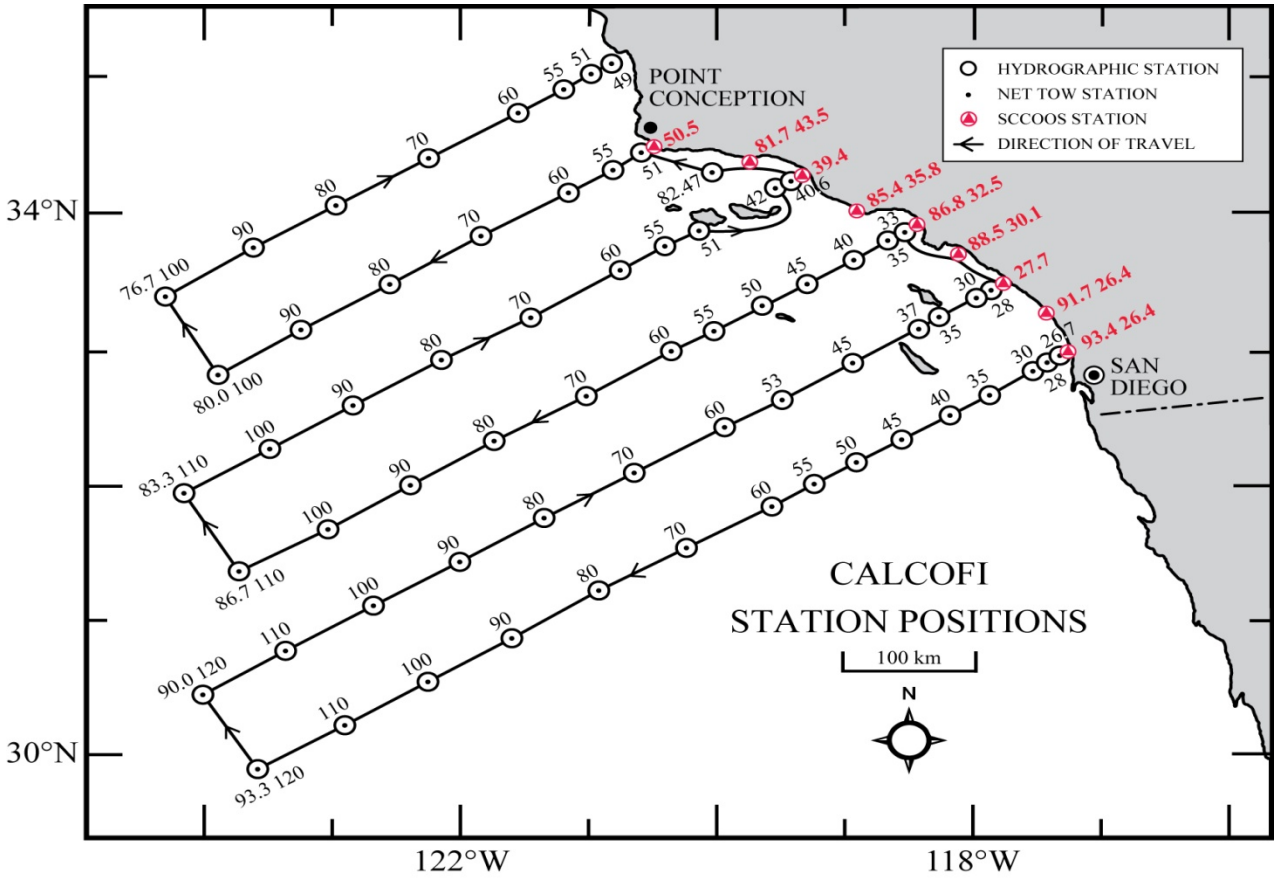
Principal Investigator, Dr. Hanan will be responsible for conducting data analysis for the Fall Southern California Pilot Survey. Mr. Jagielo will be available to provide advice and help with analysis as requested.

Transect and point set data analysis will follow the methods used in the Coastwide summer Aerial Sardine Survey, as described on page 5 of the Main Document. An estimate of total sardine biomass for the survey area will be obtained with a 3 step process: 1) measurement of individual school surface area on sampled transects, 2) estimation of individual school biomass (from measured school surface area and estimated school density), and 3) transect sampling design theory for estimation of a population total.

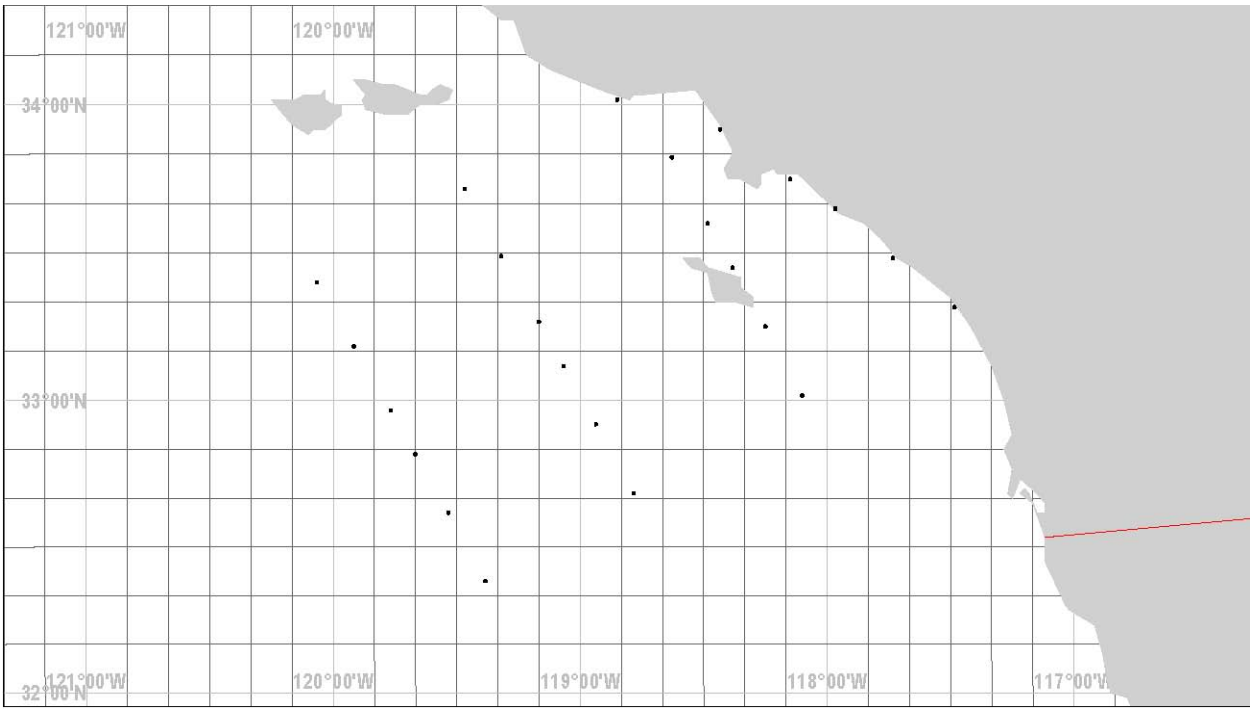
Adjunct 1, Table 1. Size and Number of Point Sets needed during 2010 EFP survey for the Southern California Pilot Sardine Survey area. Total landed weight of point sets will not exceed 800 mt.

Surface Area (m2/set)	mt/set	Number of point sets	Total mt
100	3.8	3	11.4
500	10.6	4	42.4
1000	17	5	85
2000	26.5	6	159
4000	51.9	4	207.6
8000	70.5	3	211.5
10000	82.1	1	82.1
Total		26	799

Adjunct 1, Figure 1. CalCOFI Transects



Adjunct 1, Figure 2. Fall California Pilot Study Transects.



Appendix II

NMFS Guidelines: Coastal Pelagic Species Exempted Fishing Permit (EFP)

A. Coastwide Summer Aerial Sardine Survey

Application/Proposal Contents:

1. EFP application must contain sufficient information to determine that:

a. There is adequate justification for an exemption to the regulations;

Under this EFP, the West Coast Sardine Survey (a consortium of Northern and Southern region sardine industry participants) will perform a synoptic survey of the sardine biomass off the U.S. West Coast using aerial survey data in conjunction with fishing vessel observation data. This survey will repeat and expand upon the successful survey conducted in 2009 that provided data used in the PFMC Pacific sardine stock assessment. The PFMC has indicated support for the further development of this work, and has voted to set-aside a research allocation totaling 5,000 mt for the project.

b. The potential impacts of the exempted activity have been adequately identified;

Because the fishing, fishing locations, and quantities of fish requested in this EFP are addressed as part of the 2010 sardine harvest guideline as provided for in the CPS FMP, no additional unforeseen impacts are expected from this activity.

c. The exempted activity would be expected to provide information useful to management and use of CPS fishery resources.

<See: Introduction section of the Main Document>

2. Applicants must submit a completed application in writing that includes, but is not limited to, the following information:

a. Date of application;

February 15, 2010

b. Applicant's names, mailing addresses, and telephone numbers;

<See: Survey Logistics; Project Personnel: Roles and Responsibilities (Page 9 of Main Document) >

c. A statement of the purpose and goals of the experiment for which an EFP is needed, including a general description of the arrangements for the disposition of

all species harvested under the EFP;

<See Introduction (Page 2 of Main Document); Survey Logistics; Disposition of fish harvested under the EFP (Page 11 of Main Document)>

d. Identify a single project manager (the point of contact person responsible for overall coordination of the project from beginning to end), and other staff or organizations necessary to complete the project, including specific responsibilities related to technical, analytical, and management roles. Provide evidence that the work proposed is appropriate for the experience of the investigators.

To ensure clear communications among participants and other interested parties, the single point of contact person during 2010 survey field work will be Dr. Doyle Hanan.

<See also: 1) Survey Logistics; Project Personnel: Roles and Responsibilities (Page 9 and 10 of Main Document) and 2) Appendix II, Adjunct 2; Scientific Advisors: Resumes and Curriculums Vitae>

e. Valid justification explaining why issuance of an EFP is warranted;

< See: Introduction section of the Main Document>

f. A statement of whether the proposed experimental fishing has broader significance than the applicant's individual goals;

The research to be conducted under this EFP will further expand the spatial scale of a new, scientifically rigorous survey of the Pacific sardine resource, and will again provide valuable Pacific sardine stock assessment data to the Council and to NOAA Fisheries. In addition, the pilot project proposed in this EFP application will evaluate alternative methods to measure biomass that may improve assessment methodology for sardine and potentially other CPS fisheries as well. This information is considered a high priority research and data need by NOAA Fisheries. This survey methodology has been recommended by the Council and its sub-panels for use as an index of abundance in the PFMC Pacific sardine stock assessment. Need to add STAR panel recommendations

g. An expected total duration of the EFP;

This EFP will be valid for one year, allowing for catching of Pacific sardine during the closed periods between seasonal allocations throughout the 2010 season.

h. Number of vessels covered under the EFP as well as vessel names, skipper names, and vessel ID numbers and permit numbers;

<See: Appendix I, Adjunct 3; Identification and Gear Configuration of Participating EFP Vessels>

i. A description of the species (target and incidental) to be harvested under the EFP and quantitative justification for the amount(s) of such harvest necessary to conduct the experiment; this description should include harvest estimates of overfished species and protected species;

Under this EFP, participating vessels will target Pacific sardine exclusively. At the March, 2010 meeting, the Council recommended that 5,000 mt of Pacific sardine be deducted from the 2010 Harvest Guideline prior to allocation and set aside for the dedicated sardine research to be conducted under this EFP. This recommendation is awaiting final PFMC and NMFS rulemaking approval. If approved, the harvested quantity under this EFP will be limited to this Council recommended 5,000 mt set-aside.

Bycatch is generally low in CPS fisheries because most CPS vessels fish with roundhaul gear, which encircles schools of fish with nets. This gear targets specific schools, which usually contain only one species. The most common incidental catches in the CPS fishery are other CPS species; Pacific mackerel, jack mackerel, market squid, and northern anchovy, may be encountered in small numbers and will be retained if captured. Quantities of these other coastal pelagics species are expected to be nominal, and within the harvest guidelines for those species. No other species are expected to be encountered or harvested under this EFP.

A quantitative analysis of sample size requirements was conducted to justify the amount of sardine needed to accomplish the survey objectives (See: 1) Main Document Pages 8-9 and 2) Appendix III; Documentation Supporting Analysis of Sample Size Requirements).

j. A description of a mechanism, such as at-sea or dockside fishery monitoring, to ensure that the harvest limits for targeted and incidental species are not exceeded and are accurately accounted for, and reported;

Under this EFP, participating vessels will deliver all species harvested to participating processing/freezing facilities within the survey area. Each participating vessel and participating processing/freezing facility will be responsible for collecting and recording catch data for each species delivered. Each participant will be responsible for the issuing and reporting of fish tickets to State authorities, as required by law.

Each participant will also be required to report all catch and fish ticket data to the survey regional Scientific Field Leader on a daily basis. Daily reporting is necessary to achieve the project objectives as specified in the Survey Design section of the main document. Individual point set catches will be kept in separate vessel holds and will be individually weighed at the dock upon landing. These individual point set catch weights will be tallied by the Scientific Field Leader to monitor the attainment of the project sample size goals which specify that point sets are to be collected in specific size categories (small and large) required under the survey design . This detailed accounting of daily catch will allow for a likewise detailed reporting to NMFS authorities and will ensure that the total sardine set aside amount of 5,000 mt will not be exceeded.

Any bycatch of other CPS species will be retained and a tally of the catch by species will be maintained by the Scientific Field Leader and reported to NMFS authorities on a daily basis to ensure that the harvest guidelines of incidental species taken are not exceeded. We do not expect more than a nominal amount of incidental species to be taken.

The PFMC website notes that, according to NMFS Biological Opinion, "… fishing activities conducted under the CPS FMP are not likely to jeopardize the continued existence of any endangered or threatened species." It is not expected that any fishing under this EFP would have any effect on any endangered or threatened species.

k. A description of the proposed data collection methods including procedures to ensure and evaluate data quality during the experiment and data analysis methodology and time line of stages through completion;

<See: 1) Survey Design and Survey Logistics sections of the Main Document, and 2) Appendix I: Field Operational Plan>

l. A description of how vessels were chosen to participate in the EFP;

<See: Page 11 of Main Document; EFP Purse Seine Vessel Selection>

m. For each vessel covered by the EFP, the approximate time(s) and place(s) fishing will take place, and the type, size, and amount of gear to be used;

The four vessels operating in the north will have the option to operate throughout the entire range of the Northern region (in the vicinity of transects 1-26). The eight vessels operating in the south (in the vicinity of transects 27-65) will operate in either the Monterey or Southern California area.

<See: Appendix I, Adjunct 3: Identification and configuration of participating vessels>

n. Identify potential benefits to fisheries management and coastal communities;

Sardine industry participants assert, based on the observations of fishing vessels and spotter pilots, that the survey to be conducted under this EFP will show a significantly greater Pacific sardine biomass than has been estimated under previous stock assessment models. If this assertion is proven to be true, the Pacific sardine HG may be expected to increase over that called for under the current stock assessment model. In any event this survey methodology has been demonstrated to be a valuable second index of abundance to expand understanding of the Pacific sardine resource.

A greater HG would provide benefits to all Pacific sardine and other CPS fisheries industry participants, including the fishermen, processers, spotter pilots, and all those employed by them, as well as to the coastal communities that support these industries. Due to the reduced HG in 2008, fishing was limited to 135 days in the first seasonal

allocation period, 38 days in the second seasonal allocation period, and 7 days in the third seasonal allocation period, resulting in 185 lost fishing days. Fishing seasons were further limited in 2009, [50 fishing days in the first period, 17 days in the second period, 8 days in the third period, and total prohibition on sardine retention on December 23, virtually eliminating fishing on the CPS complex including market squid. These closures precipitated even greater socio-economic impacts on communities. These lost fishing days mean reduced employment for fishing vessel and processing plant crews, and reduced income for coastal communities.

o. Discuss compatibility with existing seasons and other test fisheries, potential difficulties with processors or dealers, additional enforcement requirements, and potential negative impacts of the study (e.g., species listed under the Endangered Species Act, allocation shifts, shortened allocation periods, etc.);

The research set-aside for both the summer and fall sardine surveys is supported enthusiastically by the west coast sardine industry. There are no other test fisheries for sardine beside these two projects. Processors and dealers are supportive of this EFP; they are contributing a significant in-kind contribution to the research by processing the fish at cost and contributing the profit from the fish to the research. This EFP research set aside is part of the harvest guideline, and daily reports will be supplied to NMFS detailing the vessels fishing, their landing port[s] and amount of fish caught; no additional enforcement costs should be accrued.

p. Discuss ability to conduct proposed research - Identify the total costs (including collection of samples, data analysis, etc) associated with the research and sources of funding; identify any existing commitments for participation in, or funding of the project;

<See: Appendix II, Adjunct 2; Estimated Project Budget>

q. The signature of the applicant(s);

<See cover page>

B. Fall Southern California Pilot Study

Application/Proposal Contents:

1. EFP application must contain sufficient information to determine that:
   a. There is adequate justification for an exemption to the regulations;

   <See sections 2 & 3 above>

   b. The potential impacts of the exempted activity have been adequately identified

Because the fishing, fishing locations, and quantities of fish requested in this EFP are addressed as part of the 2010 sardine harvest guideline as provided for in the CPS FMP, no additional unforeseen impacts are expected from this activity.

c. The exempted activity would be expected to provide information useful to management and use of CPS fishery resources.

<See sections 2& 3 above>

2. Applicants must submit a completed application in writing that includes, but is not limited to, the following information:

a. Date of application;

March 15, 2010

b. Applicant's names, mailing addresses, and telephone numbers;

<See section 1 in the main document>

c. A statement of the purpose and goals of the experiment for which an EFP is needed, including a general description of the arrangements for the disposition of all species harvested under the EFP;

<See sections 2, 3, 4, & 5 above>

d. Identify a single project manager (the point of contact person responsible for overall coordination of the project from beginning to end), and other staff or organizations necessary to complete the project, including specific responsibilities related to technical, analytical, and management roles. Provide evidence that the work proposed is appropriate for the experience of the investigators.

To ensure clear communications among participants and other interested parties, the single point of contact person during 2010 survey field work will be Dr. Doyle Hanan. See contact information for Dr. Hanan section 1 above, CV attached below.

Mr. Ryan Howe and his staff will perform all photographic analysis. Dr. Hanan will perform project analysis of photographs and point sets to determine school size densities and sardine biomass documented by this survey. Mr. Tom Jagielo will be available to help with data analysis as requested.

Dr. Hanan will also evaluate biomass documented as compared to biomass detected by the CalCOFI transects and reported by NMFS. Dr. James Churnside, NOAA Environmental Technology Laboratory Boulder, CO, will work with our research team and analysts to compare and evaluate lidar results as compared to photographic results.

< See also: Appendix I Field Operational Plan>

e. Valid justification explaining why issuance of an EFP is warranted;

<See sections 2 & 3 above>

f. A statement of whether the proposed experimental fishing has broader significance than the applicant's individual goals;

The September, 2009 STAR Panel identified, among other research needs, that future research should consider methods that can be used to determine the proportion of sardine schools that are visible from aircraft. Acoustics (e.g., from fishing vessels) was identified as one potential method to achieve this goal The STAR panel also recommended that additional work should refine how photographs are analyzed to account for pitch and roll. The Fall Southern California Pilot Survey addresses both of these recommendations.

Additionally, techniques developed with this EFP may have significant influence on development of abundance indices for other CPS fisheries as well as sardine and may result in significant savings in fisheries assessment costs.

g. An expected total duration of the EFP;

This portion of the sardine aerial survey would extend through November 2010.

<See also: section 6 above>

h. Number of vessels covered under the EFP as well as vessel names, skipper names, and vessel ID numbers and permit numbers;

We are requesting that the four permitted vessels identified from S.CA. for the Coastwide Summer Aerial Sardine Survey list be continued through November 2010, to participate in the Fall Southern California Pilot Study, and that three of the four vessels will be permitted to fish during any 24 hour period to enable point sets to be obtained in as wide an area covered by transects as possible.

Vessel Name	*Skipper*	*Owner*	*USCG #*	*CPS Permit #*	*Length/GRT*
Eileen	*Nick Jurlin*	*South Sound Fisheries Inc.*	*D252749*	*38*	*79.4 ft/119.9 GT*
Trionfo	*(Neil) Guglielmo*	*Aniello Guglielmo*	*D625449*	*45*	*63.8 ft / 79.2 GT*
Endurance	*Vince Lauro*	*Vincent Lauro*	*D613302*	*35*	*49 ft / 42 GT*
Maria T	*Robert Terzoli*	*Vito Terzoli*	*D509632*	*25*	*57.3 ft / 68.1 GT*

i. A description of the species (target and incidental) to be harvested under the EFP and quantitative justification for the amount(s) of such harvest necessary to conduct the experiment; this description should include harvest estimates of overfished species and protected species;

We are requesting to target Pacific sardine as described in the summertime aerial survey, following the point set table on page 16 of the operational plan for this project. There is potential for an incidental catch of northern anchovy and/or other CPS during this EFP.

Incidental catches of other than the target species are generally nominal, per recorded observer data. We do not anticipate any catch of overfished or protected species.

<See also: sections 4 & 5 above>

j. A description of a mechanism, such as at-sea or dockside fishery monitoring, to ensure that the harvest limits for targeted and incidental species are not exceeded and are accurately accounted for, and reported;

All fish will be weighed upon landing and incidental catch sorted and weighed by processors while preparing the sardine for packaging and shipment. These data will be reported to Dr. Hanan, daily and he will forward the information to NMFS daily.

k. A description of the proposed data collection methods including procedures to ensure and evaluate data quality during the experiment and data analysis methodology and time line of stages through completion;

Photographs collected during the aerial survey will be reviewed daily to verify that proper imaging procedure has been followed.

<See also: section 5, above>

l. A description of how vessels were chosen to participate in the EFP

<See section 10, above>

m. For each vessel covered by the EFP, the approximate time(s) and place(s) fishing will take place, and the type, size, and amount of gear to be used

Fishing will be conducted during specified day- and night-time hours during October and November, 2010, paralleling the timing of the CalCOFI fall survey, within the range of the aerial transects (see section 11 above). Each fishing vessel deploys one purse seine or drum seine net. Net size is dependent on vessel size and target species. Typically sardine fisherman use 200-250 fm long by 30-36 fm deep nets of 11/16 in mesh.

n. Identify potential benefits to fisheries management and coastal communities;

<See 2 f. above>

o. Discuss compatibility with existing seasons and other test fisheries, potential difficulties with processors or dealers, additional enforcement requirements, and potential negative impacts of the study (e.g., species listed under the Endangered Species Act, allocation shifts, shortened allocation periods, etc.);

This EFP covers the season when sardine are usually most abundant in southern California, conducted at a period when the directed fishery is now typically closed. The

amount of the research set aside requested for this research is minimal, and the research set-aside for both the summer and fall sardine surveys is supported enthusiastically by the west coast sardine industry. There are no other test fisheries for sardine beside the summer aerial survey and this proposed pilot project. Processors and dealers are supportive of this EFP; they are contributing a significant in-kind contribution to the research by processing the fish at cost and contributing the profit from the fish to the research. This EFP research set aside is part of the harvest guideline, and daily reports will be supplied to NMFS detailing the vessels fishing, their landing port[s] and amount of fish caught; no additional enforcement costs should be accrued.

< See also: 1b. above>

p. Discuss ability to conduct proposed research - Identify the total costs (including collection of samples, data analysis, etc) associated with the research and sources of funding; identify any existing commitments for participation in, or funding of the project;

See cost estimate following. Any and all expenses not recovered through the sale of research fish will be covered by the special sardine assessment and other assessments collected by the California Wetfish Producers Association.

q. The signature of the applicant(s);

<See cover page>

Review of the application will consider, but will not be limited to, the following questions:

a. Is the application complete?

b. Is the EFP proposal consistent with the goals and objectives of the CPS FMP?

c. Can catch of target and non-target species be adequately monitored and reported in a timely manner?

d. Does the EFP account for fishery mortalities, by species?

e. Can the harvest estimates of overfished species and/or protected species be accommodated?

f. If deemed necessary is the EFP proposal compatible with the federal observer program effort?

g. What infrastructure is in place to monitor, process data, and administer the EFP?

h. How will achievement of the EFP objectives be measured?

i. What are the benefits to the fisheries management process of the issuance of the EFP?

j. If integrating data into management is proposed, what is the appropriate process?; how well does proposal integrate with current process and timelines?

k. What is the funding source for catch monitoring?

l. Has there been coordination with appropriate state and federal enforcement, management and science staff?

m. Are there any outstanding enforcement issues related to the proposed exempted regulation?

Appendix II, Adjunct 1. Resumes and Curriculums Vitae

Thomas H. Jagielo

2744 NE 54th St
Seattle, Washington 98105
(360) 791-9089
Email: TomJagielo@msn.com

Employment

[2008-Present] Tom Jagielo, Consulting — Seattle, WA

Fisheries Science Consultant *Current Projects include:*

- Design and execution of an aerial survey to estimate West Coast sardine abundance (Washington-Oregon–California) *for the* Pacific Fishery Management Council.
- Represent Oregon Department of Fish and Wildlife on the Scientific and Statistical Committee of the Pacific Fishery Management Council.
- Review and Evaluation of Annual Catch Limits and Accountability Measures proposed by Western Pacific Fishery Management Council *for the* National Marine Fisheries Service Pacific Islands Regional Office, Honolulu, Hawaii.
- Literature review and evaluation of West Coast Spatial groundfish management *for the* Environmental Defense Fund.

[1984-2008] Washington Dept. of Fish and Wildlife — Olympia, WA

Senior Research Scientist

- Developed stock assessments and rebuilding analyses used by Pacific Fishery Management Council; Designed surveys and conducted undersea manned submersible research; Investigated groundfish movement, survival, and abundance.

[1979-1984] University of Washington Fish. Res. Institute — Seattle, WA

Biologist

- Various projects including: *Japanese Foreign Fisheries Observer* (On Bering Sea for 6 months); *Limnology of Lake Roosevelt*; *Toutle River salmon survival* - following Mt. St. Helens volcanic eruption.

Education

[1988-1992] University of Washington — Seattle, WA

Post MS Graduate Study

- Fishery Population Dynamics, Statistical Sampling and Estimation

[1986-1988] University of Washington — Seattle, WA

Master of Science

- MS in Fisheries – Limnology of Lake Roosevelt, WA.

[1974-1977] Pennsylvania State University — University Park, PA

Bachelor of Science

- BS in Biology and Marine Science

Scientific Committees

- Pacific Fishery Management Council Scientific and Statistical Committee: Chairman (2002-2003); Vice Chairman (2000-2001); Member: (1992-2008); (2009-Present).
- US/Canada Groundfish Technical Subcommittee: Chairman (2003, 1987-1988); Member 1986-2008.
- PaCOOS – Pacific Coast Ocean Observation System: WDFW representative (2006-2008).

Selected Publications

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Doyle A. Hanan

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Education:

PhD, Biology 1996
University of California
Los Angeles

MA, Marine Biology 1976
California State University
Long Beach

BA, Biology 1969
California Lutheran University
Thousand Oaks

Current and Previous Affiliations and Panel Experience:

Member: Pacific Fishery Management Council's Highly Migratory Species Advisory Subpanel; **Representative:** California Cooperative Oceanic Fisheries Investigations (CalCOFI) committee; **Representative:** Pacific Scientific Review Group (advising Secretary of Commerce on marine mammals in the Pacific); **Member**: Pacific Drift Gillnet Take Reduction Team; **Member:** Congressional pinniped/salmon interaction working group; **Co-chair:** Pacific Fishery Management Council's CPS fishery management plan development team; **Chair:** Pacific Fishery Management Council's Coastal Pelagic Fisheries Management team; **Member:** Congressional National Ecosystem Principles Panel; **Representative:** Mexus-Pacifico; **Advisor:** United Nations Food and Agricultural Organization on shark fisheries management; **Member**: marine mammal society; **Associate Editor:** *California Fish and Game* quarterly periodical; **Journal Referee:** *Fisheries Bulletin*, *Marine Mammal Science*, *Fisheries Oceanography*, International Whaling Commission *Special Reports*, and *CalCOFI Fisheries Investigations Reports, Brazilian Journal of Oceanography*; Research and Grant **Reviewer**: California Sea Grant, Saltonstall-Kennedy, and City of San Diego; **Court-recognized Expert witness**: on retainer City of San Diego. **Member:** Scientific Advisory Team, State of California MLPA initiative.

Professional Experience:

Hanan & Associates, Inc.
President/ Chief Scientist
2001-Present

HDR Engineering, Inc.
Director Marine Coastal Program
Senior Biologist/Project Manager
2000-2001

California Dept of Fish and Game
Senior Marine Biologist, Supervisor
Pelagic Ecosystems 1993-2000
Associate Marine Biologist
Marine Mammals 1983-1993
Assistant Marine Biologist
Fisheries Analyses 1979-1983
Assistant Marine Biologist
Kelp Bed Ecosystem 1974-1979

California State Univ. Long Beach
Part-time Faculty
Invertebrate Zoology 1975-1976
Teaching Assistant
Vertebrate Zoology 1973-1975
Graduate Assistant
Biology 1972-1975
Teaching Assistant
General Biology 1973-1975

PVSD, Camarillo, CA
Teacher
Biology/Science 1969-1973

USMCR 1969-1975
Sergeant E-6 Honorable discharge

Personal **publication history** includes 30 peer-reviewed papers and 100+ contract or administrative reports. Available on request.

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Dr. Hanan formed and is president of Hanan & Associates, Inc. a marine consulting firm providing expertise to fisheries and wildlife agencies, municipalities, and foundations. After an early retirement as a senior marine biologist supervisor for California Department of Fish and Game, he was employed as marine director for HDR Engineering, Inc. At CDFG, he directed and participated in research teams investigating nearshore and offshore fisheries, as well as, marine mammals, invertebrates and plants. His projects focused on marine ecosystems and population biology; development and implementation of fishery management plans (white seabass plan, CPS plan, market squid plan); applied research, and fisheries analysis. He designed and implemented observer programs for the shark/swordfish drift gillnet fishery, the nearshore setnet fisheries, salmon troll fishery, and CPFV fishery. He was the state's voting member of California Cooperative Oceanic Fisheries Investigations (CalCOFI). He was selected to serve on two standing committees to advise the Secretary of Commerce: 1) Pacific Scientific Review Group which reviews all marine mammal stocks, research, and fisheries interactions in the Pacific Ocean; and 2) Drift Gillnet/Pacific Cetacean Take Reduction Team which was charged with developing overseeing a plan to reduce marine mammal bycatch in this fishery. The plan did effect an 80% reduction in this bycatch. He served on the National Ecosystem Principles Panel commissioned by Congress through the Sustainable Fisheries Act to develop recommendations expanding the application of ecosystem principles in fishery conservation and management activities. He participated in the working and contributing groups for the Report to Congress on Salmon-Pinniped and Greater Ecosystem Interactions commissioned by Congress in the reauthorization of the Marine Mammal Protection Act. For PFMC, he was co-chair of the CPS FMP development team and chair of the CPS management team that developed, wrote, and implemented the CPS FMP. He served recently on the PFMC Highly Migratory Species Advisory Sub panel. He recently served on the MLPA scientific advisory team for the State of California. H&A, Inc. has contracted with National Marine Fisheries Service, Pacific States Marine Fisheries Commission, Gulf & South Atlantic Fisheries Foundation, Inc., the City of San Diego, California Wetfish Producers Association, Sportfishing Association of California, American Sportfishing Association, and the Recreational Fishing Alliance. H&A projects include fish, fisheries, research, and consulting.

Ryan A. Howe

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Objective: To further my experience in the fisheries field while working with government agencies as well as public and private stakeholders.

Education:

University of Alaska: Anchorage, AK
North Pacific Groundfish Observer Program
Level 1 Observer (October 2006)
Level 2 Observer (March 2008)

Michigan State University: East Lansing, MI
Bachelor's of Science Degree (August 2006): Fisheries and Wildlife

Work Experience:

Scientific Field Lead, Northern region
West Coast Aerial Sardine Survey: WA and OR *July 2008 – Present*

- Coordinate coast wide data collection of aerial sardine survey
- Interaction with state and federal agencies as well as public and private stakeholders
- Collect biological information routinely of Pacific sardine (i.e. otolith, sex/length/weight, maturity)
- Daily analysis and archiving of photographic and biological data
- Enhancement and analysis of digital photos using Adobe Photoshop CS3 and Adobe Lightroom 2
- Oversee the aerial sardine survey photo analyst staff
- Experience with Simrad ES60 hydro acoustics echo sounder
- Experience with Canon EOS 1Ds camera in an Aerial Imaging Solutions FMC mount system

Fisheries Technician
Pacific Whiting Conservation Cooperative: Seattle, WA *May 2008 - Present*

- Collect biological information daily of Pacific Whiting and other species (i.e. species I.D., length/weight, species retention and storage)
- Record raw data on deck forms and enter in Microsoft Excel daily
- Assist in Seabird CTD operations (conductivity, temperature, depth)
- Work with vessel operator and crew to accomplish project tasks

North Pacific Fisheries Observer
TechSea International Inc.: Seattle, WA *September 2006 – March 2008*

- Collect biological information for NMFS (i.e. otolith, scale, s/l/w, tissue samples, species id, species retention)
- Collect and record catch and positional information on fishing vessels within the Bering Sea and Gulf of Alaska
- Interaction with state and federal agencies as well as public and private stakeholders

Fisheries Technician
Michigan State University: East Lansing, MI *June 2006 – August 2006*

- Electro-shocked streams in Northwestern and Southwestern Ontario, Canada for a Ph.D. candidates Sea Lamprey research project.
- Maintained electro-shocking equipment and USGS vehicle provided for project
- Recorded biological, positional and catch information of sampled transects.

Fisheries Technician
Michigan State University: East Lansing, MI *Fall 2005*

- Aided in electro-shocking of streams across southern lower Michigan to capture mottled sculpin for an undergraduate research project
- Gained teamwork skills by working with other technicians to accomplish the project goals

Fisheries Technician
Michigan State University: East Lansing, MI *Fall 2005*

- Gained communication skills through interaction with hatchery biologists of the Michigan Department of Natural Resources
- Collect biological samples (i.e. kidney, liver, spleen, heart and gonads) of over 100 Chinook Salmon for future genetic analysis and to check for the presence of bacterial kidney disease (BKD).

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Dr. Churnside is currently developing airborne instrumentation for marine ecosystem studies and conducting experimental marine surveys for fisheries research and management. This instrumentation includes the NOAA Fish Lidar, which can profile the density of fish and plankton in the upper ocean from a small aircraft, and radiometers for ocean color and sea-surface temperature. He used the lidar to make the first comparisons between airborne surveys and traditional ship-based methods, proving that valuable data can be obtained through airborne surveys at a fraction of the cost of ship surveys.

Dr. Churnside has extensive experience with large, multi-year field projects. He was the PI on a three-year study of menhaden in Chesapeake Bay, the lead PI on a four-year, multi-agency National Ocean Partnership Program (NOPP) on the west coast of the United States, and a Co-PI on a multi-agency North Pacific Research Board investigation in the Bering Sea. The NOPP project required coordination of a NOAA aircraft with several surface vessels and fixed moorings.

Dr. Churnside received his Ph.D. from the Oregon Graduate Center in 1978. He then became a Member of the Technical Staff of The Aerospace Corporation in Los Angeles working on atmospheric propagation and laser speckle statistics. In 1985, he joined the Environmental Technology Laboratory, where he has worked on propagation and on infrared emission from the atmosphere in addition to the Fish Lidar. From 1991 to 2001, he was chief of the Optical Remote Sensing Division. In 2005, the laboratories were reorganized to become the NOAA Earth System Research Laboratory. He has published 81 articles in refereed journals and holds 3 patents. He is a Fellow of OSA and a member of SPIE, AGU, and TOS.

Recent journal publications:

J. H. Churnside, D. A. Demer, D. Griffith, R. L. Emmett, and R. D. Brodeur, "Comparisons of lidar, acoustic and trawl data on two scales in the northeast Pacific Ocean," CalCOFI Rep. **50**, 118-122 (2009).

J. H. Churnside, E. Tenningen, and J. J. Wilson, "Comparison of data-processing algorithms for the lidar detection of mackerel in the Norwegian Sea," ICES J. Mar. Sci. 66, 1023-1028 (2009). doi:10.1093/icesjms/fsp026

J. H. Churnside and P. L. Donaghay, "Thin scattering layers observed by airborne lidar," ICES J. Mar. Sci. 66, 778-789 (2009).

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J. H. Churnside, H. E. Bravo, K. A. Naugolnykh, and I. M. Fuks, “Effects of underwater sound and surface ripples on scattered laser light,” Acoustic. J. **54**, 244-250 (2008) (in Russian). *and* Acoust. Phys. 54, 204-209 (2008) (in English).

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J. H. Churnside, “Polarization effects on oceanographic lidar,” Opt. Exp. **16**, 1196-1207 (2008).

W. G. Pichel, J. H. Churnside, T. S. Veenstra, D. G. Foley, K. S. Friedman, R. E. Brainard, J. B. Nicoll, Q. Zheng, and P. Clemente-Colon, “Marine debris collects within the north Pacific subtropical convergence zone,” Mar. Pollut. Bull. **54**, 1207-1211 (2007).

P. Carrera, J. H. Churnside, G. Boyra, V. Marques, C. Scalabrin and A. Uriarte, “Comparison of airborne lidar with echosounders: a case study in the coastal Atlantic waters of southern Europe,” ICES J. Mar. Sci. **63**, 1736-1750 (2006).

Appendix II, Adjunct 2. Estimated Project Budgets

SARDINE AERIAL SURVEY 2010 BUDGET PROJECTION (Preliminary)

Appendix III

Estimated EFP Project Budget - 2010 [Expanded into S.CA.]

									Budget 2010 Revised
CALIFORNIA (SOUTH): Revenues projected from the sale of research quota are based on the following formula, for the purpose of constructing this budget: $700 mt [rounded] delivered Asia * 1,925 mt packed = $1,347,500. Estimated processing cost for 20 kilo polywrap = approx. $400/mt. Proceeds [exclusive of cost of fish] = approximately $300/mt. Net revenue projected [rounded] = $550.000.									**$526,600.00**
NOTE: CWPA established a Special Sardine Assessment, with revenues accounted for in a dedicated account, to help fund this research. Any costs incurred beyond the proceeds generated by sale of the research fish will be paid from the dedicated sardine research account. Any proceeds received in excess of costs will be held in a dedicated account for the next year's survey.									**$70,000.00**
									$596,600.00
EXPENSES - CA:						Weather			
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	contingency	Total	Extension	
Flying the transects	39	1	$300	$11,700	3	1.5	$52,650		**$58,600.00**
Processing transect images	39	4	$20	$3,120	3		$9,360		**$8,640.00**
Point Sets	# Point sets	#Sets/day	$/Day	# Days					
Charter-point sets on schools	56	1.5	$4,500	40			$180,000		**$180,000.00**
Charter - tow Biosonics									
	Hrs/Day		$/Hr	# Days					
Flying the point sets [2 planes]	12		$300	20			$72,000	$314,010	**$72,000.00**
CA Scientific PI - hours							$96,750		**$96,750.00**
CA Scientific staff - expenses							$10,000		**$10,000.00**
CA Sample collection (processing)									**$5,000.00**
Data coordinator - expenses (Howe)							$3,500		**$3,500.00**
CA data coordination (Ryan Howe)							$16,000		**$16,000.00**
								$126,250	
Equipment									
FMC Camera System [Rent]	$6,000.00						$6,000		**$6,000.00**
FMC Balance on camera purchase	$12,000.00						$12,000		**$12,000.00**
FMC Support	$4,500.00						$4,500		**$4,500.00**
ES 60 Sounders (1)							--		
Biosonics DT-X Mod.Transducer	$6,000.00						$6,000		**$6,000.00**
Biosonics Data Analysis	$5,000.00						$5,000		**$5,000.00**
								$33,500	
50:50 Share - PI Planning & Oversight									
Scientific staff - hours							$65,000		**$65,000.00**
Scientific staff - expenses							$7,500		**$7,500.00**
								$72,500	
Misc. Travel for May, June field trials							$2,500		**$2,500.00**
Accounting/bookkeeping							$5,000		**$5,000.00**
Office equipment, software & misc. expense							$1,800		
5% contingency on operations									**$28,199.50**
								$6,800	
PROJECT SUBTOTAL - CALIFORNIA									**$592,189.50**

SARDINE AERIAL SURVEY 2010 BUDGET PROJECTION (Preliminary)

Appendix III

Estimated EFP Project Budget - 2010 [FALL S.CA. PILOT PROJECT]

CALIFORNIA (SOUTH): Revenues projected from the sale of research fish [728 mt packed wt] are based on the following formula, for the purpose of constructing this budget: $550 mt [rounded] FOB Long Beach *. Estimated processing cost = approx. $300/mt. Proceeds [exclusive of cost of fish] = approximately $250/mt. Net revenue projected [rounded] = $182,000.

NOTE: CWPA established a Special Sardine Assessment, with revenues accounted for in a dedicated account, to help fund this research. Any costs incurred beyond the proceeds generated by sale of the research fish will be paid from the dedicated sardine research account. Any proceeds received in excess of costs will be held in a dedicated account for the next year's survey.

									Budget 2010 Revised
									$182,153.43
									$182,153.43
EXPENSES - CA:									
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	Weather contingency	Total	Extension	
Flying the transects-daylight	6	1	$600	$3,600	2	1.5	$10,800		**$25,100.00**
Flying the transects-night	6	1	$600	$3,600	2	1.5	$10,800		
Processing transect images	12	4	$20	$960	2		$1,920		**$1,920.00**
Point Sets	# Point sets	#Sets/day	$/Day	# Days					
Charter-point sets on schools	26	2	$4,500	14			$63,000		**$63,000.00**
Charter - tow Biosonics									
	Hrs/Day		$/Hr	# Days					
Flying the point sets	6		$300	14			$25,200	$111,720	**$25,200.00**
CA Scientific PI - hours							$15,000		**$15,000.00**
CA Scientific staff - expenses							$5,000		**$5,000.00**
Lidar - Equipment & Analysis by Churnside							$44,957		**$44,957.00**
CA Sample collection (processing)							$1,680		**$1,680.00**
Data coordinator - expenses (Howe)									**n/a**
CA data coordination (Ryan Howe)									**$3,600.00**
								$66,637	
Equipment									
FMC Camera System [Rent]	$3,000.00						$3,000		**$3,000.00**
FMC Balance on camera purchase	$6,000.00						$6,000		**$6,000.00**
FMC Support	$4,500.00						$4,500		**$4,500.00**
ES 60 Sounders (1)									
Biosonics DT-X Mod.Transducer									**n/a**
Biosonics Data Analysis - 50 hrs							$6,500		**$6,500.00**
								$20,000	
Advisor Planning & Oversight									
Scientific staff - hours							$7,500		**$7,500.00**
Scientific staff - expenses									**n/a**
								$7,500	
Misc. Travel for field trials							$2,500		**$2,500.00**
Accounting/bookkeeping							$1,000		**$1,000.00**
Office equipment, software & misc. expense									
5% contingency on operations									**$10,822.85**
								$3,500	
PROJECT SUBTOTAL - CALIFORNIA									**$227,279.85**

Estimated EFP Project Budget - February, 2010

PACIFIC NORTHWEST (Northern region): Revenues projected from the sale of research quota are based on the following formula, for the purpose of constructing this budget: $675 mt FOB container yard * 2,100 mt = $1,417,500. Estimated processing cost = approximately 300/mt. = $630,000. Net revenue projected = $-20,600.

EXPENSES - PNW:						Weather		
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	contingency	Total	Extension
Flying the transects	26	3	$500	$39,000	3	1.5	$175,500	
Processing transect images	26	8	$25	$5,200	3		$15,600	
Point Sets	# Point sets	#Sets/day	$/Day	# Days				
Fishing Point sets on schools	56	2	$12,500	28			$350,000	
	Hours		$/Hr					
Flying the point sets	112		$300				$33,600	$574,700
PNW Specific Scientific support costs:								
PNW Science Advisor - hours							$15,000	
PNW Science Advisor - expenses							$5,000	
PNW Science Staff - hours							$40,000	
PNW Science Staff - expenses							$15,000	
								$75,000
Equipment								
Software for 2 laptops	$4,000.00						$4,000	
Laptops (2)	$2,200.00						$2,200	
								$6,200
50:50 Share - Science Advisor planning, oversight, analysis, report preparation, results presentation								
Science Advisor - hours							$65,000	
Science Advisor - expenses							$7,500	
								$72,500
Accounting/bookkeeping							$5,000	
Office equipment, software & misc. expense							$1,800	
10% contingency on operations							$72,900	
								$79,700
PROJECT SUBTOTAL - PACIFIC NORTHWEST								**$808,100**
Processing Costs								**$630,000**
TOTAL COSTS - PACIFIC NORTHWEST								**($1,438,100)**
Estimated gross revenue								**$1,417,500**
NET Proceeds								**($20,600)**

Appendix III

Documentation in Support of
Evaluation of Sample Size Requirements

Appendix III, Adjunct 1

Documentation of R Function “MSBVAR”

Package 'MSBVAR'

July 21, 2009

Version 0.4.0

Date 2009-06-12

Title Markov-Switching, Bayesian, Vector Autoregression Models

Author Patrick T. Brandt <pbrandt@utdallas.edu>

Maintainer Patrick T. Brandt <pbrandt@utdallas.edu>

Depends R (>= 2.8.0), KernSmooth, xtable, coda, bit, mvtnorm

Description Provides methods for estimating frequentist and Bayesian Vector Autoregression (VAR) models. Functions for reduced form and structural VAR models are also available. Includes methods for the generating posterior inferences for VAR forecasts, impulse responses (using likelihood-based error bands), and forecast error decompositions. Also includes utility functions for plotting forecasts and impulse responses, and generating draws from Wishart and singular multivariate normal densities. Current version includes some limited functionality to build models with Markov switching.

LazyLoad yes

License GPL (>= 2)

URL http://www.utdallas.edu/~pbrandt/

Repository CRAN

Date/Publication 2009-07-21 12:26:57

R topics documented:

Appendix III, Adjunct 2

R code developed to propagate error from Stage 1 and Stage 2 sampling through to the biomass estimate.

```
# Modified from Dvora with covariance on pointset data obtained from library 'MSVBAR'
cdata <- read.csv(file="cdata.csv")              #file of point set data
transectdata <- read.csv(file="transectdata.csv") #file of transect surface area data

 bootsard3 = function(nboots,cdata,transectdata){
  convert = function(yint, asymp, cc, x) {   #defines function to convert area to bms - yint = y intercept
    return((yint*cc+asymp*x)/(cc+x))} #asymp = asymptote as x->infty, asymp/c = slope at orgin
  nls.control(maxiter = 5000,tol = 2e-6) #control parameters for nonlinear fitting
  ntransects <- 41
  dimcdata <-  dim(cdata)
  npdata <- dimcdata[1] #number of point sets
  larea <- log(cdata$Area) #logs of areas of point sets
  parea <- cdata$Area  #point set areas
  obs <- cdata$ObsDens
  lobs <- log(cdata$ObsDens) #log of observed densities of point sets
  mmfit <- nls(lobs~log(convert(exp(lyint),exp(lasymp),exp(lcc),parea)),
    start = list(lyint= log(0.061), lasymp = log(0.004), lcc = 7),
    upper=list(lyint = 1e10,lasymp=0.02,lcc=1e10),algorithm="port")  #fit point set data
  #mmfitalt <- nls(lobs~(a*mmc+b*parea)/(mmc+parea),start=list(a=-5000,b=-5,mmc=2000))
  mmcoef <- coef(mmfit)
  yint <- exp(mmcoef[1])  #fitted coef a
  asymp <- exp(mmcoef[2])  #fitted coef b
  cc <- exp(mmcoef[3])  #fitted coef c
  predobs <- convert(yint,asymp,cc,cdata$Area)
  res <- predobs - obs  #residuals of point sets
  windows()
  plot(ObsDens~Area,data = cdata,ylab="Density",pch=19) #plots point set data
  areas <- 100*(1:95)
  pdens0 <-  convert(yint,asymp,cc,areas)#predicted curve
  lines(pdens0~areas,col='dark red',lwd=3)  #plots predicted curve
  Density <- convert(yint,asymp,cc,transectdata$sarea)
  transectdata$bms <- Density*transectdata$sarea  #estimated bms of schools
  transectbms1 <- tapply(transectdata$bms,transectdata$transect,sum)#calc bms on transect by
summing over schools
  tbms0 = 599*sum(transectbms1)/41  #calculate total bms
  print(paste("Est bms = ",round(tbms0)),quote=F)
  cof <- matrix(nrow=nboots,rep(0,3*nboots)) #set up bootstraps
  bms <- rep(0,nboots)
  library('MSBVAR')
  covmatrix <- vcov(mmfit)
  meanparams <- coef(mmfit)
  newcoef <- rmultnorm(nboots,vmat=covmatrix,mu=meanparams)
  for (i in 1:nboots){
    nyint <- exp(newcoef[i,1])
    nasymp <- exp(newcoef[i,2])
    nasymp <- min(nasymp,0.02)
    nc <- exp(newcoef[i,3])   #simulated coefficients
    #if (i < 20){ #draw refitted lines on pointset plot
```

```
    pdens <- convert(nyint,nasymp,nc,areas)
    lines(pdens~areas,col=i,lwd=0.05)
  #   }
  Density <- convert(nyint,nasymp,nc,transectdata$sarea)
  bms1 <- Density*transectdata$sarea  #bms of schools
  #plot(bms1~transectdata$sarea,xlim=c(0,20000),ylim=c(0,100))
  transectbms <- tapply(bms1,transectdata$transect,sum) #bms on each transect
  tresample <- sample(1:ntransects,replace=T)  #sample the transect indicies
  retransect <- transectbms[tresample] #bootstrap of transects
  bms[i] <- 599*sum(retransect)/41  #calculated bms of this bootstrap
  #print(paste("interation = ",i),quote=F)
 }
 write.csv(bms, file = "bms.csv")
 #lines(pdens0~areas,col='dark red',lwd=4)
 windows()
 hist(bms,breaks=20,density=10,col='dark blue') #histogram of bootstrapped biomasses
 print(paste("SE = ",round(sd(bms,na.rm=TRUE))),quote=F)
 print(paste("CV = ",round(sd(bms,na.rm=TRUE))/tbms0), quote=F)
 quant <- round(quantile(bms,(0:20)*0.05)) #quantiles by 5%
 quant100 <<- round(quantile(bms,(0:100)/100)) #quantiles by 1%
 print(paste("Median Bms = ",quant[11]),quote=F)
 print(paste("95% C.I. = (",quant[2],quant[19],")"),quote=F)
 print(paste("99% C.I. = (",quant100[2],quant100[100],")"),quote=F)
 print("Quantiles",quote=F)
 print(quant)

}
```

Appendix III, Adjunct 3

R code developed to simulate the effect of increasing point set sample size on the variance of the biomass estimate (n = 41 transects).

```
# Modified from Dvora with covariance on pointset data obtained from library 'MSVBAR'

runbs6 = function(nruns){
 transectdata <- read.csv(file="transectdata.csv") #file of transect surface area data
 bscdata <- read.csv(file="sdens95.csv",header=TRUE)
 sdens95 <- read.csv(file="fmt95.csv",header=TRUE)
 sdens95$Area <- bscdata[,1]

   for (i in 1:nruns){
     sdens95$ObsDens <- bscdata[,i+1]
     if (i>0) {print(paste("iteration = ",i),quote=F)}
      bootsard6(1000,sdens95,transectdata)
      #write.csv(output95, file = "output95.csv")
                 }
                 }

bootsard6 = function(nboots,cdata,transectdata){
  #cdata = calibration (point set data)
  #transectdata = areas of schools observed in transect
  convert = function(yint, asymp, cc, x) {   #defines function to convert area to bms - yint = y intercept
    return((yint*cc+asymp*x)/(cc+x))} #asymp = asymptote as x->infty, asymp/c = slope at origin
  nls.control(maxiter = 5000,tol = 2e-6) #control parameters for nonlinear fitting
  ntransects <- 41
  dimcdata <-  dim(cdata)
  npdata <- dimcdata[1] #number of point sets
  larea <- log(cdata$Area) #logs of areas of point sets
  parea <- cdata$Area  #point set areas
  obs <- cdata$ObsDens
  lobs <- log(cdata$ObsDens) #log of observed densities of point sets
  mmfit <- nls(lobs~log(convert(exp(lyint),exp(lasymp),exp(lcc),parea)),
    start = list(lyint= log(0.061), lasymp = log(0.004), lcc = 7),
    upper=list(lyint = 1e10,lasymp=0.02,lcc=1e10),algorithm="port")  #fit point set data
  #mmfitalt <- nls(lobs~(a*mmc+b*parea)/(mmc+parea),start=list(a=-5000,b=-5,mmc=2000))
  mmcoef <- coef(mmfit)
  yint <- exp(mmcoef[1])  #fitted coef a
  asymp <- exp(mmcoef[2])  #fitted coef b
  cc <- exp(mmcoef[3])  #fitted coef c
  predobs <- convert(yint,asymp,cc,cdata$Area)
  res <- predobs - obs  #residuals of point sets
  #windows()
  #plot(ObsDens~Area,data = cdata,ylab="Density",pch=19) #plots point set data
  areas <- 100*(1:95)
  pdens0 <-  convert(yint,asymp,cc,areas)#predicted curve
  #lines(pdens0~areas,col='dark red',lwd=3)  #plots predicted curve
  Density <- convert(yint,asymp,cc,transectdata$sarea)
  transectdata$bms <- Density*transectdata$sarea  #estimated bms of schools
  transectbms1 <- tapply(transectdata$bms,transectdata$transect,sum)#calc bms on transect by
summing over schools
```

```
 tbms0 = 599*sum(transectbms1)/41  #calculate total bms
 print(paste("Est bms = ",round(tbms0)),quote=F)
 gpsd <- matrix(nrow=95,rep(0,nboots*95)) #set up storage for generated point set data
 bms <- rep(0,nboots)
 library('MSBVAR')
 covmatrix <- vcov(mmfit)
 meanparams <- coef(mmfit)
 newcoef <- rmultnorm(nboots,vmat=covmatrix,mu=meanparams)
 for (i in 1:nboots){
   nyint <- exp(newcoef[i,1])
   nasymp <- exp(newcoef[i,2])
   nasymp <- min(nasymp,0.02)
   nc <- exp(newcoef[i,3])   #simulated coefficients
   #if (i < 20){ #draw refitted lines on pointset plot
     pdens <- convert(nyint,nasymp,nc,areas)
     #lines(pdens~areas,col=i,lwd=0.05)
   #    }
   # store generated point set data
   for (j in 1:95) {
      gpsd[j,i] <- pdens[j]
      }
   Density <- convert(nyint,nasymp,nc,transectdata$sarea)
   bms1 <- Density*transectdata$sarea  #bms of schools
   #plot(bms1~transectdata$sarea,xlim=c(0,20000),ylim=c(0,100))
   transectbms <- tapply(bms1,transectdata$transect,sum) #bms on each transect
   tresample <- sample(1:ntransects,replace=T)  #sample the transect indicies
   retransect <- transectbms[tresample] #bootstrap of transects
   bms[i] <- 599*sum(retransect)/41  #calculated bms of this bootstrap
   #print(paste("interation = ",i),quote=F)
  }

  #lines(pdens0~areas,col='dark red',lwd=4)
  #windows()
  #hist(bms,breaks=20,density=10,col='dark blue') #histogram of bootstrapped biomasses

  SE95 <-  round(sd(bms,na.rm=TRUE))
  CV95 <-  round(sd(bms,na.rm=TRUE))/tbms0
  output95 <- cbind(SE95,CV95)
  write.csv(output95, file = "output95.csv",append=TRUE,row.names=FALSE)

  print(paste("SE = ",SE95),quote=F)
  print(paste("CV = ",CV95), quote=F)

}
```

Appendix III, Adjunct 4

R code developed to simulate the effect of increasing point set sample size on the variance of the biomass estimate (n = 82 transects).

```
# Modified from Dvora with covariance on pointset data obtained from library 'MSVBAR'
# This one increases the number of transects from 41 to 82
runbs6 = function(nruns){
 transectdataX2 <- read.csv(file="transectdataX2.csv") #file of transect surface area data
 bscdata <- read.csv(file="sdens95.csv",header=TRUE)
 sdens95 <- read.csv(file="fmt95.csv",header=TRUE)
 sdens95$Area <- bscdata[,1]

   for (i in 1:nruns){
     sdens95$ObsDens <- bscdata[,i+1]
     if (i>0) {print(paste("iteration = ",i),quote=F)}
      bootsard6(1000,sdens95,transectdataX2)
                 }
                 }

bootsard6 = function(nboots,cdata,transectdataX2){
  #cdata = calibration (point set data)
  #transectdata = areas of schools observed in transect
  convert = function(yint, asymp, cc, x) {   #defines function to convert area to bms - yint = y intercept
    return((yint*cc+asymp*x)/(cc+x))} #asymp = asymptote as x->infty, asymp/c = slope at origin
  nls.control(maxiter = 5000,tol = 2e-6) #control parameters for nonlinear fitting
  ntransects <- 82
  dimcdata <-  dim(cdata)
  npdata <- dimcdata[1] #number of point sets
  larea <- log(cdata$Area) #logs of areas of point sets
  parea <- cdata$Area  #point set areas
  obs <- cdata$ObsDens
  lobs <- log(cdata$ObsDens) #log of observed densities of point sets
  mmfit <- nls(lobs~log(convert(exp(lyint),exp(lasymp),exp(lcc),parea)),
    start = list(lyint= log(0.061), lasymp = log(0.004), lcc = 7),
    upper=list(lyint = 1e10,lasymp=0.02,lcc=1e10),algorithm="port")  #fit point set data
  #mmfitalt <- nls(lobs~(a*mmc+b*parea)/(mmc+parea),start=list(a=-5000,b=-5,mmc=2000))
  mmcoef <- coef(mmfit)
  yint <- exp(mmcoef[1])  #fitted coef a
  asymp <- exp(mmcoef[2])  #fitted coef b
  cc <- exp(mmcoef[3])  #fitted coef c
  predobs <- convert(yint,asymp,cc,cdata$Area)
  res <- predobs - obs  #residuals of point sets
  #windows()
  #plot(ObsDens~Area,data = cdata,ylab="Density",pch=19) #plots point set data
  areas <- 100*(1:95)
  pdens0 <-  convert(yint,asymp,cc,areas)#predicted curve
  #lines(pdens0~areas,col='dark red',lwd=3)  #plots predicted curve
  Density <- convert(yint,asymp,cc,transectdataX2$sarea)
  transectdataX2$bms <- Density*transectdataX2$sarea  #estimated bms of schools
  transectbms1 <- tapply(transectdataX2$bms,transectdataX2$transect,sum)#calc bms on transect by
summing over schools
```

```
 tbms0 = 599*sum(transectbms1)/82  #calculate total bms
 print(paste("Est bms = ",round(tbms0)),quote=F)

 #gpsd <- matrix(nrow=95,rep(0,nboots*95)) #set up storage for generated point set data
 bms <- rep(0,nboots)
 library('MSBVAR')
 covmatrix <- vcov(mmfit)
 meanparams <- coef(mmfit)
 newcoef <- rmultnorm(nboots,vmat=covmatrix,mu=meanparams)
 for (i in 1:nboots){
   nyint <- exp(newcoef[i,1])
   nasymp <- exp(newcoef[i,2])
   nasymp <- min(nasymp,0.02)
   nc <- exp(newcoef[i,3])   #simulated coefficients
   #if (i < 20){ #draw refitted lines on pointset plot
     pdens <- convert(nyint,nasymp,nc,areas)
     #lines(pdens~areas,col=i,lwd=0.05)
   #    }
   # store generated point set data
   #for (j in 1:95) {
   #    gpsd[j,i] <- pdens[j]
   #    }
   Density <- convert(nyint,nasymp,nc,transectdataX2$sarea)
   bms1 <- Density*transectdataX2$sarea  #bms of schools
   #plot(bms1~transectdata$sarea,xlim=c(0,20000),ylim=c(0,100))
   transectbms <- tapply(bms1,transectdataX2$transect,sum) #bms on each transect
   tresample <- sample(1:ntransects,replace=T)  #sample the transect indicies
   retransect <- transectbms[tresample] #bootstrap of transects
   bms[i] <- 599*sum(retransect)/82  #calculated bms of this bootstrap
   #print(paste("interation = ",i),quote=F)
  }

  #lines(pdens0~areas,col='dark red',lwd=4)
  #windows()
  #hist(bms,breaks=20,density=10,col='dark blue') #histogram of bootstrapped biomasses

  SE95 <-  round(sd(bms,na.rm=TRUE))
  CV95 <-  round(sd(bms,na.rm=TRUE))/tbms0
  output95 <- cbind(SE95,CV95)
  write.csv(output95, file = "output95.csv",append=TRUE,row.names=FALSE)

  print(paste("SE = ",SE95),quote=F)
  print(paste("CV = ",CV95), quote=F)

}
```

West Coast Sardine Survey – 2010

Response to September 2009 STAR panel Research Recommendations

The following narrative gives a point-by point description of how the 2010 West Coast Sardine Survey intends to address the recommendations of the STAR Panel held at the NOAA / Southwest Fisheries Science Center, La Jolla, California, September 21-25, 2009.

Research Recommendations
The Panel noted that most of the short-term recommendations of the May 2009 Panel had been implemented and identified a number of additional recommendations (not in priority order).

1. Further attempt to quantify (and then account for) the impact of "edge effects" on photographs, including the effect of calculating school weight for an estimate of school area, in which only part of a school is visible in a photograph.

   Ryan: Select a set of photographs with multiple sardine schools present from the 2009 survey archives. Work with Tom to design an evaluation of the impact of "edge effects". Conduct the analysis by analysing the photographs. Repeat analysis with photographs from the 2010 Summer and Fall surveys. Use IMU data from Fall Survey if feasible (see Research Item 4, below).

2. Further attempt to calibrate the scheme used to estimate surface area from photographs. Specifically, calibration experiments should consider objects which do not have a regular shape (e.g., a baseball field was identified as a possible "target") and explore whether there are "analyst effects" and/or "photograph effects" by analysing existing and future calibration data. (SUMMER/FALL)

   Ryan: Select photographs from the 2009 survey calibration tests in the PNW and/or CA, where a baseball diamond (or another irregular shaped object) can be used as a target. Work with Tom to design an evaluation of "analyst effects" and/or "photograph effects". Conduct the analysis with Photo Analysis Team. Repeat analysis with calibration photographs from the 2010 Summer survey, and photographs provided by Doyle from the Fall Pilot Study.

3. Future research should consider methods that can be used to determine the proportion of sardine schools that are visible from aircraft. Acoustics (e.g., from fishing vessels) was identified as one potential method to achieve this goal.

   As part of the Fall Pilot Study, Doyle will design and conduct a study to compare school sightings from aerial photographs with acoustic sampling of the same transects during the collaboration with the CalCOFI cruise in the S. Ca. Bight.

4. Continue to refine the approach used to identify sardine schools in photographs. The use of mosaicing and recording lines on the images were identified as possible areas of investigation.

   As part of the Fall Pilot Study, Doyle will be conducting aerial transects using the same camera equipment employed in the 2009 survey – with the addition of a new roll/pitch (IMU) sensor. This roll/pitch data will be used to investigate the feasibility of geo-referencing the survey photographs.

5. Examine the trade-offs associated with different flight heights between area surveyed and the ability to fly transects.

   An analysis of sample size requirements (see 2010 EFP Application) showed the value of obtaining more survey area coverage. Additional (and faster) airplanes are planned for the 2010 survey to improve our likelihood of increasing area coverage and also completing replicate transects.

6. Estimate the variation in the perceived size of sardine schools using multiple photographs of the same schools.

   As part of the Stage 2 sampling, schools will be photographed before and during the process of conducting the point sets. Multiple photographs of the same school (3 or more) taken prior to the vessel capture of the school will provide data to conduct this analysis. Tom will conduct this analysis using data from the Summer Survey and also using data provide by Doyle from the Fall Pilot Study.

7. Refine the method of variance estimation to account for all sources of uncertainty. Specifically, identify methods (e.g., based on bootstrapping; see Adjunct 2) that can take into account: (a) inter-transect variation in density, (b) uncertainty about the school weight – school area relationship, (c) variation for individual schools about the school weight – school area relationship, and (d) uncertainty arising from attempting to estimate the size of schools.

   An analysis of sample size requirements (see 2010 EFP Application) demonstrated the use of a method of variance estimation based on bootstrapping to account for (a) and (b), above. Tom will develop an extension of this approach and will use the data collected in the analyses described in Research Items 2 and 6 (above) to evaluate the additional sources of uncertainty identified in (c) and (d), above.

8. Consider the use of geostatistical methods to estimate sardine abundance and the uncertainty of the estimate, especially if the likelihood of obtaining multiple replicates within a single aerial survey is likely to remain low.

The classical random sampling approach is preferred if logistics permit, however, geostatistical methods may be employed in the future if the 2010 survey again fails to yield multiple replicates.

9. Consider further stratification of the area surveyed during the aerial survey. In particular, consider the benefits of offshore strata. Such strata could have lower coverage, consistent with likely lower density.

   We expect increased (coastwide) survey coverage and better transect replication in 2010. The data collected in 2010 should help to better evaluate the potential advantages of refinements in stratification.

10. Consider whether it is possible to use acoustics to calculate the density associated with schools that are too large to be sampled using point sets. Consideration must be given to the impact of vessel avoidance in the analysis of such data.

    As part of the Fall Pilot Study, Doyle will evaluate the feasibility of using acoustics to calculate the density of schools that are too large to be sampled using point sets (data permitting).

11. Collect data on environmental conditions from point sets (e.g., using onboard loggers) and explore whether environmental covariates explain some of the variation about the school weight – school area relationship.

    We have no plans (at present) to equip fishing vessels with onboard loggers to record environmental data. As part of the Fall Pilot Study, Doyle will be collecting point set data in areas where CalCOFI surveys will be logging environmental variables. It may be possible to begin to explore whether environmental covariates can help to explain some of the variation about the school weight – school area relationship with this pilot data.

12. Refine how photographs are analysed to account for pitch and roll.

As part of the Fall Pilot Study, Doyle will be conducting aerial transects using the same camera equipment employed in the 2009 survey – with the addition of a new roll/pitch sensor. Tom and Doyle will evaluate how the use of this pilot data may be used to improve how photographs are analysed to account for pitch and roll in future surveys.

13. Provide all of the data on which the aerial survey estimate is based (including the original photographs and details regarding school size identification and quantification) to the STAT.

Ryan has compiled (and indexed) all of the 2009 Survey data on which the aerial survey estimate of sardine abundance is based. The data are archived on a 1TB external hard drive. A copy of the 1TB archive has been provided to Dr. Kevin Hill at the SWFSC.

Additional recommendations from the May 2009 STAR Panel:

- Record qualitative information related to processing photographs, and the difficulty in assigning species and calculating school areas.

This is routine procedure for the Photo Analysis Team. Ryan will work to further formalize how this information is collected and reported in the future.

- Observer effects when viewing photographs could be evaluated using double-blind comparisons and similar techniques.

The analyses described in Research Item 2, as well as additional multiple-reader analyses using photographs taken on transects during the Summer Survey and the Fall Pilot Study will be conducted using the double-blind technique.

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON EXEMPTED FISHING PERMITS FOR 2010

The Coastal Pelagic Species Advisory Subpanel (Subpanel) heard a presentation from Tom Jagielo, a science advisor for sardine research planned for 2010. Tom reviewed highlights from the summer survey, Diane Pleschner-Steele reviewed the pilot project proposed for southern CA in the fall on behalf of science advisor Dr. Doyle Hanan, and both answered questions from the Subpanel and CPS management team.

The Subpanel expresses appreciation to industry for taking the initiative to develop the sardine research program. The Subpanel fully supports both the summer survey and fall pilot research projects as described in the exempted fishing permit (EFP) and recommends the Council approve the EFP for public review.

PFMC
03/09/10

COASTAL PELAGIC SPECIES MANAGEMENT TEAM REPORT ON EXEMPTED FISHING PERMITS FOR 2010

The Coastal Pelagic Species Management Team (CPSMT) received an overview from Mr. Tom Jagielo and Ms. Diane Pleschner-Steele on the West Coast Aerial Sardine Survey application for an exempted fishing permit (EFP). The EFP will allow industry representatives to harvest sardines outside of the directed fishing periods in the summer and fall of 2010. The methods for the summer research will be the same as those carried out in 2009; however, the survey area will extend from the US/Canada border into southern California, whereas in 2009, Monterey was the southern bound of the survey. The fall research period will be used to explore new methods for assessing sardine biomass in the southern California Bight.

For the summer portion of the EFP, the investigators will carry out aerial transects and point sets to estimate sardine abundance within the survey area. The CPSMT notes that in 2009, of the 80 point sets that were conducted, data from 28 of those point sets were valid and used in the 2009 sardine stock assessment. In November 2009, the CPSMT requested that the applicants revise their protocols to ensure that the data collected from the EFP point sets are scientifically acceptable and useable. Specifically, the CPSMT requested that the applicants outline clear and concise methods in the 2010 EFP application that describe the steps that will be taken to check the data after each point set to make sure the methods were carried out correctly before allowing a purse seine vessel to capture sardine in a subsequent point set. After review of the 2010 EFP application, the CPSMT found that specific language clearly explaining the steps that will be used to verify data acceptability between point sets and aerial photography had not been included; the CPSMT requests that the EFP language be revised to include such details.

In 2009, two vessels were allowed to operate within a fishing region to collect point set data for the EFP research. For 2010, the applicants are requesting that 4 vessels be allowed to operate at the same time within a region. The CPSMT acknowledges that having this allowance could be beneficial for field operations; however, the CPSMT requests that the applicants verify the validity of the data for point sets (w/aerial photographs) before completing multiple subsequent point sets. Therefore, the CPSMT requests weekly reports from the investigators regarding the success of completing point sets (w/aerial photography) and the validity of the corresponding data. Deciding that pilots and vessels are adequately trained to allow for multiple point sets to occur in one day is at the discretion of the investigators. The CPSMT expects that the investigators will minimize the number of invalid point sets (with aerial photographs).

Regarding the fall pilot project research, the CPSMT acknowledges the need to explore additional assessment techniques. The CPSMT notes that in 2009, 51 aerial transects with 3 replicates were planned and 41 transects of 1 replicate were completed. The CPSMT believes that the increases in sample size and survey area for 2010 are ambitious given the failure to achieve the completion of 1 replicate in a smaller survey area in 2009.

Therefore, the CPSMT recommends that the investigators place a higher priority on successfully completing the summer survey for 2010.

The CPSMT agrees with the Scientific and Statistical Committee (SSC) recommendation that the EFP be revised to include explicit protocols for spatial distribution of the point sets and how the survey design will be further revised in accordance with Stock Assessment Review Panel Recommendations from September 2009.

The CPSMT recognizes the value of the EFP research and resulting data and finds merit in continuing this research. The CPSMT recommends the Council encourage the National Marine Fisheries Service to continue to support coastwide annual CPS research, and recommends the proposal be approved for public review.

PFMC
03/09/10

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON EXEMPTED FISHING PERMITS (EFP) FOR 2010

The Scientific and Statistical Committee (SSC) was briefed by Mr. Tom Jagielo and Dr. Doyle Hanan on the west coast sardine survey application for an EFP in 2010. Dr. Kevin Hill of the National Marine Fisheries Service was also present to answer questions about how the survey results could be used in the next sardine stock assessment. The permit application expands upon an EFP that was conducted from Monterey Bay to the U.S./Canada international boundary in 2009, and is composed of a summer survey and an autumn pilot study. The coastwide summer survey is slated for July through early September 2010, and is divided into northern (WA-OR) and southern (CA) regions. The pilot study is proposed for the Southern California Bight during the autumn of 2010.

A coordinated synoptic summer survey would range from the Southern California Bight to the U.S./Canada international boundary. Survey design is a two-stage sampling approach that includes: 1) a photographic aerial survey, and 2) an at-sea point set sampling component to estimate species composition, school density, and biological characteristics of the fish, including the collection of otoliths for age determination. Changes from the 2009 survey design include a latitudinal expansion in survey coverage so that it encompasses the entire coastline, and an increase in the number of transects and point sets to achieve a reduction in the variance of biomass estimates. In addition, the 2010 survey design provides for eight vessels to participate in point set sampling, four from each region, which is double the number compared to 2009.

The autumn pilot study is designed to explore ways to further improve biomass estimates by using acoustic methods, LIDAR (Light Detection and Ranging), and night-time bioluminescence to determine school size, as well as aerial photography. The pilot study will be conducted off southern California during autumn months, which also provides an opportunity to investigate seasonal changes in abundance by comparison with summer results from the same area.

As part of their presentation to the SSC, the applicants included a supplemental handout that discusses the summer survey design revisions in accordance with Stock Assessment and Review Panel recommendations from September 2009. The SSC recommends that these changes be included in a revised EFP proposal.

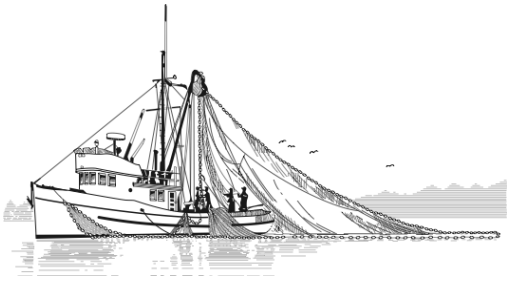
The SSC further recommends that a revised proposal include explicit protocols for spatial distribution of point sets, to address a concern that the sets tended to be geographically clustered in the 2009 survey, and therefore, might not have captured possible spatial variability in the relationship between school size and biomass. Finally, the proposal should also provide the experimental design and survey protocols for the autumn pilot study.

There may be a correlation between the the estimates of abundance for 2009 and 2010 because they will be based upon the same data, and this needs to be addressed. An extended stock assessment update review is currently scheduled for the next sardine assessment during the

autumn of 2010, and provides a venue to address the technical basis for recalculating the variance from 2009 and incorporating the new 2010 survey results into the assessment.

There is a strong scientific basis for this application. The SSC recommends that it be approved for public review following submission of a revised proposal that addresses the issues described above.

PFMC
03/07/10



CALIFORNIA WETFISH PRODUCERS ASSOCIATION

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February 17, 2010

Mr. Dave Ortmann, Chair &
Dr. Don McIsaac, Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place #200
Portland OR 97220-1384

RE: Agenda Item H.3.c: Experimental Fishing Permit (EFP) for Pacific coast Sardine Research in 2010

Dear Chairman Ortmann, Dr. McIsaac and Council members,

The California Wetfish Producers Association (CWPA) represents the majority of active wetfish fishermen and processors from both Monterey and southern California. We very much appreciate this opportunity, once again, to address the Council on the subject of Pacific sardine research.

As we've testified in the past, we believe developing indices of sardine abundance in addition to DEPM surveys is essential to expand understanding of the sardine resource and improve management. We appreciate the Council's interest in the industry-sponsored aerial research program launched synoptically in 2009, leading to your approval of a 5,000 mt research set aside at your November 2009 meeting for continuing survey work in 2010. We ask that you approve the full EFP application, including both the summer aerial survey and fall pilot project.

The 5,000 mt research request was based in part on the table created by participating scientists, proposing to allocate 2,100 mt each to PNW and CA for the summer aerial survey (a table recommending distribution of the point sets, totaling 4,200 mt, was included in the 2009 EFP final report). As noted in the power analysis conducted for this EFP application, the proposed sample size of n = 56 point sets per region, totaling 112 point sets coastwide, is a realistic request given the time constraints and resources available. We expect the full 4,200 mt [but no more than 4,200 mt] will be taken during the course of the summer survey, as this research fish also provides revenue to help finance the survey. Any amount not taken by September 15 will roll into the fall directed fishery, following the Council's recommendation and NMFS rulemaking in 2009.

Industry in both the Pacific Northwest and California supported increasing the set aside to 5,000 mt, with the intent to reserve the remaining 800 mt for a fall pilot project in S.CA. Under the proposed EFP, the West Coast Sardine Survey (a consortium of Pacific Northwest and California sardine industry participants) plans to conduct, for the second year, a semi-synoptic survey of the sardine biomass along the U.S. West Coast, employing the methodology approved by STAR panels and the SSC in 2009. The summer survey is conducted during daylight at a time when sardines are at peak abundance in the Pacific Northwest. Repeating the summer aerial survey in 2010 is important to reduce uncertainty and improve on the 2009 survey.

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We've demonstrated that sardines are visible at the surface during daylight hours in California, as in the Pacific Northwest; however, these fish are also observed and may be more readily measured at night in California. Sardine abundance peaks in California during fall and winter months [traditionally California's peak fishing season]. Thus industry and participating scientists request a small portion of this EFP, not to exceed 800 mt, be designated to permit scientists to investigate, compare and further improve survey methodology by evaluating the use of lidar, acoustics, and night-time bioluminescence photography in addition to the daylight photography methods used in the summer survey to estimate sardine abundance.

The proposed fall pilot study allows identified vessels to catch Pacific sardine, both day and/or night as directed by the principal investigator, during October-November 2010, a time when the directed fishery is now closed. The aerial component of the study consists of transects placed in a designated area of southern CA along and adjacent to the fall CalCOFI cruise tracks, extending out 75 miles from the mainland, and will be conducted in conjunction with the fall CalCOFI survey. The goal is to develop and refine survey methodology for review by a sardine STAR panel in 2011, for potential inclusion in future sardine stock assessments to improve measurements of sardine; techniques developed could also be employed to assess other CPS. Conducting this fall research in 2010 is critically important to meet the sardine STAR panel schedule; after 2011 the next panel will not occur until 2013 or 2014. Moreover, the only way this research can be accomplished is under an EFP because the sardine fishery is otherwise closed before October, when this research is planned.

We are fully committed to ensure the success of this sardine research both summer and fall. In CA the research set aside will be taken under the guidance of CA scientists, in coordination with PNW scientists and industry, with the goal to achieve representative samples of school size to reduce uncertainty, improve on the 2009 survey, and test additional promising survey techniques.

Again, we appreciate the Council's interest in this research and urge you to approve the Pacific coast sardine EFP application, including the 800 mt allocated for a pilot project in southern CA in October-November, evaluating methods to improve biomass estimates.

Thank you for your consideration.

Best regards,

Diane Pleschner-Steele
Executive Director

Agenda Item H.3.c
Supplemental Public Comment
March 2010

Ryan D. Kapp

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February 24, 2010

Mr. Dave Ortmann, Chair &
Dr. Don McIsaac, Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place #200
Portland, OR 97220-1384

RE: Agenda item H.3.c. – Public Comment

Dear Chairman Ortmann, Dr. McIsaac, and Council members,

I am a sardine fisherman from Bellingham, Washington. My vessels have operated out of Astoria, Oregon since 1999. I have attended many Council meetings in the past and am sorry I couldn't be there this time. I am writing to encourage you to support the EFP for continuing the West Coast Sardine Aerial Survey.

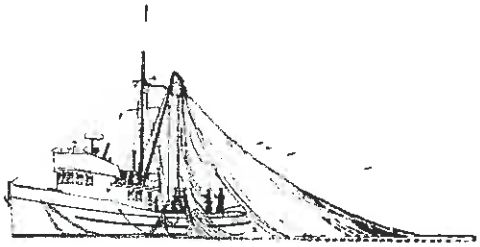
Last year's EFP saved the sardine fishery for 2010! Without last year's EFP the necessary work to begin establishing a second index of abundance for the stock assessment model would not have happened and there would be no fishery this year. Last year the industry and some scientists were able to develop a plan, have it approved by the STAR panel, and get the results included in the stock assessment. It was a truly remarkable endeavor. None of this success would have happened without the support of the Council and I am very appreciative of your efforts.

I hope that you will approve the 2010 EFP and allow us to continue what we started and make the "best available" science even better. It is even more important this year to keep this project going and keep gathering data that can be used in the assessment for years to come. I hope the Council continues to support the contributions of industry now and in the future.

Thank you for your time and consideration of this matter.

Regards,

Ryan Kapp



CALIFORNIA WETFISH PRODUCERS ASSOCIATION

Representing California's Historic Fishery

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March 4, 2010

Mr. Dave Ortmann, Chair &
Dr. Don McIsaac, Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place #200
Portland OR 97220-1384

RE: Agenda Item H.3.c: Supplemental Information pertaining to Fall Sardine Pilot Project proposed in Experimental Fishing Permit (EFP) for Pacific coast Sardine Research in 2010

Dear Chairman Ortmann, Dr. McIsaac and Council members,

The California Wetfish Producers Association (CWPA) represents the majority of active wetfish fishermen and processors from both Monterey and southern California. We very much appreciate this opportunity to provide supplemental information re: the fall sardine pilot project proposed in the 2010 EFP application.

As noted in our earlier letter, industry and participating scientists request a small portion of this EFP, not to exceed 800 mt, be designated to permit scientists to investigate, compare and further improve survey methodology by evaluating the use of lidar, acoustics, and night-time bioluminescence photography in addition to the daylight photography methods used in the summer survey to estimate sardine abundance.

The proposed fall pilot study allows identified vessels to catch Pacific sardine, both day and/or night as directed by the principal investigator, during October-November 2010, a time when sardines are in peak abundance in California but the directed fishery is now closed. The goal is to develop and refine survey methodology for review by a sardine STAR panel in 2011, for potential inclusion in future sardine stock assessments to improve measurements of sardine; techniques developed could also be employed to assess other CPS.

Again, we appreciate the Council's interest in this research and urge you to approve the Pacific coast sardine EFP application, including the 800 mt allocated for a pilot project in southern CA in October-November timed to coordinate with the fall CalCOFI cruise, for the purpose of evaluating methods to improve biomass estimates.

Thank you for your consideration.

Best regards,

Diane Pleschner-Steele

Diane Pleschner-Steele
Executive Director

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Fall Southern California Pilot Sardine Survey

Additional justification and potential benefits of this survey

STAR Panel Recommendations Addressed by Fall Survey:

- determine proportion of sardine schools visible from aircraft: consider acoustics
- consider possible use of acoustics to calculate density associated with schools too large to be sampled using point sets
- quantify impact of "edge effects" on photographs, including effect of calculating school weight
- calibrate scheme to estimate surface area from photographs

Addressed STAR Recommendations (continued)

- refine approach to identify sardine schools
- examine trade-offs associated with altitude between area surveyed and ability to fly transects (weather dependency)
- estimate variation in perceived size of sardine schools using multiple photographs of same schools

Aerial Photography

- Advantages: speed, cost, accuracy
- Disadvantages: subject to weather, detection of schools deeper in water column, positive fish identification

Ship-board Acoustics

- Advantages: survey during most weather and fog conditions, survey remote areas, accuracy of results, many survey results available from other fisheries for comparison
- Disadvantages: cost and availability of ship time, relative slow speed of ships, number of personnel, school vessel avoidance/scattering, positive fish identification
- Churnside et. al. (2003) found correlation of 0.994 for echosounder and lidar fish school reflective measurements thus very similar results

Lidar

- Advantages: speed, comparative cost (airplane vs ship), accuracy of results, no fish school scattering/avoidance, tolerates higher surface disturbance (wind), detection of schools deeper in water column
- Disadvantages: dependent on good flying weather, positive fish identification

Planned Use of Photography, Acoustics, & Lidar Survey Techniques

- Obtain locations of likely sardine school targets from CalCOFI ship and from aerial survey; direct spotter pilot and research vessels to those areas for point sets
- Estimate school tonnage for photographed schools to get relative school density, especially for schools too large to capture with purse seine
- Compare return signals of acoustics and lidar to photos to determine school species identification and obtain ratio of fish schools by species

Fall survey justification and potential benefits

- Fish already designated for harvest, survey enhances use of harvested fish to better estimate abundance for improved management
- 100% biological sampling compared to small fraction during fishery, thus improved accuracy
- Explore day-night difference in sardine presence/ detection by each survey technique
- Increased information on density of schools by measured surface area from both photo & lidar

Justification and Benefits: (continued)

- Expanding photo catalog of identified schools
- Improved detection of schools deeper in water column with lidar - Churnside et. al. (submitted for publication)
- Enhanced measurements of school thickness in center and at edges with lidar and acoustics
- Compare photography of bioluminescence vs lidar & acoustic school detection and measurements for day-night differences

Justification and Benefits: (conclusion)

- Finally, test findings of Churnside et. al. (submitted for publication) that the performance of photographic techniques coupled with lidar reduces uncertainties of using either technique alone even in turbid waters of Chesapeake Bay

Effective Use of Lidar

- Sardines and anchovies in California waters (Lo et al., 2000)
- Capelin and herring in the north Pacific (Brown et al., 2002)
- Mullet off the west coast of Florida (Churnside et al., 2003), and anchovy, sardine, and juvenile
- Mackerel in the coastal Atlantic waters of southern Europe (Carrera et al., 2006)
- Anchovy, sardine, and juvenile mackerel in the coastal Atlantic waters of southern Europe (Carrera et al., 2006)
- Cost-per-km estimates 10% or less of ship-based surveys (Brown et al., 2002; Churnside et al., 1997)
- Speed, no avoidance (Churnside et al., 1997, Churnside et al., 2003).