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.

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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 NWSS 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 preliminary research.

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, and maintain daily communication and cooperation with Northwest principals. Under the direction of Mr. Jagielo, Mr. Ryan Howe and Mr. Jerry Thon 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, National Marine Fisheries Service (NMFS), Southwest Fisheries Science Center (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 onshore-offshore 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-i 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 3-38 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 be 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. In addition, the California camera systems will capture heading from the GPS and be equipped with inertial measurement units (IMUs) so the log will record GPS heading, camera pitch angle, camera roll angle, and camera heading. 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 make the sardine schools visible. 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.

<u>*Data Analysis*</u>
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 $(\hat{B})$ will be estimated using the unbiased estimator for a population total (Stehman and Salzer 2000),

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

with estimated variance

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

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 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. Logistically, it is desirable to have multiple boats available to be set by a single spotter plane in any given area. For example, after setting the first boat on a sardine school, the spotter pilot can direct a second (and potentially third, or fourth) boat to another school while the first boat is bringing the fish on board. 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. 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 (approximately 10,000 m^2). 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.

<u>*Biological Sampling of Point Sets*</u>

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:	Principal, 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 (See Appendix I, Adjunct 3).

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 summer survey 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 science adviser/project director (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 a 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 (Appendix I, Adjunct 5, Table 1). 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 the 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. A small industry-contracted research boat will perform hydroacoustic assessments on and/or near CalCOFI track lines.

8. 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.

9. 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.

10. 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 5,000 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.

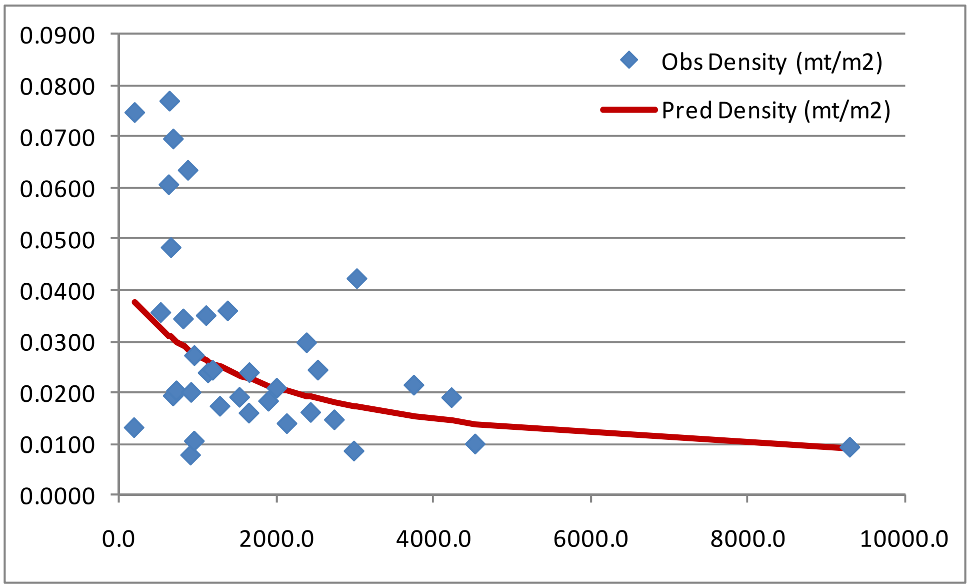
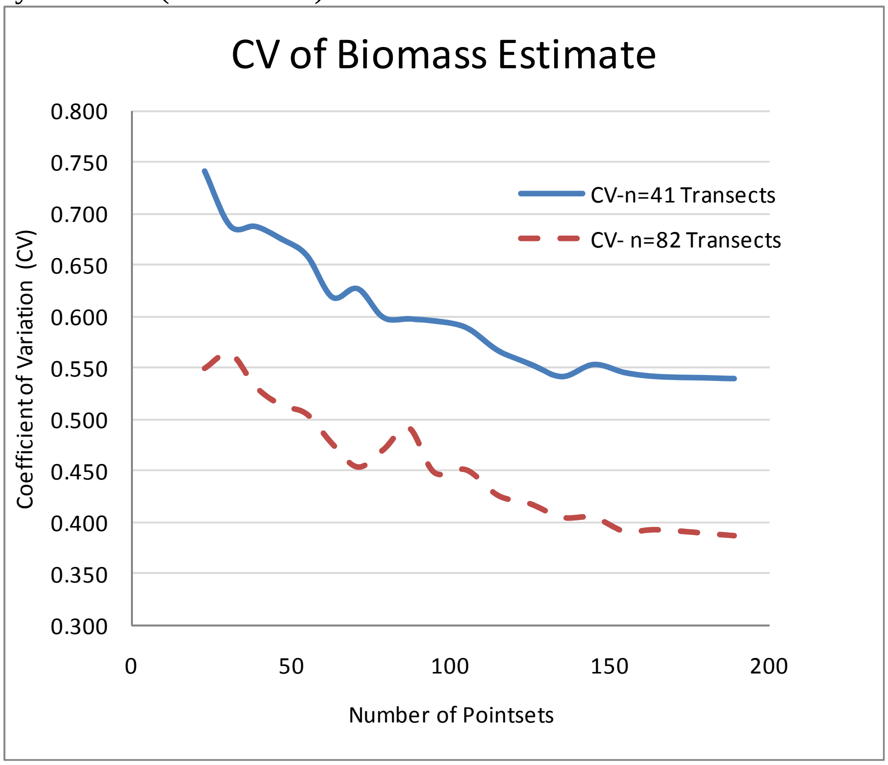


Figure 5. CV as a function of point set sample size for n = 41 (solid line), and n = 82 aerial survey transects (dashed line).



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.

West Coast Sardine Survey
2010 EFP Application
Addendum: 4-10-2010

The CPSMT and the SSC have made recommendations regarding the revised EFP at the April, 2010 Council meeting. This addendum is intended to respond to the suggestions made by those Council advisory bodies.

1. The CPSMT requested a format for a weekly report to transmit a summary of point set information to the NMFS point of contact. A weekly report format has been developed by the applicants, and is attached.

2. Both the CPSMT and the SSC requested a more specific protocol for the spatial distribution of point sets.

The SSC suggested that an adequate spatial stratification would divide the survey into four equally sized areas with no less than 15 percent of point sets allocated to each quadrant.

We understand the need to spatially distribute the point sets to ensure that they are representative of the sampled aerial transects. However, there are logistical reasons why the full implementation of a study design such as that suggested by the SSC will not be possible in 2010. The main problem is the lack of sardine processing plants the more remote areas, which would result in long steaming times and thus fish spoilage. Another issue is that boats currently identified for participation in the EFP do not hold permits to deliver in out of state ports (e.g. Astoria, Oregon boats would need Washington permits to deliver into Westport, Washington, etc.

Thus, we propose an incremental process to move toward the suggested study design over a period of time. For 2010, the applicants propose the following plan to improve the spatial distribution of point sets. Quadrant definitions are attached, below.

Northern region. Our plan is to sample quadrants 1-3 in the northern region in 2010, following the SSC recommendation. Sampling of quadrant 4 will require development of an infrastructure to harverst and process sardine that is not feasible to put in place for 2010 (Mike Okoniewski, personal communication).

Southern region. Our plan is to sample quadrants 2-4 in 2010, again following the SSC recommendation. Sampling of quadrant 1 will require development of an infrastructure to harvest and process sardine that is not feasible to put in place for 2010 (Diane Pleschner-Steele, personal communication).

Weekly Point Set Acceptability Report

Regional Entity:__________ **Week Ending:___________**

Week Ending: Distribution of Sardine Point Sets by Size

Size (m²)	Total Point Sets Attempted	Total Point Sets Preliminarily Acceptable	Weeks End Total Sardine Weight (mt)	Cumulative Total Sardine Weight (mt)
100				
500				
1000				
2000				
4000				
8000				
10000				

Proposed Distribution of Point Set Sizes

Size (m²)	Weight (mt)	Total Weight (mt)	Number of point sets
100	4	31	8
500	11	85	8
1000	17	136	8
2000	27	212	8
4000	52	415	8
8000	71	564	8
10000	82	657	8
		2099	56

Comments: ____

Summer Sardine Survey 2010: Spatial Quadrants

Northern Area			
		Transect	**Location**
Quadrant 1	Northern Transect	1	Cape Flattery
	Southern Transect	7	Willapa Bay
Quadrant 2	Northern Transect	8	Long Beach
	Southern Transect	13	Pacific City
Quadrant 3	Northern Transect	14	Lincoln City
	Southern Transect	19	Coos Bay
Quadrant 4	Northern Transect	20	Charleston
	Southern Transect	26	Brookings

Southern Area			
		Transet	**Location**
Quadrant 1	Northern Transect	27	Klamath
	Southern Transect	35	Fort Bragg
Quadrant 2	Northern Transect	36	Caspar
	Southern Transect	44	Half Moon Bay
Quadrant 3	Northern Transect	45	Pescadero
	Southern Transect	53	Morro Bay
Quadrant 4	Northern Transect	54	Port San Luis
	Southern Transect	65	Oceanside

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.

April 30, 2010

A. Coastwide Summer Aerial Sardine Survey (July-September, 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, SWFSC, 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 three additional planes, a Cessna 172 and/or a Cessna182, will be used to conduct point sets and transects if

needed. Spotter pilots familiar with southern California and Monterey will be contracted to participate in the survey, which will include flying transect replicates and directing 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 (Adjunct 2) 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 (Adjunct 2) 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. Point sets will be made over as wide an area as feasible within each region, in order to distribute the sampling effort spatially.

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 (Adjunct 2). 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 (Adjunct 2). 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 (Adjunct 2). 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 individually bagged, identified with sample number and frozen with other fish in the subsample, clearly identified as to point set number, vessel, and location captured 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). Point sets will be targeted working in general from the smallest size category to the largest. 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. Every effort will be made to ensure, as soon as possible, that successfully landed point sets were also successfully photographed. This will in general be at the end of each fishing day or sooner. After verification of point set acceptability, the list of remaining school sizes needed from Table 2 will be updated accordingly for ongoing 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. Pumping large sets onto more than one vessel should be avoided, and should only be done in the accidental event that school size was grossly underestimated.

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.

Spatial Distribution of Point Sets
In order to distribute point sets spatially, sampling will occur both north and south of the Columbia River in the north (approximately 50% in each area). In the south, 50% of the point sets will be taken from northern California, and 50% from southern California. In each zone, efforts will be made to distribute the point sets offshore vs. nearshore, as well. Quadrants have been identified in each area to facilitate spatial distribution of the point sets (Figure 2).

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 the purpose of species identification. These photographs are 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.

For each area (north and south) the reference photographs 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 (typically a small, relatively fast boat) will collect a jig sample to document the species identification. This sampling will most likely occur in June, prior to commencement of the Summer fishery opening.

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

Location	Survey Area	Transect Number	Transect Latitude Lat Deg	Lat Min	West End Long Deg	Long Min	Way Point #	East End Long Deg	Long Min	Way Point #	Shoreline 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. Total Weight is in metric tons.

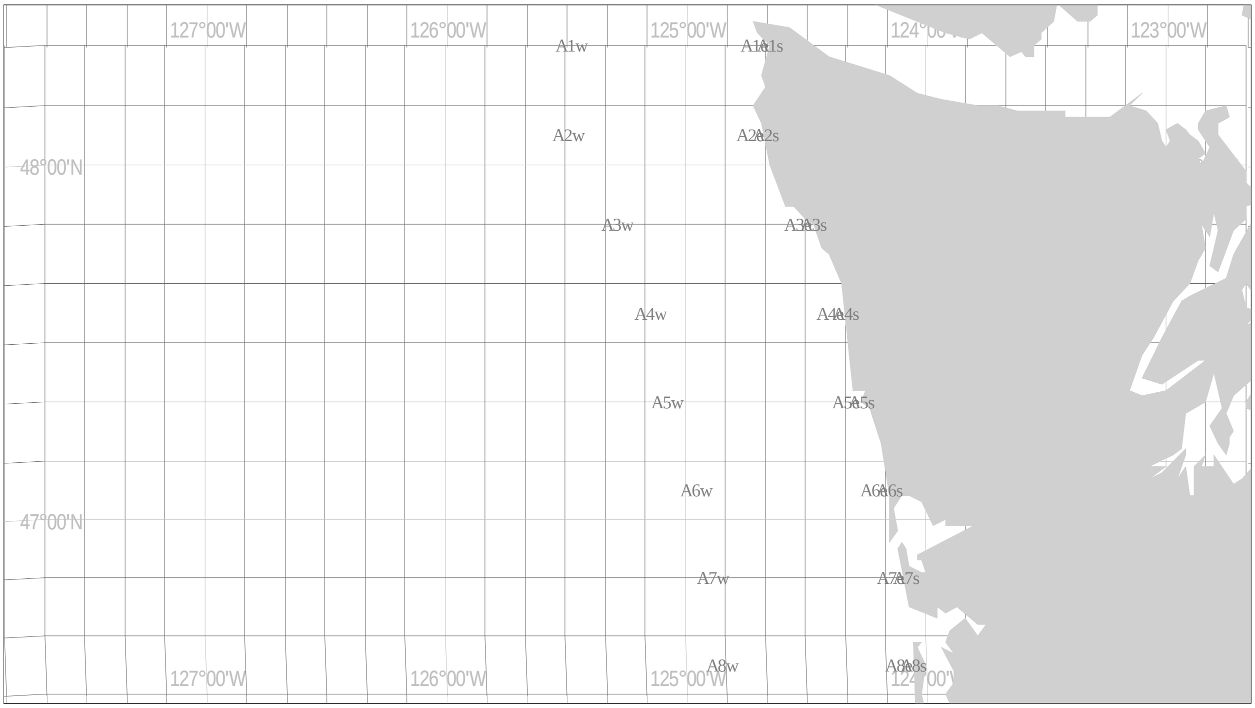
Size (m^2)	Weight (mt)	Total Weight	Number of Point Sets
100	3.8	31	8
500	10.6	85	8
1000	17.0	136	8
2000	26.5	212	8
4000	51.9	415	8
8000	70.5	564	8
10000	82.1	657	8
		2099	56

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

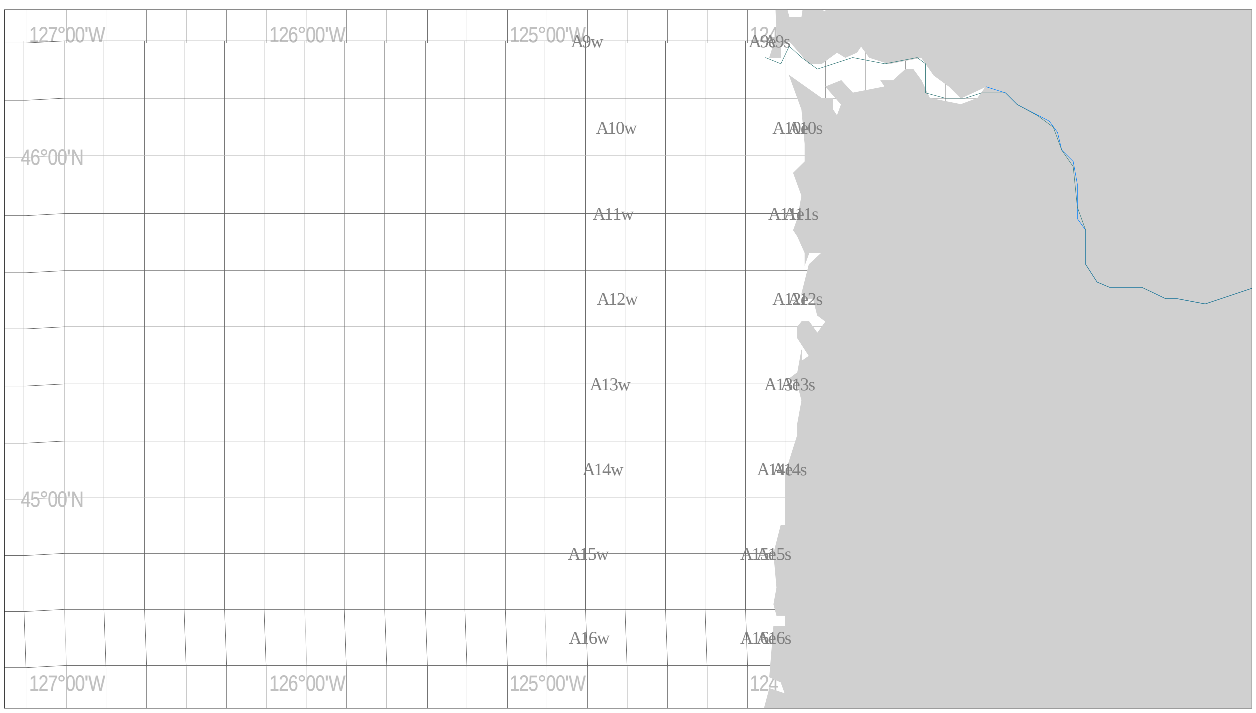
Female maturity codes	**Male maturity codes**
1. Clearly immature- ovary is very small; no oocytes present	1. Clearly immature- testis is very small thin, knifed-shaped with flat edge
2. Intermediate- individual oocytes not visible but ovary is not clearly immature; includes maturing and regressed ovaries	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

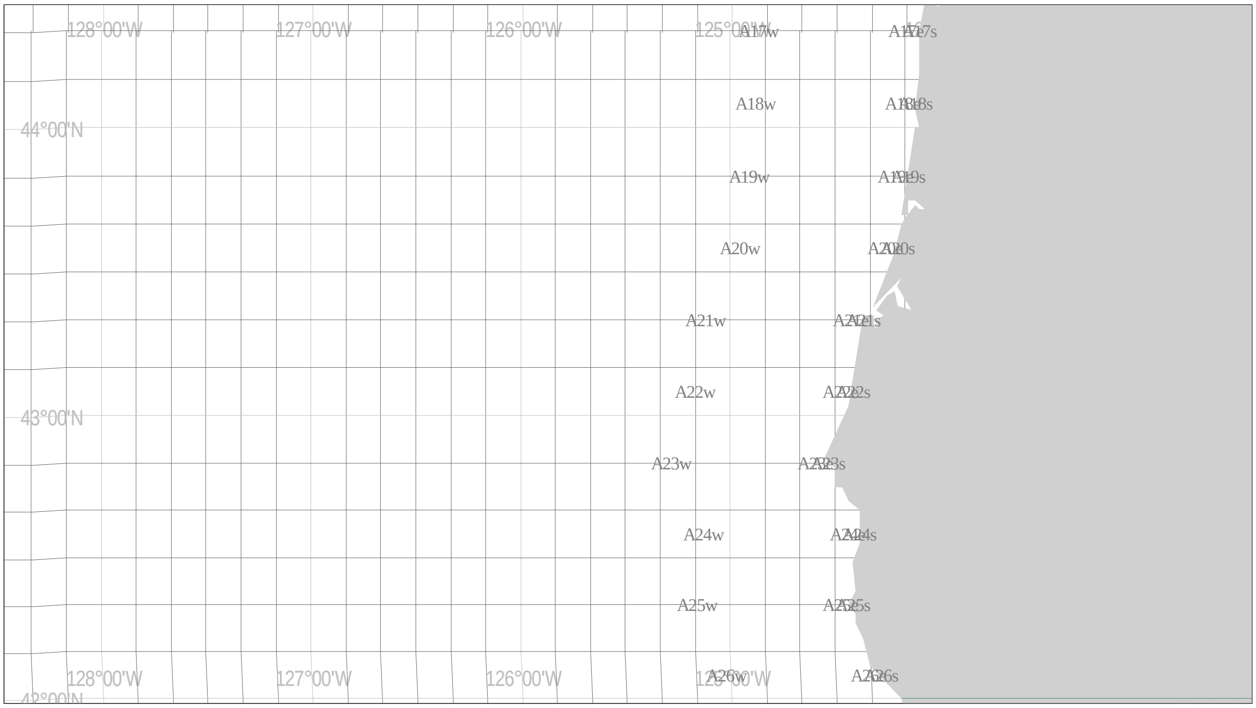
SET A northern region: Transects 1-8



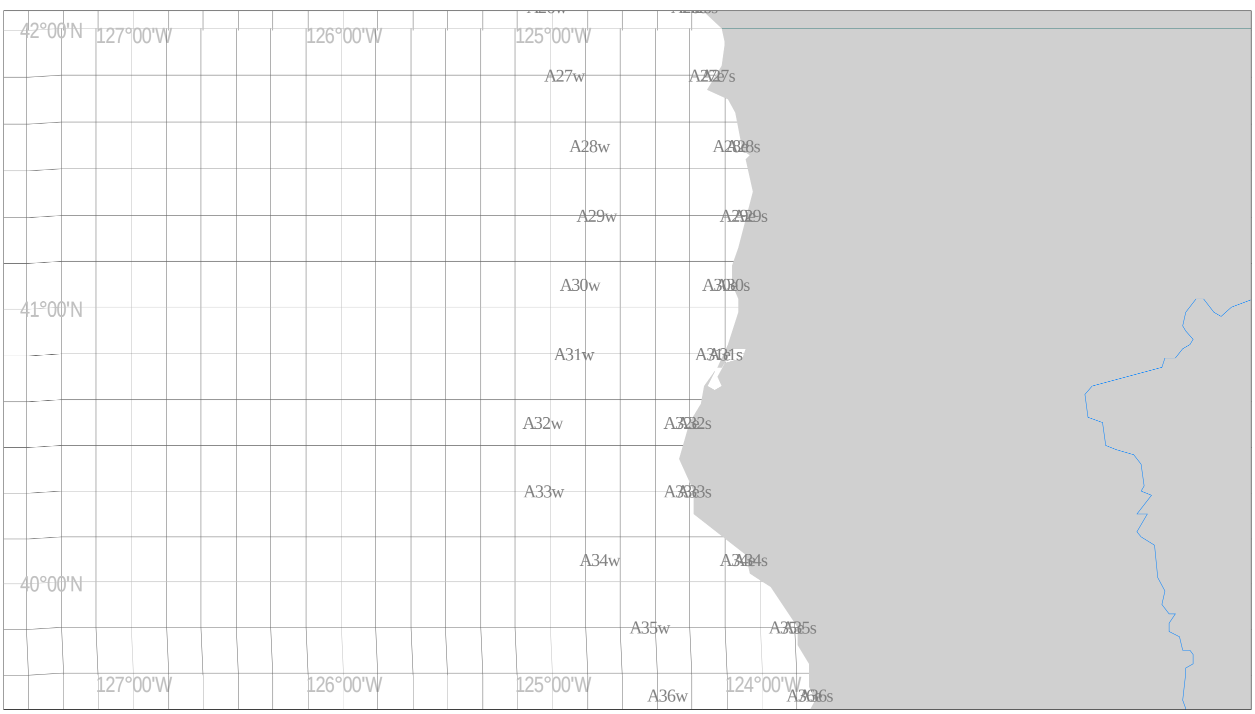
SET A northern region: Transects 9-16



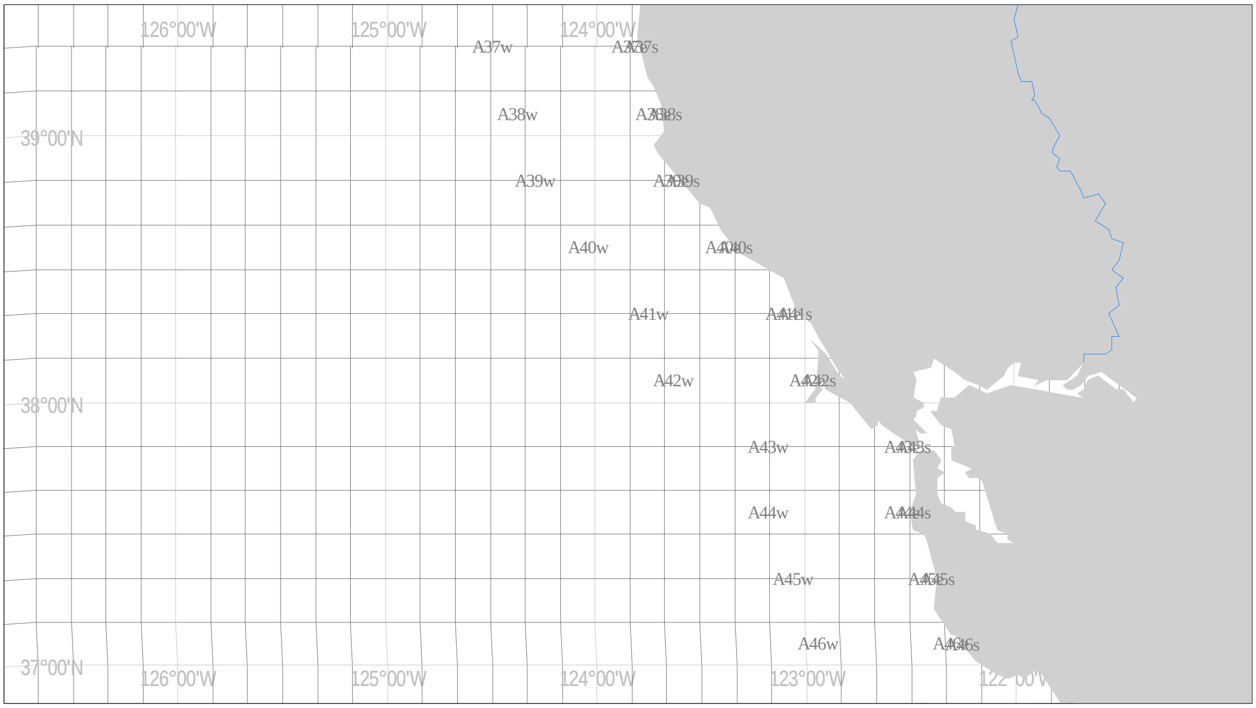
SET A northern region: Transects 17-26



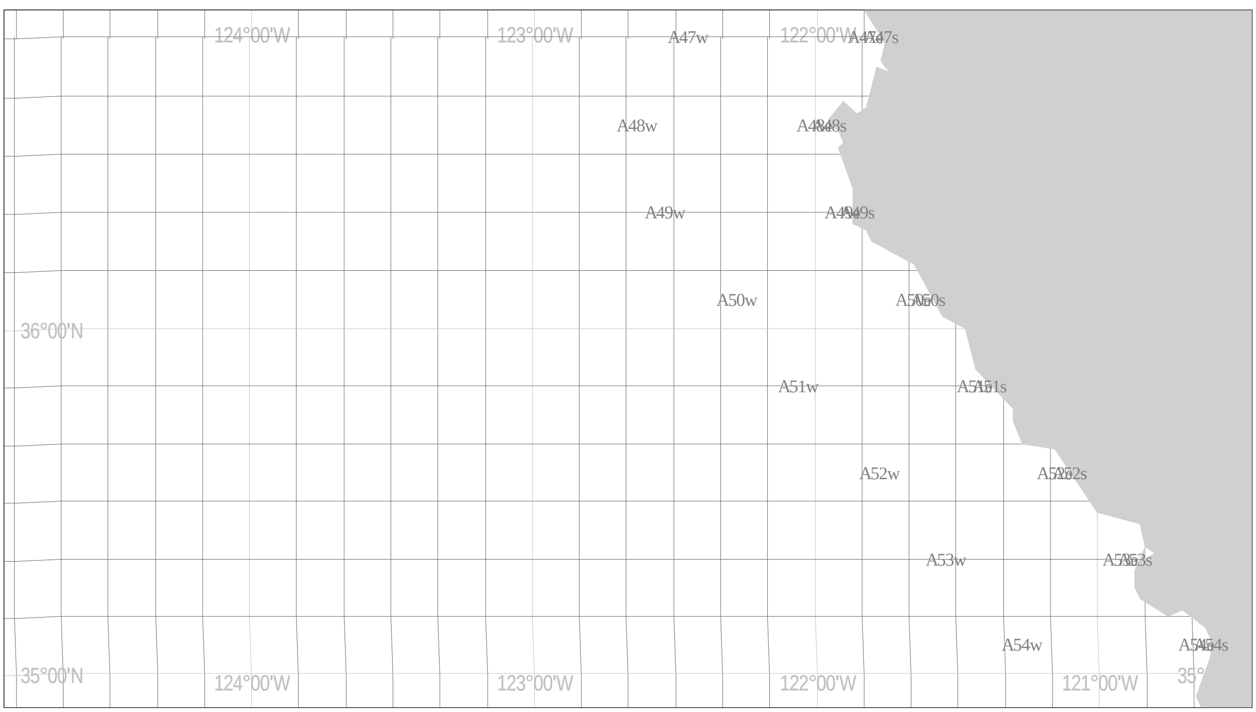
SET A southern region: Transects 27-36



SET A southern region: Transects 37-46



SET A southern region: Transects 47-54



SET A southern region: Transects 55-66

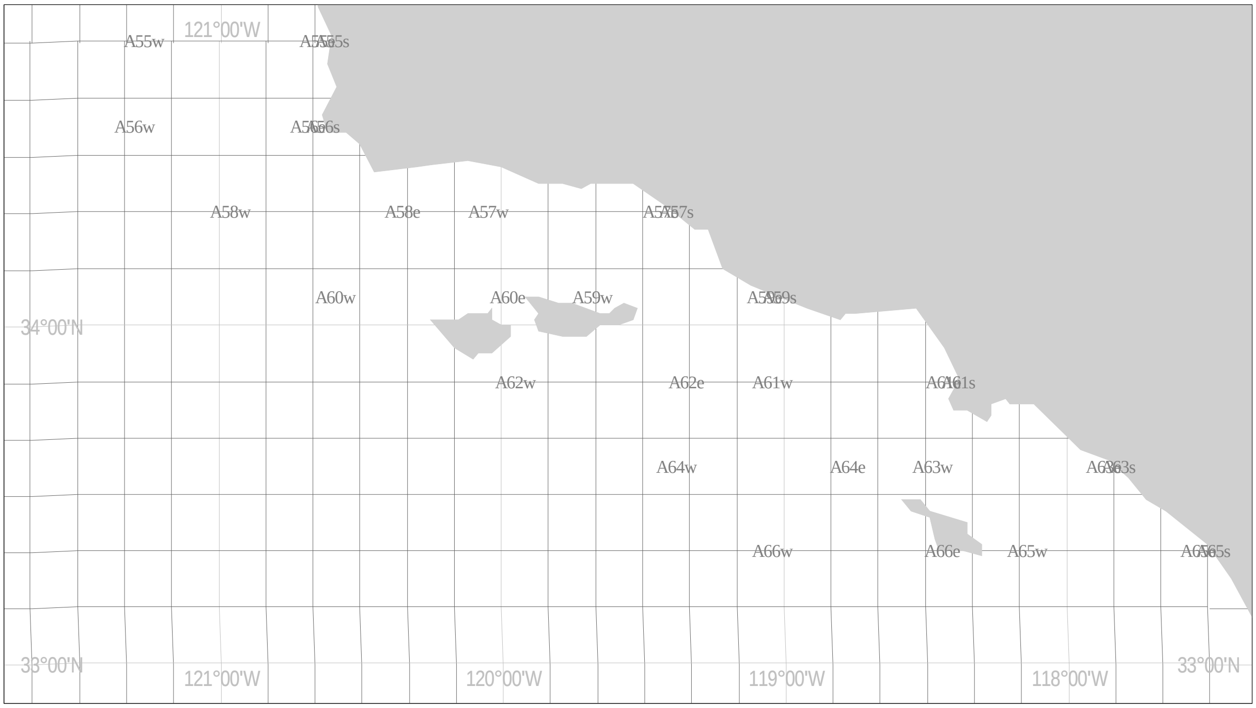
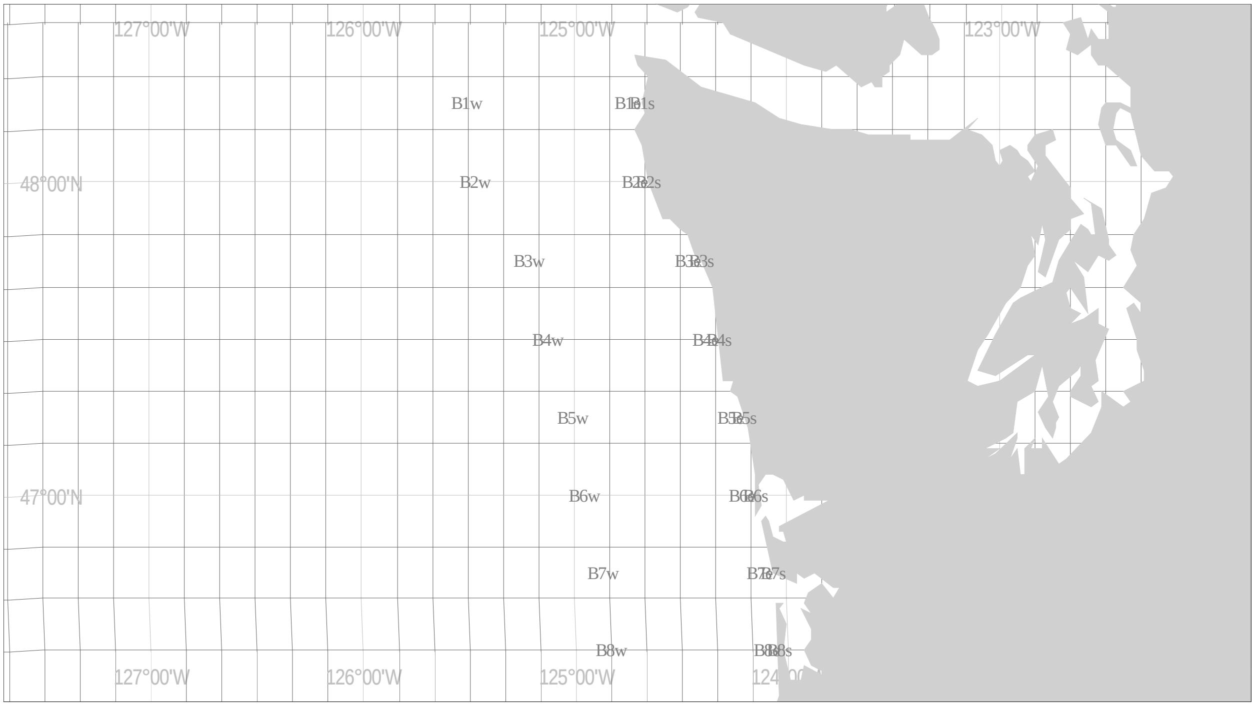
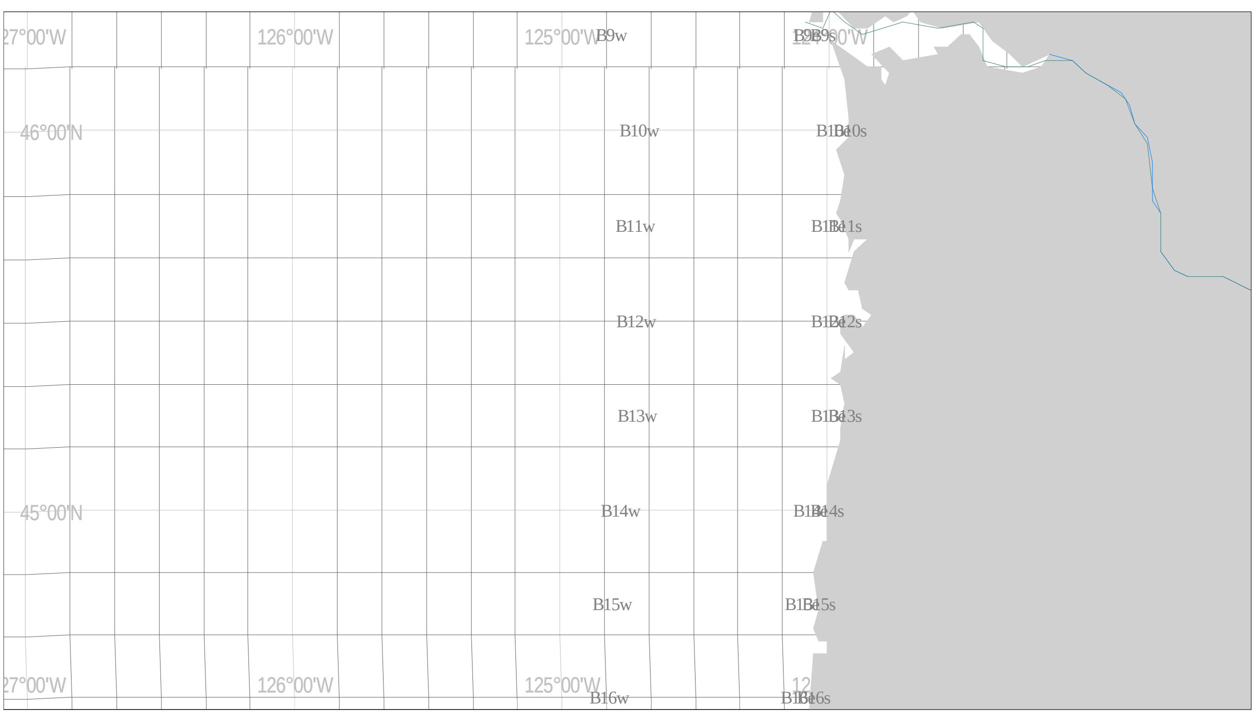


Figure 1b. Maps showing locations of transects comprising Replicate SET B

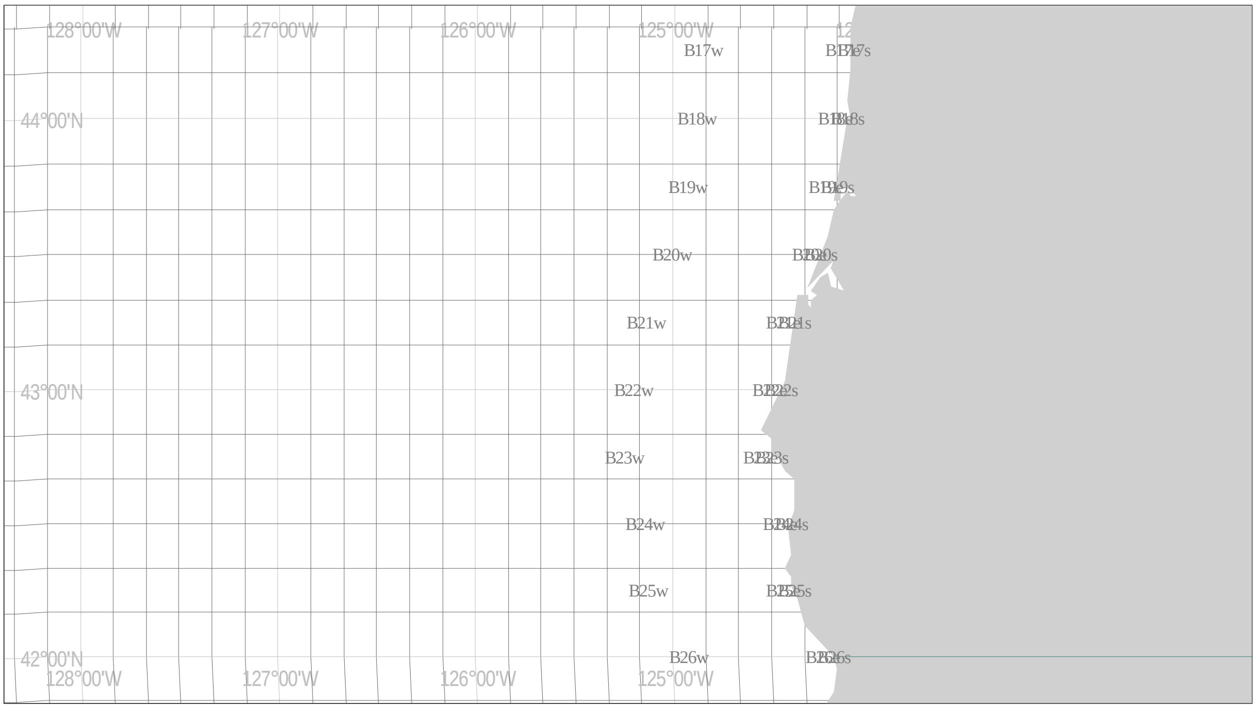
SET B northern region: Transects 1-8



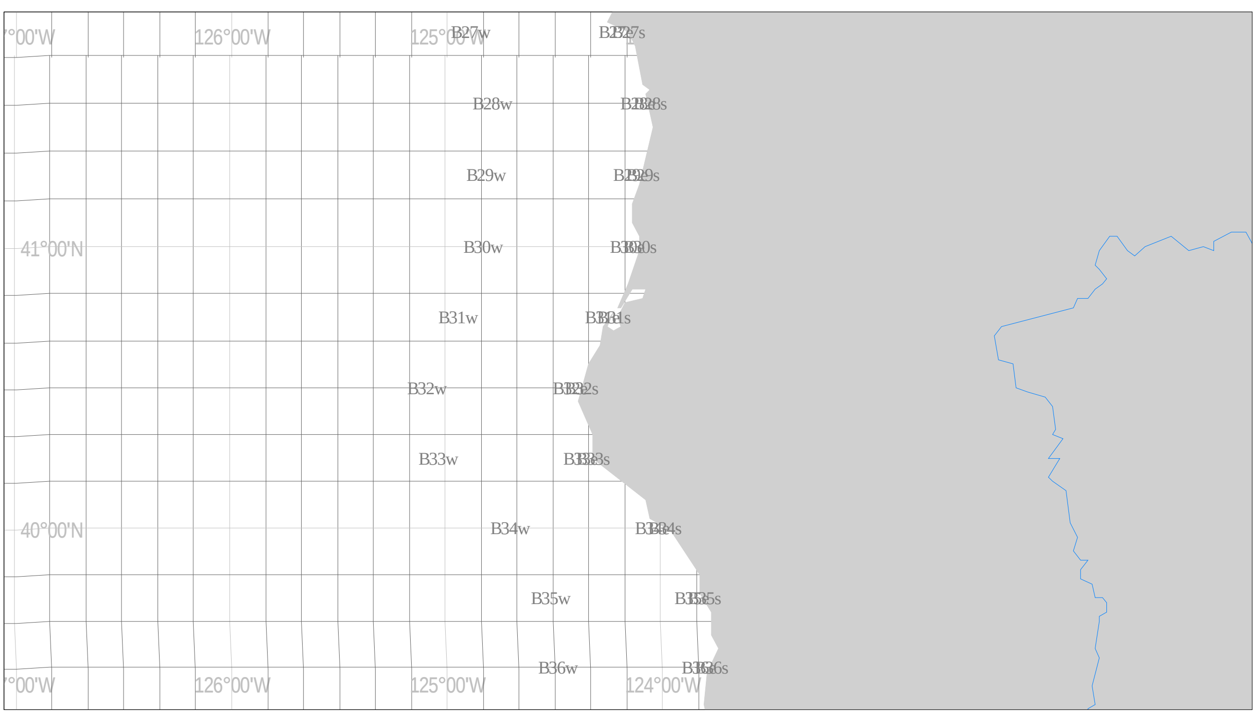
SET B northern region: Transects 9-16



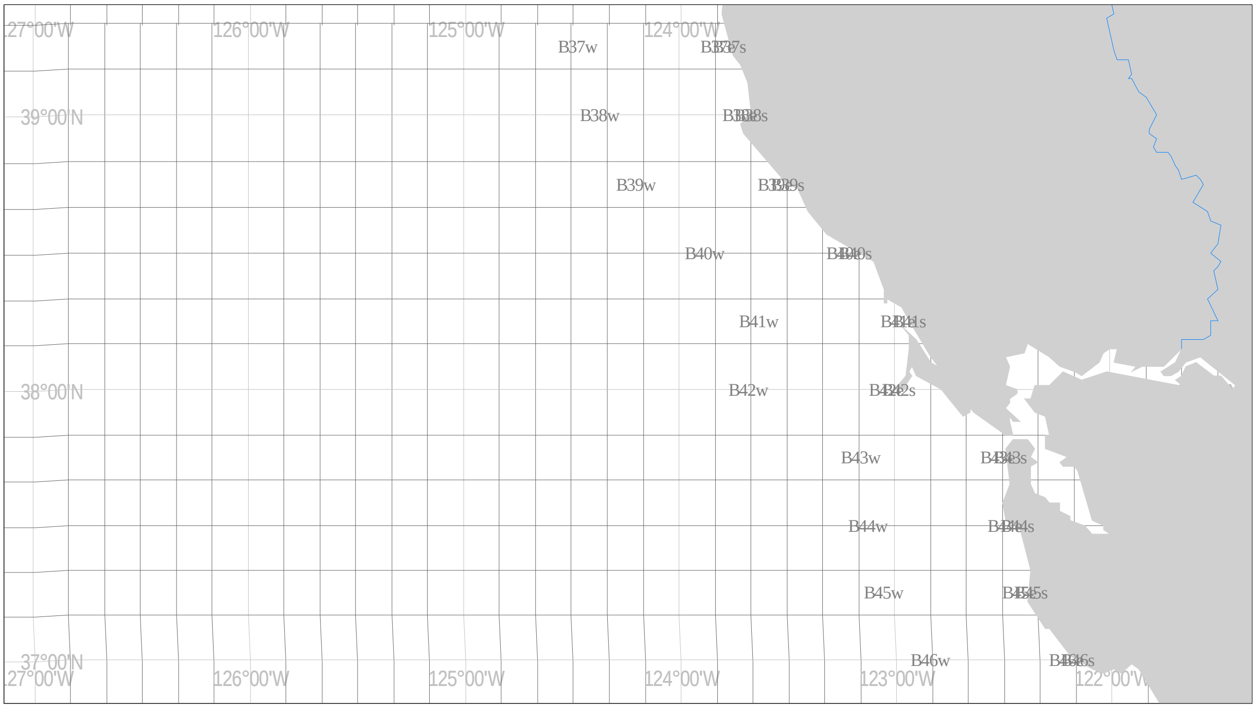
SET B northern region: Transects 17-26



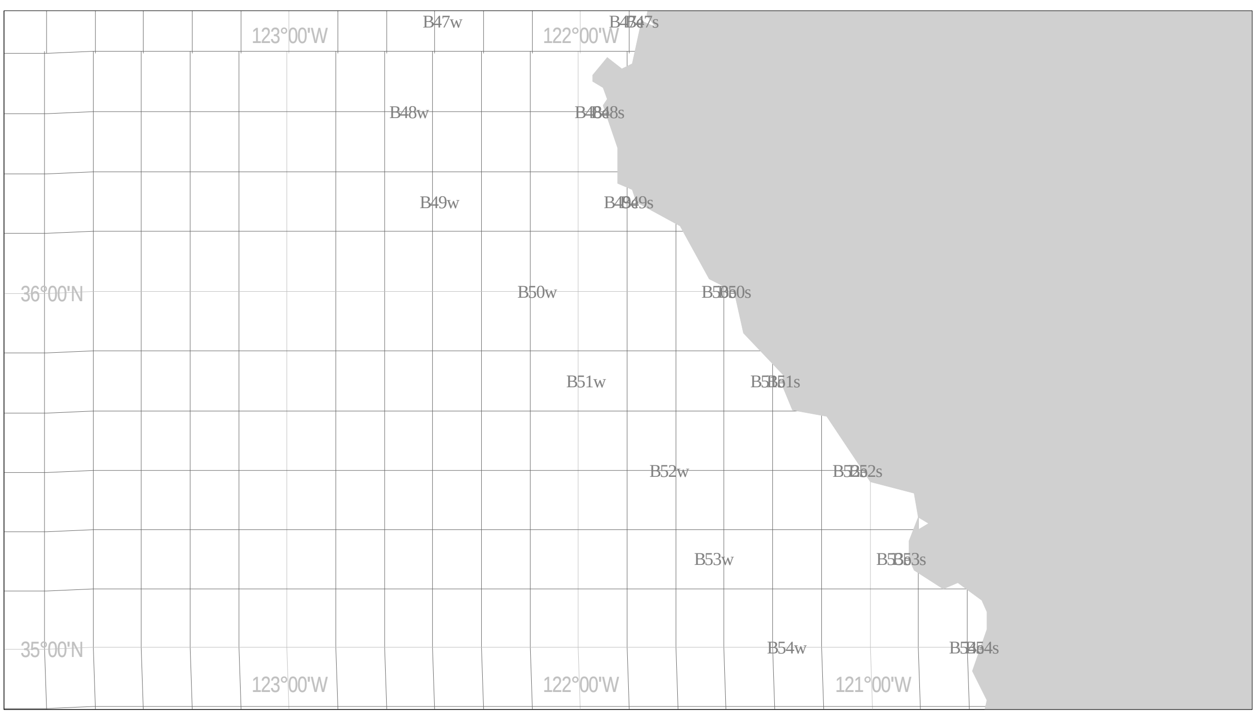
SET B southern region: Transects 27-36



SET B southern region: Transects 37-46



SET B southern region: Transects 47-54



SET B southern region: Transects 55-66

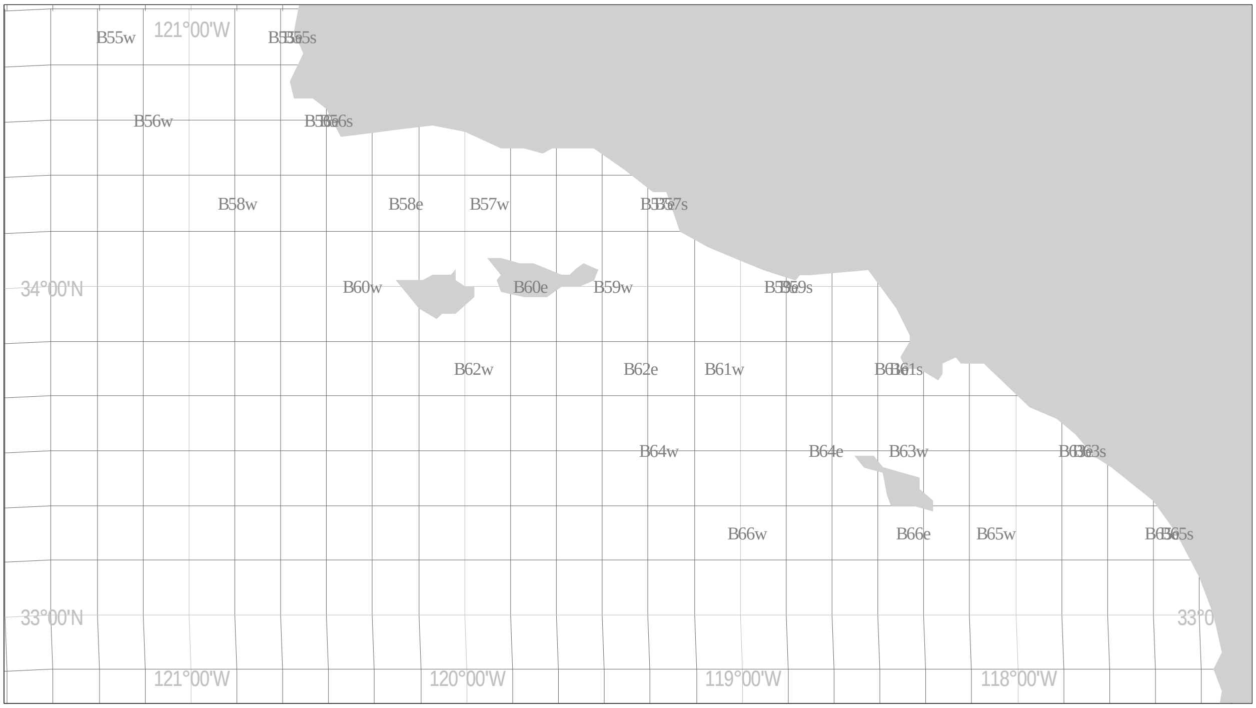
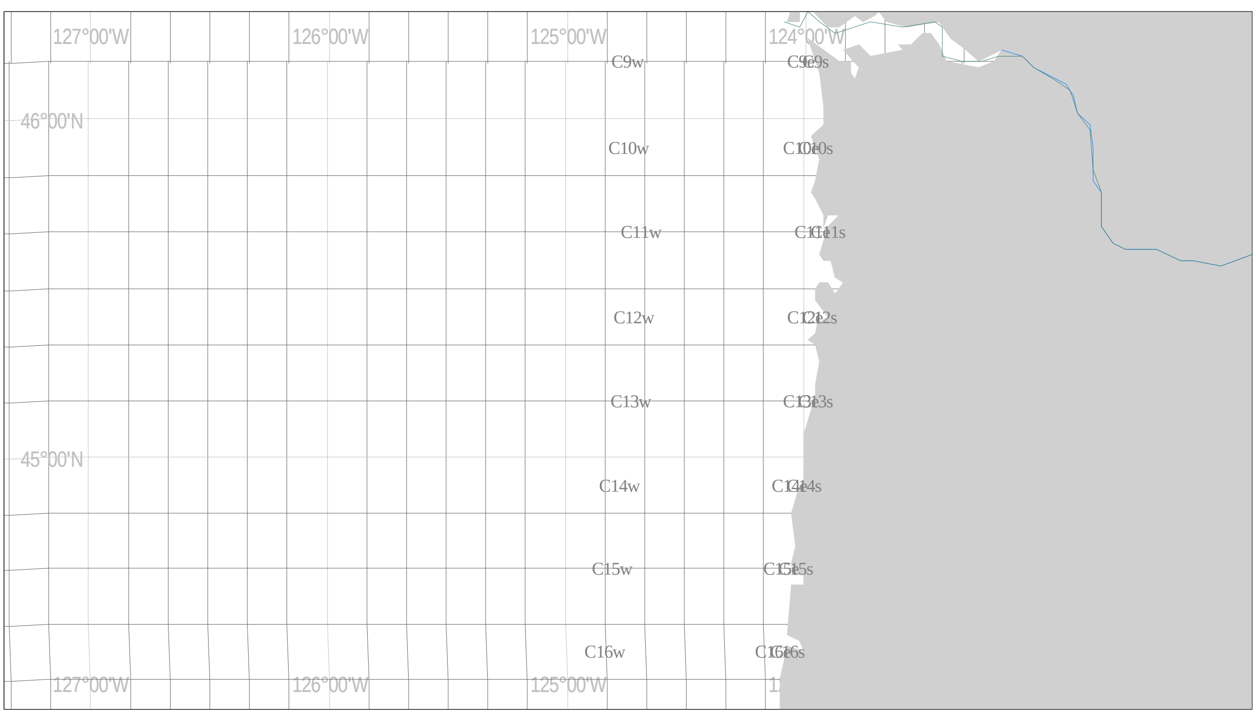


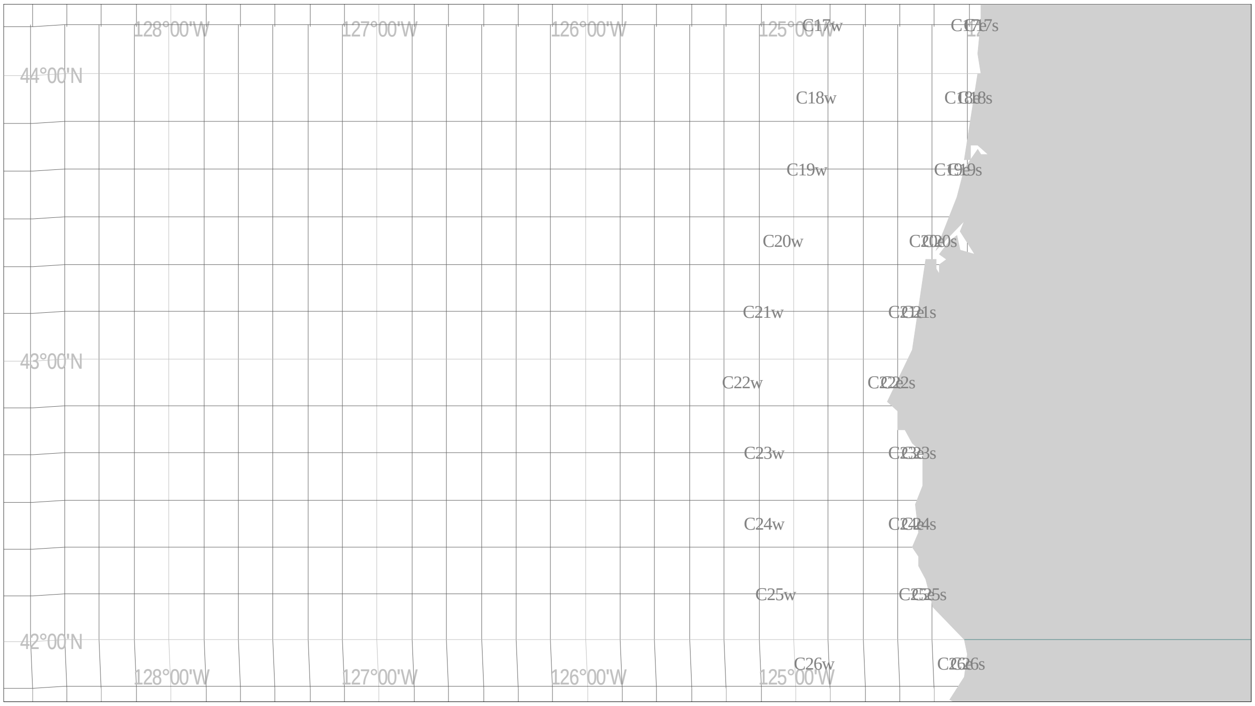
Figure 1c. Maps showing locations of transects comprising Replicate SET C

SET C northern region: Transects 1-8

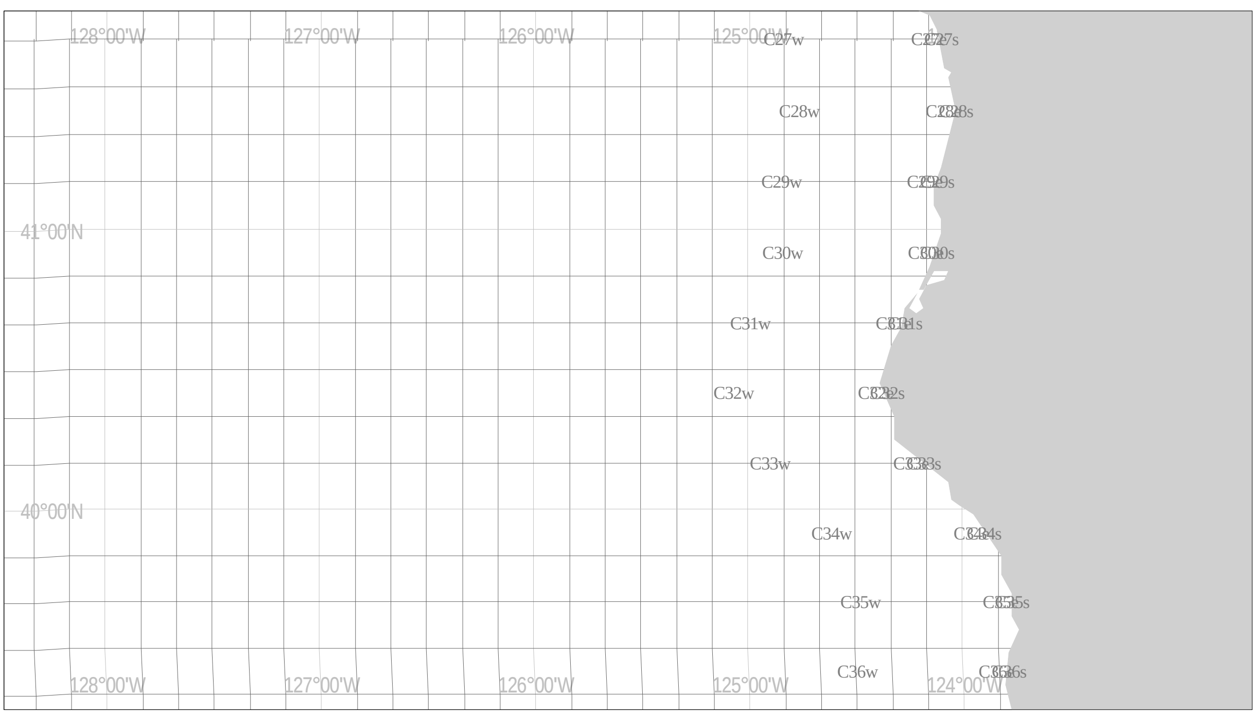
SET C northern region: Transects 9-16



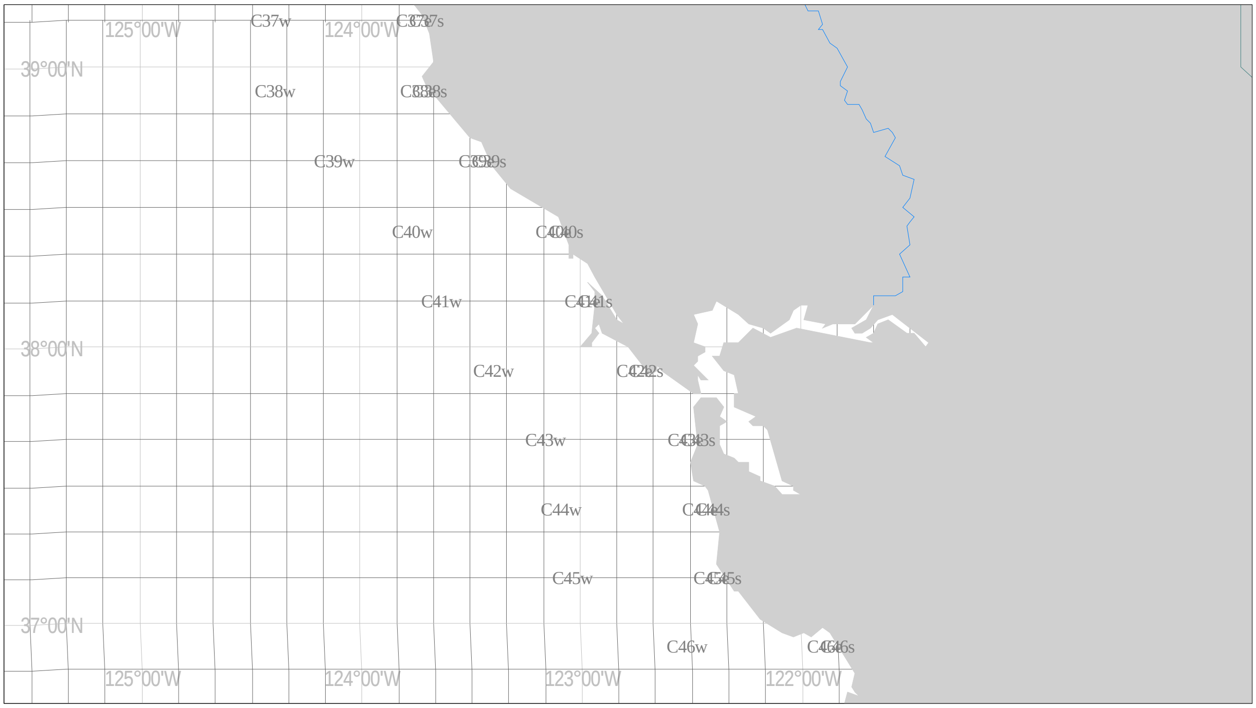
SET C northern region: Transects 17-26



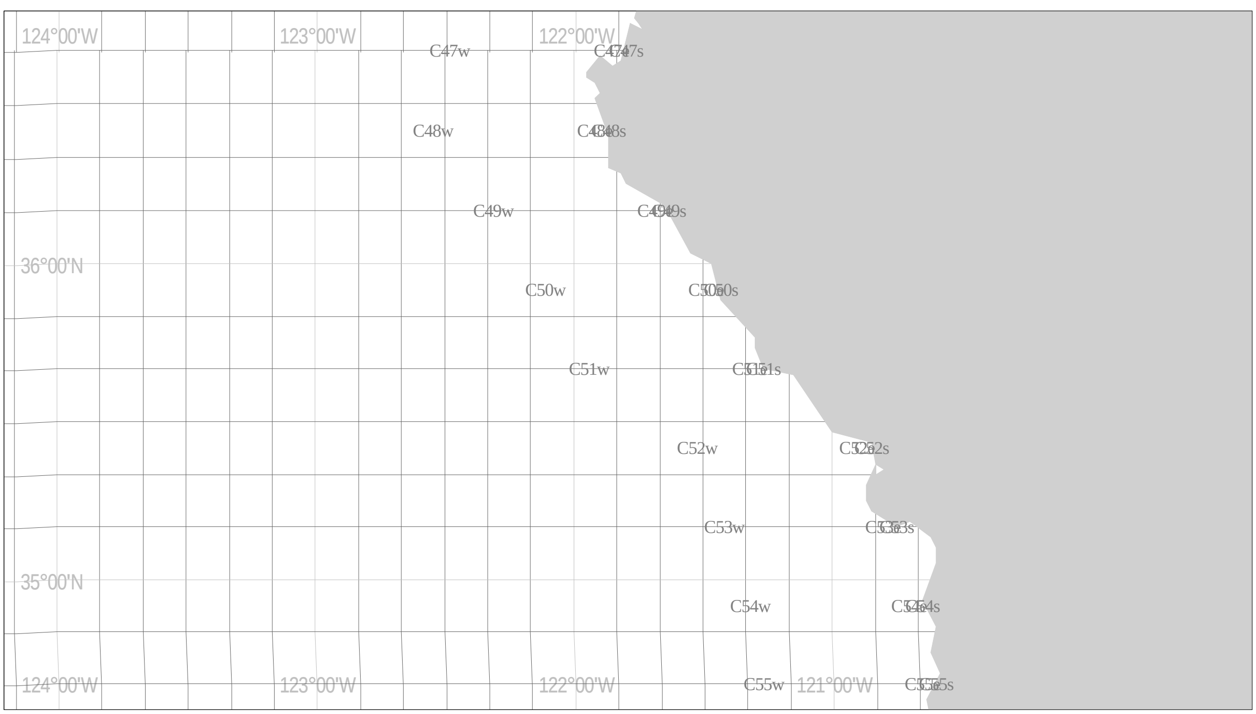
SET C southern region: Transects 27-36



SET C southern region: Transects 37-46



SET C southern region: Transects 47-55



SET C southern region: Transects 55-66

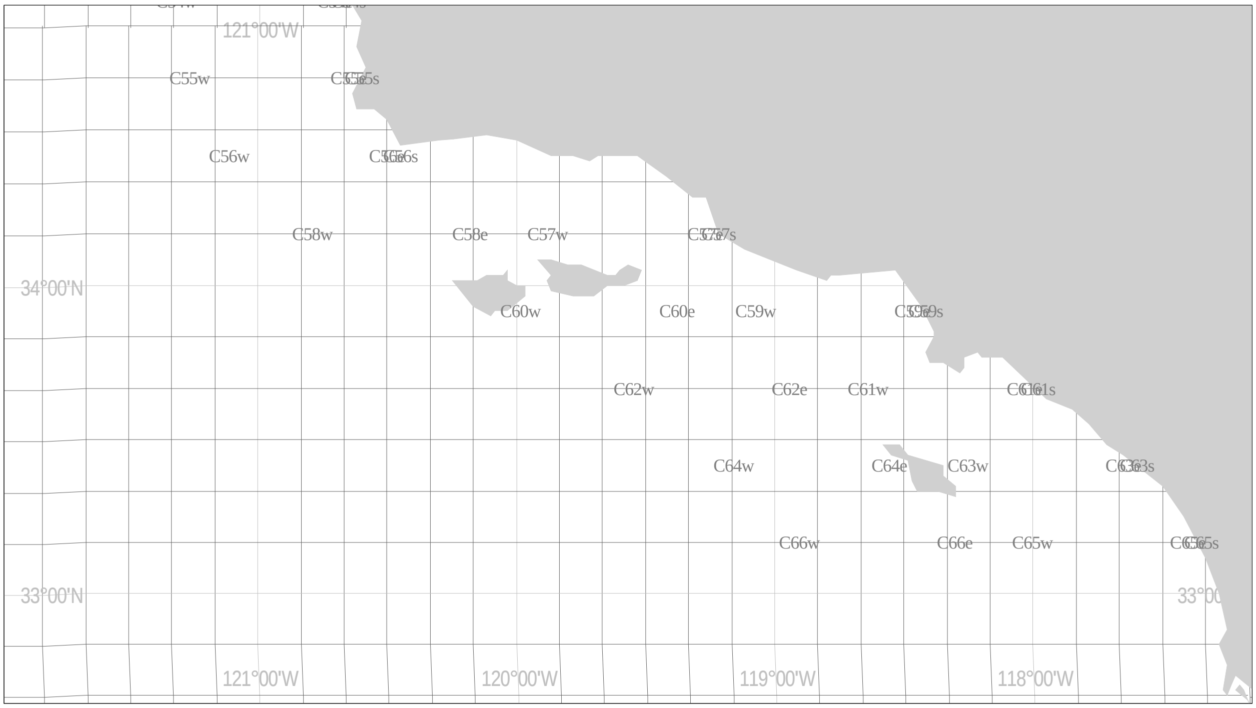
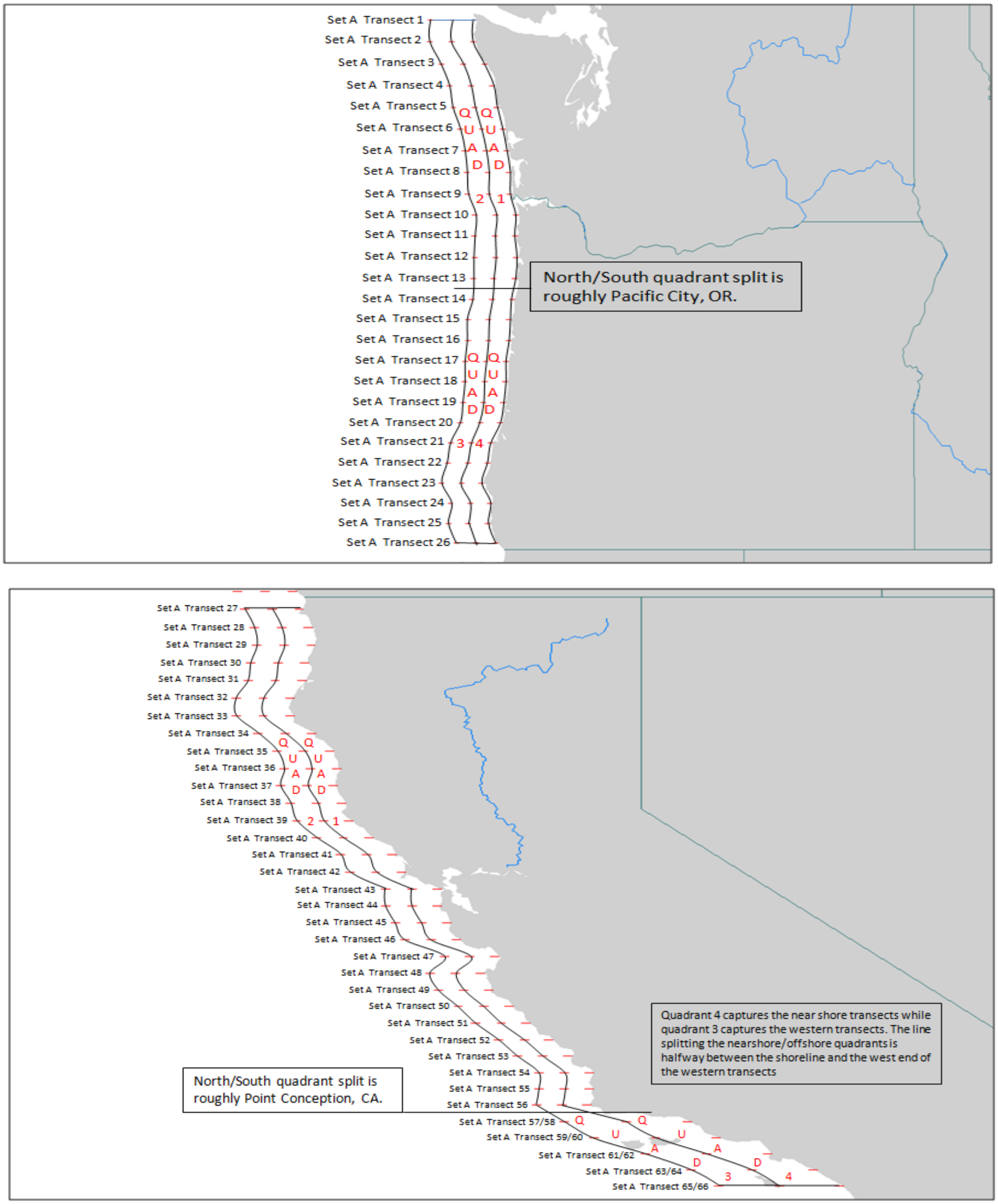
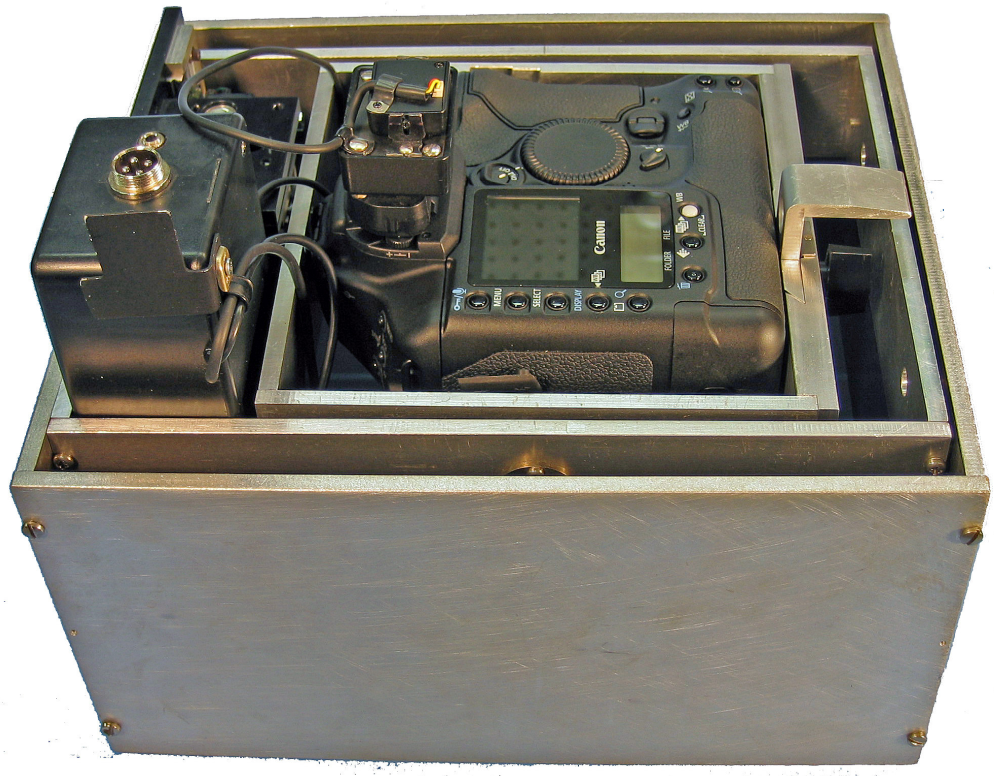


Figure 2. Maps showing quadrants for spatial distribution of point sets.



Appendix I, Adjunct 1. Aerial Imaging Solutions FMC System

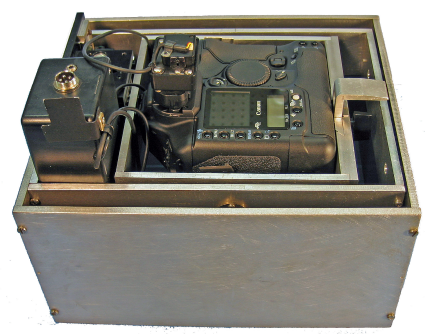
AERIAL IMAGING SOLUTIONS
FMC MOUNT SYSTEM

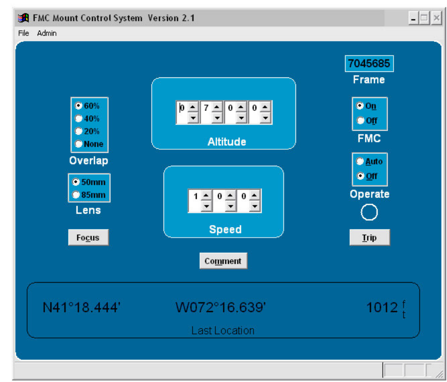


DESCRIPTION

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 Aerial Sardine Survey 2010

Survey Data Form Discussion

The purpose of this document is to help guide us through each of the 2010 sardine survey data forms. If you are still unclear of what a field within a form is asking, please contact your regional field coordinator for further clarification. Please have all survey forms completed and submitted to the regional field coordinator by the end of each survey day.

Transect Flight Log Form

Aerial survey pilots will complete the Transect Flight Log Forms for each transect flown for each survey day. The information recorded on this form will help the photo analyst identify fish schools during the transect survey photo processing period, so be as detailed as possible while recording notes. *If a transect is skipped or aborted due to poor visibility or some other factor, please make a note of it on the Transect Flight Log Form and also let your regional field coordinator know as early as possible.

Heading Information

- **Transect No.** – Record the transect number that is flown
- **Date** – Record the date that the transect is flown
- **Pilot** – Name of pilot flying the transect
- **Observer** – Name of observer on board if any
- **Plane** – Type of aircraft flying the transect
- **Transect Aborted** – If a survey transect is aborted or cut short of being completed, give the reason why i.e. fog, low cloud ceiling, ocean conditions and contact the regional field coordinator when time allows. Use the comments section for additional writing space.

Transect Data

- **Time** – Pilots are asked to log the time a fish school is observed along the survey transect
- **Photo #** - Pilots are asked to log the photo number that corresponds with the school identified on that transect.
- **Latitude/Longitude** – Record the latitude and longitude of the school observed while flying the survey transect.
- **Altitude (ft)** – Record the altitude of the plane as it passes over the school observed
- **Species Observed** – Record the species observed on each transect. Use comments section for additional writing space as needed.
- **Estimated School Tonnage (mt)** – Pilots are to estimate the observed tonnage of fish schools identified along the survey transect. If there are too many schools to estimate tonnage for each individual school, estimate the schools as a whole.
- **Comments** – Please write any additional information or notes in this section

Biological Sampling Form

During the 2010 West Coast Aerial Sardine Survey, biological samples will be taken from landed point sets to collect individual fish data. This form is to be filled out by the person/s working up the biological sample. Please contact your in season regional field coordinator with any questions or further clarification.

Heading Information

- **Date Landed**– Record the date the point set was landed at the processing plant
- **Date Sampled** – Record the date the biological sample was worked up
- **Vessel** – Record the vessel name that delivered the point set catch
- **Sample No.** – Record the sample number consecutively as they occur during the 2010 season
- **Point Set No.** – Record the point set number that the biological sample corresponds to
- **Sampler** – Record the name of the person/s processing the biological sample
- **Processor** – Name of the fish processing plant the sample was collected at
- **Sample Wt. (kg)** – Record the total biological sample weight in kilograms

Biological Data

- **Weight (g)** – Record the individual fish weights using an electronic scale accurate to 0.5 gm
- **Standard (Std.) Length (mm)** – Record the length of each individual fish. Standard length is measured from the tip of fish snout to last vertebrae in millimeters.
- **Sex** – Record the sex of each individual fish (M = male ; F = female)
- **Maturity Code** – Record the maturity code that closely matches the maturity of the fish. Refer to Table. 3 of the Operational Plan for detailed sardine maturity codes.
- **Otolith vial #** - The otolith vial number is determined by the following information: the point set number, fish number and the year date the otolith was collected. This information allows for easy reference to the individual fish information as needed.
  Example: Point set number 23 is being offloaded. You collect your biological sample from the processing plant. You have already determined which fish will be the otolith fish. It is a good idea to pre-label the capsules before working up the sample. So our otolith capsule would read **PS23F37-10** which again refers to **P**oint **S**et **23** and **F**ish number **37** of 50 collected in 20**10**.
- **Comments** – Please write any additional information or notes in this section.

Point Set Flight Log Form

During the 2010 West Coast Aerial Sardine Survey, pilots are asked to record important point set information that will be used in the photo enhancement process. Each pilot is asked to fill out a new Point Set Flight Log Form each day point sets are attempted. The Point Set Flight Log Form allows for six point sets to be recorded on each form. Use additional Point Set Flight Log Forms as needed. Also on the form is a comments section for the pilot to include any other important details or notes.

Heading Information

- **Date** – Record the date the point sets are completed
- **Pilot** – Name of pilot the setting the vessel for point sets
- **Plane** – Type of aircraft flying for point sets
- **Observer** – Name of observer onboard airplane if any
- **Processor** – Name of the fish processing plant that the catch will be delivered to

Point Set Flight Log Data

- **Point Set Number** – Number the point sets consecutively as they occur during the 2010 season
- **Time** – Record the time when the point set is attempted
- **Photo #** - Pilots are asked to log the photo number that corresponds with the point set school that is identified and being targeted
- **Position (Latitude/Longitude)** - Record the latitude and longitude of the school being targeted for the point set
- **Altitude(ft)** – Record the altitude of the airplane for which species identification was made
- **Vessel** – Record the name of the vessel being set during each point set
- **Species Observed** – Record the species observed for each point set. Use comment section for additional writing space
- **% of School Captured** – Pilots are to estimate a percentage of point set school capture. Pilots estimated percent capture should be independent of captain's vessel estimate.
- **Estimated School Tonnage (mt)** – Pilots are to estimate the tonnage of the targeted fish school prior to setting on it.
- **Comments** – Please write any additional information or notes in this section.

Fisherman's Log Form

During the 2010 West Coast Aerial Sardine Survey, vessel captains participating in the capture of point sets are asked to record important fish school data, ocean data, catch estimates and delivery information. Additional vessels may be utilized during point set operations, so be sure to include this information in the '**Other Vessel utilized**' field under the Captains Estimate and Delivery Information heading. If additional vessels are used to land a point set, please contact your regional coordinator.

*Heading Informati*on

- **Date** – Record the date the point set is completed
- **Vessel** – Name of the vessel participating in the point set operations (also include any additional vessels that were utilized during a point set landing)
- **Captain** – Name of the person operating the vessel
- **Processor** –Name of the processing plant the point set catch will be delivered to

Fisherman's Log Data

Hydro acoustic Gear

- **Manufacturer –** Record the manufacturer name of the sounder and sonar being used during point set operations
- **Model –** Record the model number or series number of the sounder and sonar being used during point set operations
- **Frequency –** Record the frequency used for both the sounder and sonar during point-set operations

Net Dimensions

- **Net Length –** Record the length of the net (in fathoms) being used during point set operations
- **Net Depth –** Record the depth of the net (in fathoms) being used during point set operations
- **Mesh size –** Record the size of the net mesh (in inches) being used during point set operations

School and Ocean Data

- **Point Set Number –** Number the point sets consecutively as they occur during the 2010 season
- **Time –** Record the time the skiff was deployed from the vessel for point set capture
- **Latitude/Longitude –**Record the positional information related to the targeted point set school
- **Depth to Top of School (fath) –** Record the distance from the water surface to the top of the targeted point set school
- **Depth to Bottom of School (fath) –** Record the distance from the water surface to the bottom of the targeted point set school
- **Ocean Depth (fath) –** Record the ocean depth at which the point set occurred
- **Temperature –** Record the temperature of the water that the point set occurred in

- **Weather Condition –** Refer to the key at the bottom of the Fisherman's Log form for weather codes (Weather Codes: 1=calm, clear; 2=light wind, good visibility; 3=moderate wind, fair visibility; 4=poor fishing conditions)

Captains Estimate and Delivery Information

- **Species Observed** – Record the species observed for each point set
- **% of School captured** – Record the percentage of school captured. The captain's estimate will be independent of the pilot's estimated percent capture.
- **Estimated School Tonnage (mt)** – Record the estimated landed weight (mt)of the targeted point set
- **Fish Hold** – Record the fish hold that the point set is being held in for delivery. Below are abbreviations to be used for identifying which hold a specific point set is being held. Of course not all vessels will have six fish holds, use the fish hold code that best represents your vessels.

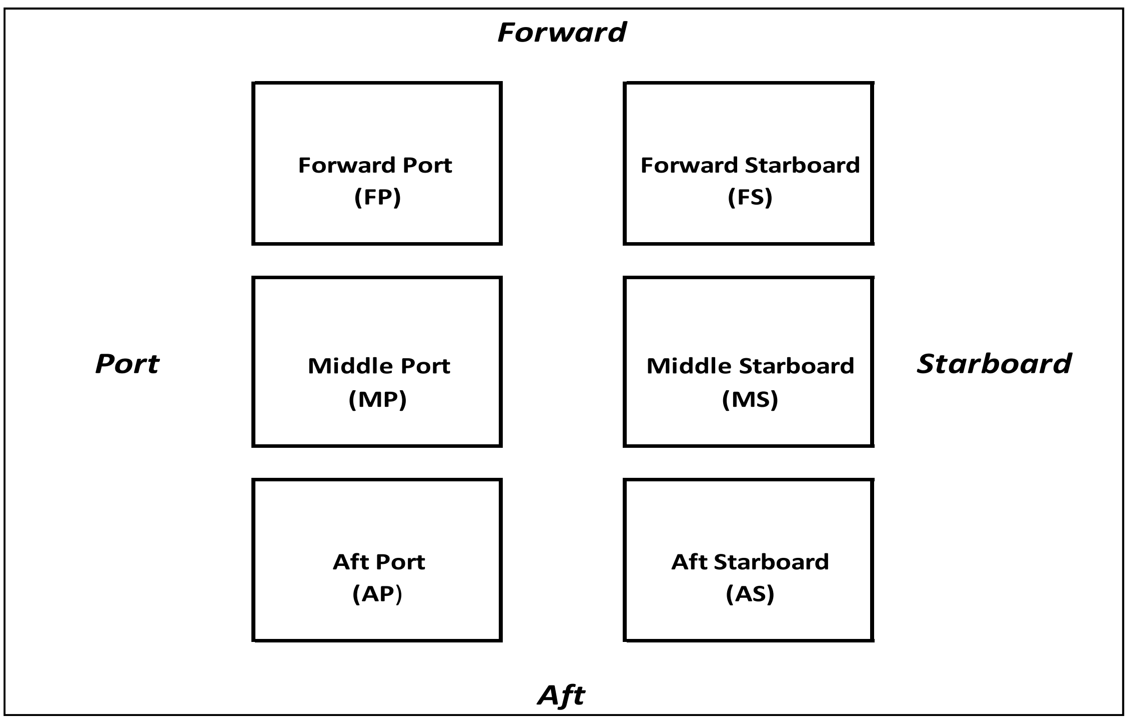


Diagram of fish hold abbreviations to be used on Fisherman's Log Form

- **Other Vessel utilized** – If an additional vessel is utilized to land a point set school, record the vessels name, estimated weight (mt) and in what holds the fish are being held. Use the comments section at the bottom of the form to report any additional information.
- ***Delivered Weight** (Office Use Only) – Leave this field blank. After the delivery is completed, the regional field coordinators will acquire this information from the processing plant manager.
- ***Fish Ticket Number** (Office Use Only) – Leave this field blank. The regional field coordinator will acquire this information from the processing plant manager.
- **Comments** – Please write any additional information or notes in this section.

West Coast Aerial Sardine Survey 2010

Pilot Pre-Flight Survey Checklist

Pre-Flight Checklist

- Check/clean the Plexiglas window on bottom of plane for condensation, dirt, etc.
- Check that the 28V Milwaukee battery is charged before departing.
- Ensure both memory cards are in the camera (CF – compact flash, SD – secured digital) and/or replace memory cards as they become full to prevent from filling up during flight.
- Check that a copy of the transect waypoint document is aboard the aircraft.
- Check GPS reading and enter waypoints if necessary.
- Check all camera system cables
  - Thick grey video cable: connect to black box on camera mount and to the computer box.
  - S-Video cable: connect to black box on camera mount and the splitter end to the camera.
  - Vaster (IOIOI) cable: connect to laptop and to computer box.
  - GPS cable: connect to GPS and to computer box.
  - Video cable: connect to camera, to USB converter, and to USB port on the laptop.
  - Portable power source: connect to shop light and to computer box.
  - Camera power source: connect to camera and to computer box.
  - Laptop power source: connect to laptop and to computer box.
- Power ON laptop, camera, inverter, 28V Milwaukee battery, and computer box.
- Open FMC Mount Control System 3.1 and FMC Mount Remote Viewfinder programs on the laptop.
- Adjust FMC Mount Control System settings as necessary.
  - Altitude: 4000ft (or TBD).
  - Speed: TBD.
  - Overlap: 60%.
  - Reset frame count to 0.
      - Admin
        - Frame Count
          - Enter 0.
  - FMC: On.
  - Ensure that GPS is functioning properly and that the location reading in the box is accurate.
- Adjust FMC Mount Remote Viewfinder settings as necessary.
  - Ensure that the number between the brackets (the number of photos remaining on the memory card) is higher than the number of photos to be taken that day.

    - ☐ Press the setting button in the center of the quick control dial on the camera and ensure that the camera view is displayed in the Viewfinder window.
- ☐ Press F9 (trip) to ensure that the camera system is functioning properly.
- ☐ Power OFF the camera system so that power does not spike when starting the airplane.
- ☐ Start up airplane.
- ☐ Power system ON and press the settings button in the center of the quick control dial on the camera and ensure that the camera view is displayed in the Viewfinder window.
- ☐ Again, verify that the camera system GPS reads approximately equal to the pilot's GPS.
- ☐ Press F9 (trip) to take a single photo to ensure that the camera system is functioning properly and that it can be seen through the Veiwfinder window. This is your last chance to make any corrections to the system before taking flight.

Mid-Flight Check

- ☐ Upon approaching the beginning of a transect/point-set, press F5 (auto) to begin automatic photo recording. Occasionally compare the camera system GPS to the pilots GPS. Also, remember to adjust the FMC altitude and speed settings when necessary.

Post-Flight Checklist

- ☐ Upon landing, the photos and FMC datalog will need to be downloaded.
- ☐ Connect USB/USB 2.0 cable from camera to laptop.
- ☐ The system will automatically recognize the photo folder to be downloaded.
- ☐ Press "ctrl A" to highlight all of the photos taken throughout the survey day of flying.
- ☐ Right-click on one of the highlighted photos and select Copy.
- ☐ Paste the photos into a new folder on the laptop labeled with the survey days date.
- ☐ Open the C: drive (if prompted, choose to open with Internet Explorer) on the laptop and locate the folder named "FMCdatalog."
- ☐ Right-click on the FMCdatalog folder, select Copy, and then Paste the folder into the survey day's photo folder.
- ☐ Attach a thumb drive to the computer via USB connection. Drag the survey day's photo folder onto the thumb drive. The photos and FMCdatalog folder will be copied onto the thumb drive.
- ☐ Attach a mass external hard drive to the computer via USB/USB cable. Drag the survey day's photo folder onto the WD external hard drive. The photos and FMCdatalog folder will be copied onto the hard drive.
- ☐ The day's photos and FMCdatalog folder should now be archived to three locations (laptop, thumb drive, and external hard drive).
- ☐ Open all photo locations to ensure that the photos and FMCdatalog folder are properly saved.
- ☐ Power OFF the camera system and charge the 28V Milwaukee battery.
- ☐ Contact the regional data coordinator to coordinate the shipment of data
- ☐ Mail data frequently to ensure quick processing time.

Mail data to: Ryan Howe Address TBD

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

Vessel Name	Skipper	Owner	USGS/OR Reg#	CPS/Sardine Permit #	Length	GRT	Holds	Capacity (Tons)
Astoria								
Pacific Pursuit	Keith Omey	Pacific Pursuit, LLC	OR873ABY	30920	73'	86	4	80
Lauren L. Kapp	Ryan Kapp	Daryll Kapp	OR072ACX	57008	72'	74	4	60
Pacific Knight	Mike Hull	Dulcich, Inc.	OR155ABZ	57011	62'	53	4	50
Pacific Raider	Nick Jerkovich	Nick Jerkovich	972638	57010	58'	75	2	55
Monterey								
Sea Wave	Andy Russo	Sea Wave Corp-Sal Tringali	D951443	10	78'	206.9	2	75
King Philip	Anthony Russo	Sea Wave Corp-Sal Tringali	D1061827	9	79'	156.9	6	125
El Dorado	Frank Aliotti	Aliotti Brothers, Inc.	D690849	32	56'	54.9	3	40
Aliotti Bros.	Dominic Aliotti	Joseph D. Aliotti	D685870	48	67.6'	107	3	80
Southern CA								
Eileen	Nick Jurlin	South Sound Fisheries, Inc.	D252749	38	79.4'	119.9	2	85
Trionfo	Neil Guglielmo	Aniello Guglielmo	D625449	45	63.8'	79.2	3	60
Endurance	Vince Lauro	Vincent Lauro	D613302	35	49'	42	3	40
Maria T	Robert Terzoli	Vito Terzoli	D509632	25	57.3'	68.1	3	65

Appendix I, Adjunct 3a. Identification of participating sardine processors

In Washington and Oregon, participating fish processors will be established by a bid process using the same procedure as in 2009. At this writing, the bid process has not been completed. Likely processors for 2010 may include Ocean Gold, Astoria Pacific, Astoria Holdings, and/or potentially others.

In central California, Monterey Fish Company will process the sardines captured from three of the identified vessels, and Del Mar Seafood will process for the fourth vessel.

In southern California Fish landed at Port Hueneme will be sampled at the dock and trucked to Tri-Marine Fish Company in San Pedro for processing. Fish landed in San Pedro will be processed either at Tri-Marine or State Fish Company, depending on the vessel making the delivery.

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 (with individual fish identified as to sample number, point set, vessel and location captured, to link back to biological data) 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. Point sets will be targeted working in general from the smallest size category to the largest. 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. 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. Pumping large sets onto more than one vessel should be avoided, and should only be done in the accidental event that school size was grossly underestimated.

13) The field director will also oversee the spatial distribution of point set sampling, to ensure adequate dispersal of point set data collection.

14) Photographs and FMCdatalogs of point sets will be forwarded from the field for lab analysis daily. In the northern region, these will be collected by Mr. Howe directly. In the southern region, they will be overnighted by Dr. Hanan to Mr. Howe via FedEx or UPS.

15) The total landed weight of point sets taken will not exceed the EFP 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. Howe will make the final determination of point set acceptability in the lab. A preliminary judgment will be made in the field, generally at the end of each day (or sooner) by the Field Project Leader in each region, to ensure ongoing sampling is being properly accomplished.

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

Doyle Hanan, PhD
Science Advisor / Project Director

April 30, 2010

I. Transect Survey

Overall Aerial Survey Design

We intend to conduct an aerial survey consisting of six transects laid out to parallel existing CalCOFI lines in the Southern California Bight near Santa Catalina Island. An aerial SET will consist of six transects and will make up one replicate. We intend to fly three SETs during daytime and three SETs during night-time (thus a total of 36 transects) to test sardine school: 1) day versus night detection, 2) photogrammetry versus lidar detection, and 3) acoustic versus lidar detection. For these tests we will be calculating and testing densities/biomass of individual sardine schools. Two airplanes will participate in the survey, one performing aerial transects and one directing point sets by the purse seine vessels. Both airplanes will be equipped with a digital camera and one will also carry lidar equipment to detect and record sardine schools. To ground truth estimates of density and thus biomass we will follow summer survey protocols of deploying purse seine vessels to make point sets. Landed weights from point sets will determine density/biomass of individual sardine schools.

Location of Transects

Transects and corresponding shoreline positions are plotted in Figure 2. The six parallel transects are arranged 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 extend on or parallel to the CalCOFI lines, running from shore and extending south-westerly for 75 statute miles in length; they are spaced approximately 15 nautical miles (15 minutes) apart in latitude.

Aerial Resources Available

The airplanes (Cessna 337 and Cessna 172) used for this survey will be equipped with a Canon EOS 1Ds camera mounted in an *Aerial Imaging Solutions* FMC (Forward Motion Compensating) mounting system, installed inside the fuselage to shoot pictures through a downward viewing port. The transect airplane (C337) will also carry lidar equipment ((1) laser and beam-control optics, 2) receiver optics and detector, and 3) data collection and display computer))[1] using a 2nd downward viewing port.

Use of Aerial Resources - Transects

The survey pilot in the Cessna 337 will begin with the most northerly transect, surveying from shore to the offshore end, then move to the next more southern transect and survey from offshore to shore. The pilot will repeat this pattern until each transect is surveyed and the SET is completed. Transects or portions of transects may be skipped for fog or other weather problems.

Use of Aerial Resources – Point Sets

The Cessna 172 will have a camera pod (CessnaCam by Airborne Scientific Inc.) attached under the C172 fuselage with the Canon EOS 1Ds camera mounted in an *Aerial Imaging Solutions* FMC (Forward Motion Compensating) mounting system inside the pod. The spotter pilot in the C172 will use sardine school location information provided by the C337 transect pilot, the

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

CalCOFI Chief Scientist (based on acoustic data during and immediately following passage of the research vessel in the fall survey area), and his own aerial reconnaissance to locate suitable sardine schools for photographs and purse seine point sets. On an opportunistic basis (before and/or after transect SETS) the C337 pilot will (with both camera and lidar equipment running to record sardine schools throughout the point set process) participate in the point sets especially for those schools located further from port/shore. Dr. Hanan will direct both pilots and make every effort to distribute these directed point sets along transect lines throughout the fall survey area where sardines are available.

Use of Acoustic Resources

We propose to estimate a function which relates aerially-observed fish school area (estimated from photographs) to fish biomass estimated from acoustics, including error bounds; and estimate the target strength of sardine (and perhaps other fish species) versus acoustic frequency and fish length, including error bounds. We will use regression and correlation statistical techniques to examine and compare these relationships for the aerial transects as compared to the acoustic results from the fall CalCOFI cruise acoustic data collected on the two CalCOFI lines through the study area. We will be in communication with the CalCOFI research vessel chief scientist (while the cruise passes through our research area) to facilitate coordinating our point sets to focus on areas where sardine schools were observed by the CalCOFI acoustic gear and by our aerial survey. On an opportunistic basis, we will also deploy a chartered vessel with BioSonics acoustic gear aboard (DT-X echosounder equipped with a 6^{o}, 208 kHz splitbeam transducer configured for side scanning). We will collect acoustic data to estimate school surface area and biomass of selected sardine schools just prior to point sets on those schools. All aerial and acoustic data will be geo-referenced for comparison of aerial photographs and lidar images taken during the point sets. Acoustic data will be analyzed by BioSonics (Seattle) using Echoview software. Results will be transmitted to Dr. Hanan for final comparative analysis to area and biomass estimates described above.

Use of Lidar Resource

We will be incorporating and following closely assessment methods developed by Dr. Jim Churnside for comparison of lidar to photogrammetric techniques (high definition video[2]) and acoustics (BioSonics 208 kHz splitbeam transducer[3]). In the video study, Dr. Churnside counted fish schools for analysis, but we intend to measure surface area and density of fish schools for comparison to the photographs we will collect, adopting and expanding his survey methods to correspond with our existing STAR panel approved photographic analysis. We expect to use lidar gear, techniques, and settings very similar to (Churnside, et al., 2001): “frequency-doubled, Q-switched Nd:YAG laser that produced 120 mJ of green (532 nm), linearly polarized light in a 12 nsec pulse at a rate of 30 pulses per second. The beam from the laser will be diverged, using a

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[2] Churnside, J. H., A. F Sharov, R. Richter. (Submitted for publication). Aerial Surveys of Fish in estuaries: A Case Study in Chesapeake Bay. 27 pages.

[3] Churnside, J. H., Demer, D. A., and Mahmoudi, B. 2003. A comparison of lidar and echosounder measurements of fish schools in the Gulf of Mexico. ICES Journal of Marine Science, 60:147–154.

lens in front of the laser, to be eye-safe at the surface (laser spot diameter of approximately 8 m) from the flight altitude of 600 m. The diverged beam will be directed by a pair of mirrors to be parallel to the axes of the two receiver telescopes, which collected the two orthogonal polarizations of the backscattered light. The first receiver channel uses a 7 cm diameter refracting telescope with a polarizer aligned with the laser polarization to measure the co-polarized lidar return. The other channel uses a 17 cm diameter telescope with a polarizer oriented perpendicular to the laser polarization to measure the cross-polarized lidar return. Each of the telescopes collects light onto an interference filter to reject background light. An aperture at the focus of the primary lens also limits background light by limiting the field of view of the telescope to match the divergence of the transmitted laser beam. A photomultiplier behind each telescope converts the lidar return into an electronic signal, which is passed through a logarithmic amplifier to improve the dynamic range. This signal is digitized at a rate of 109 samples per second during the return from each laser pulse. The computer records the digitized returns, along with the position and time from a GPS receiver, and displays the data to the operator. Sardine schools will be identified by visual examination of the photographs and lidar data and then lidar data will be plotted in grey scale. Return from water near the school will be estimated and subtracted from the sardine school returns to account for water scattering between fish. This return will also used to estimate lidar attenuation and the signal will be corrected by multiplying with the inverse of attenuation. In addition, the penetration depth of lidar will be estimated as the depth at which the lidar signal reaches the same level as from background light in the absence of sardine schools. Length of each school along the flight track will be estimated from the number of lidar pulses across the school, the time between pulses, and the speed of the aircraft. The school area will then be estimated by assuming the measurement passes through the center of a circular school. Average distance between sea surface and maximum lidar return within schools is assumed to be a measure of school depth for calculating school volume."

Conditions Acceptable for Aerial Surveying
At the beginning of each potential survey day, the survey pilot will confer with the project director; 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.

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 or other weather problems in a transect portion). The goal is to cover a full 6-transect SET in one day or night and additional replicate SETs of transects in as few days and nights as possible.

Data Transfer
Photographs and FMC camera log files will be downloaded daily, field checked for suitability, and forwarded, as soon as practicable, to Mr. Ryan Howe (in Oregon) to archive and analyze. Lidar data will be provided as soon as practicable to Dr. James Churnside (who will be on site during the survey), 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 Southern California vessels are identified in 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 within the fall study area; 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.

Sardine processing

Processing of sardines in the fall project will take place at Tri-Marine Fish. Co. and State Fish Company, following the same delivery protocol established for the summer survey.

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, individually bagged and frozen from each n = 50 fish point set sample for future age reading analysis. Each fish bagged will be identified with sample number, and the 25 fish sample intended for otolith extraction will be bagged together for freezing, and identified with specific information detailing point set number, vessel, skipper and location captured.

Hydroacoustic Sounding of School Height

Each purse seiner will measure school height and depth 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. Photographs documenting point sets will be reviewed daily to ascertain their suitability for analysis. 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 or night 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, will review photographs for suitability 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
Each airplane will photograph 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) if they can be found. For the actual schools photographed, a vessel at sea will collect a jig sample, if possible, to document the species identification. This set of reference photographs will be added to the set 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.[4] We are assuming these same methods are applicable to the nighttime photographs which will focus on detecting and photographing the

[4] 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. Hanan Oral presentation at 10th Trinational Sardine Forum November 17-18, 2009 and CCS workshop, November 19-20, 2009 in La Paz, Mexico.

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.

Experimental Design and 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. In addition, Dr. James Churnside will provide analysis of lidar data and BioSonics Inc. will provide Echoview analysis of hydroacoustic data collected with the BioSonics DT-X.

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 (night-time photographs will be of bioluminescence caused by fish movement through phytoplankton) 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.

Because this is a pilot project, we are essentially testing the feasibility of improving the coast-wide aerial survey with techniques that have been previously used to survey fish schools. We will calculate areas and biomass and then compare results from each technique to each other appropriate technique using regression and correlation statistical tests. Specifically, we will test (1) daytime versus daytime and then night-time versus night-time estimated surface areas of individual sardine schools obtained from the photographic results to those obtained from the lidar results; (2) we will test daytime versus daytime and then night-time versus night-time estimates of school biomass from photographs (applying actual landed weight by set) to those calculated from lidar results. We will also test daytime estimates against night-time estimates of surface areas and biomass for each technique. All analyses will be performed at the individual school level (Table 2).

Based on previous studies, we expect to find strong positive correlation between daytime photogrammetry and lidar, as well as, strong positive correlation between daytime acoustics and lidar. At this point, we can not speculate what relationships we will see for day-night differences but they should be very informative.

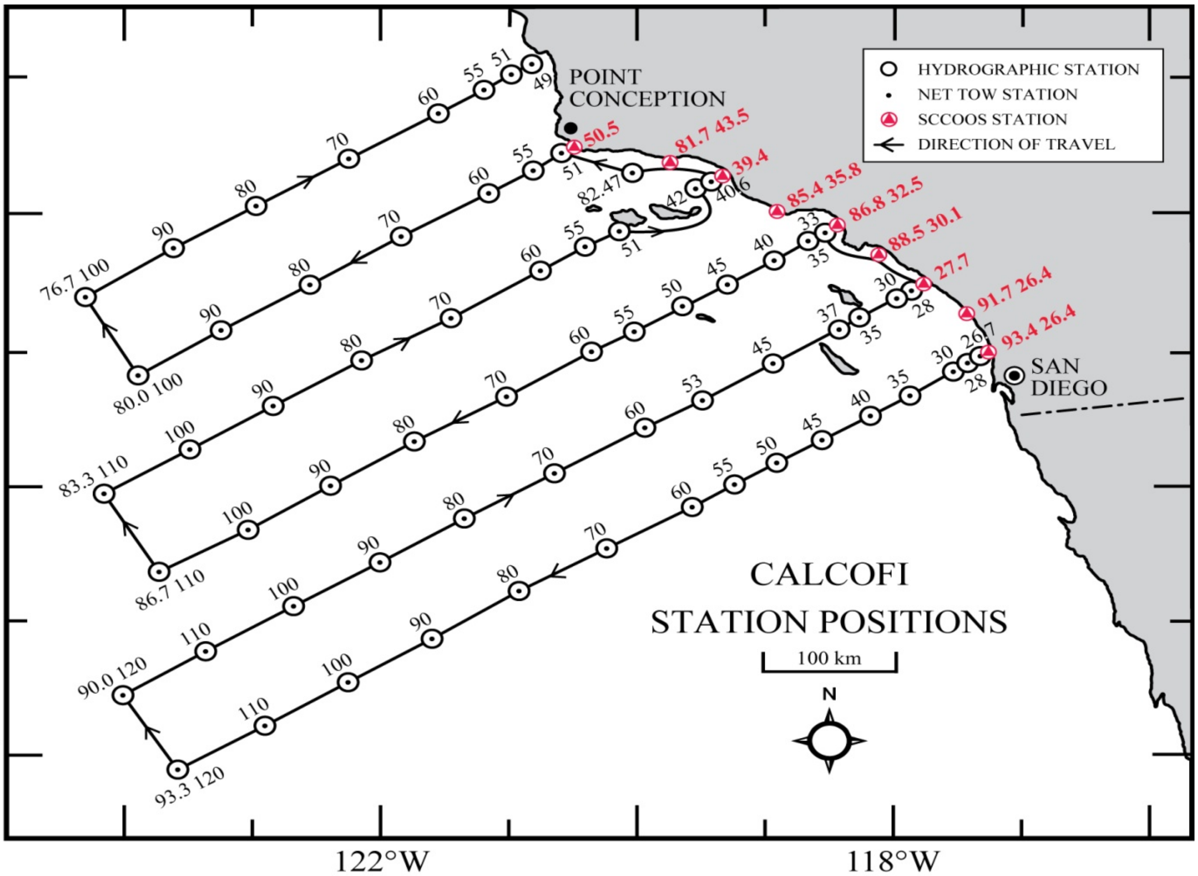
Adjunct 1, Table 1. Size and Number of Point Sets needed during 2010 EFP survey for the Southern California Pilot Sardine Survey area. Total landed weight of point sets will not exceed 800 mt.

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

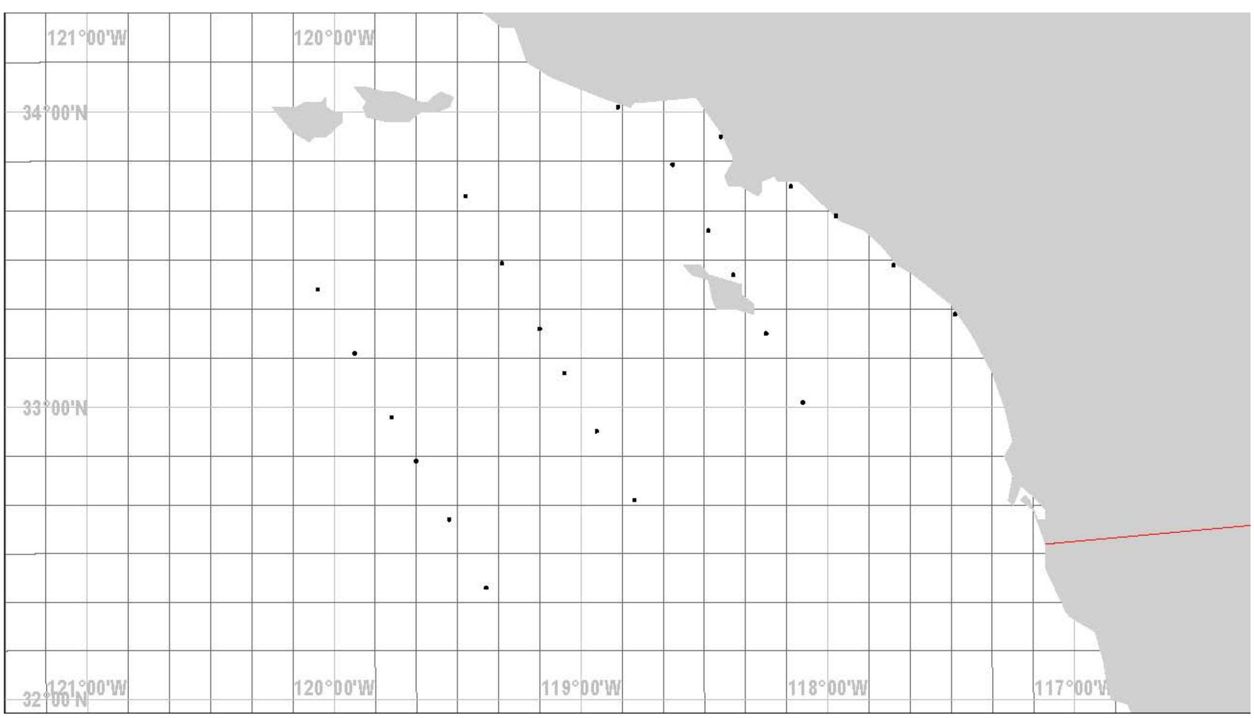
Adjunct 1, Table 2. Proposed variables and units for fall survey testing with correlation and regression analysis using area or density/biomass of observed sardine schools (e.g., Estimates of individual school area from photographs will be tested against daytime and night-time area estimates of individual schools from lidar; these tests will also be performed for estimates of density/biomass).

	Photo		Lidar		Acoustic	
	day	night	day	night	day	night
Photo (units)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)
Lidar (units)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)
Acoustic (units)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)	area & density (m^2 & mt)

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;

In 2008, pilot work began in the Northwest to evaluate the quantitative aerial survey method with point sets collected during the summer period of open fishing. It was very difficult to collect the data in a deliberate, methodical manner during the frenetic pace that typically accompanies a derby-style fishery opening. The issuance of an EFP allows for a more controlled sampling process with the focus on research and data quality, and will help to ensure better and more complete study results while using industry resources.

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. 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.

In addition, the pilot project proposed in this EFP application (described in Appendix I, Adjunct 5, and Appendix II, Section B) will evaluate alternative methods to measure biomass that may improve assessment methodology for sardine and potentially other CPS fisheries as well.

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. Few 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 24, 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. Biosonics Inc. will provide Ecoview analysis of acoustic data collected with the Biosonics DT-X.

< 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>

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

Jagielo, T.H. 1988. The spatial, temporal, and bathymetric distribution of coastal lingcod trawl landings and effort in 1986. State of Wa. Dept. of Fish. Prog. Rept. No. 268. June 1988. 46 pp.

Jagielo, T.H. 1990. Movement of tagged lingcod, (*Ophiodon elongatus*), at Neah Bay, Washington. Fish. Bull. 88:815-820.

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Jagielo, T. H., LeClair, L.L., and B.A. Vorderstrasse. 1996. Genetic variation and population structure of lingcod. Trans Amer. Fish Soc. 125(3).

Jagielo, T.H., Adams, P., Peoples, M., Rosenfield, S., Silberberg, K, and T. Laidig. 1997. Assessment of lingcod (Ophiodon elongatus) for the Pacific Fishery Management Council in 1997. *In* Pacific Fishery Management Council, 1997. Status of the Pacific Coast Groundfish Fishery Through 1997 and Recommended Acceptable Biological Catches

for 1998. Pacific Fishery Management Council, Portland, Oregon.

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Jagielo, T.H., Vandenberg, D.V., Sneva, J., Rosenfield, and F. Wallace. 2000. Assessment of lingcod (Ophiodon elongatus) for the Pacific Fishery Management Council in 2000. *In* Pacific Fishery Management Council, 2001. Status of the Pacific Coast Groundfish Fishery Through 2000 and Recommended Acceptable Biological Catches for 2001. Pacific Fishery Management Council, Portland, Oregon.

Jagielo, T.H. and J. Hastie 2001. Updated rebuilding analysis for lingcod. Report prepared for the Pacific Fishery Management Council, Portland, OR.

Kocak, D.M., Caimi, F.M., **Jagielo, T.H.** and J. Kloske. 2002. Laser Projection Photogrammetry and Video System for Quantification and Mensuration. Oceans 2002, Marine Technology Society. Biloxi MS.

Jagielo, T.H., Hoffmann, A, Tagart, J., and Zimmermann, M. 2003. Demersal groundfish densities in trawlable and untrawlable habitats off Washington: implications for the estimation of habitat bias in trawl surveys. Fish Bull. 101:545–565.

Jagielo, T.H. and F. R. Wallace. 2005. Assessment of Lingcod (*Ophiodon elongatus*) for the *Pacific Fishery Management Council* in 2005. *In* Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council 2130 SW Fifth Ave. Suite 224, Portland, Ore. 97210.

Wallace, F., Tsou, T., **Jagielo, T**., and Cheng, Y.W. 2006. Status of Yelloweye Rockfish off the U.S. West Coast in 2006. *In* Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council 2130 SW Fifth Ave. Suite 224, Portland, Ore. 97210.

Doyle A. Hanan

Post Office Box 8914
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858-832-1159

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

Ryanhowe9@yahoo.com · (989) 941-2241 · 7215 NE Siskiyou St. Portland, OR 97232

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).

James H. Churnside
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web: http://www.esrl.noaa.gov/csd/fishlidar/

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).

J. H. Churnside, L. Ostrovsky, and T. Veenstra, “Thermal footprints of whales,” Oceanography 22, 206-209 (2009).

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).

J. H. Churnside and J. J. Wilson, “Ocean color inferred from radiometers on low-flying aircraft,” Sensors **8**, 860-876 (2008).

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]

	Budget 2010 Revised
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.	**$182,153.43**
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.	
	$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:								
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	Weather 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 Library, Function "MSBVAR":

Package: 'MSBVAR'

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

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 Hart, NMFS-NEFSC, with covariance on pointset data obtained from R 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 Hart, NMFS-NEFSC, 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 Hart, NMFS-NEFSC, 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)
}
```

Appendix IV
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 Summer and Fall Surveys if feasible (see Research Item 4, below). Timeline: April-September 2010.

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. Timeline: April-September 2010.

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. Timeline: Fall 2010.

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 Summer Survey and 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. Timeline: Fall 2010.

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. Timeline: Summer-Fall 2010.

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. Timeline: Summer-Fall 2010.

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). Timeline: Fall 2010.

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 Summer survey and 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. Timeline: Fall 2010.

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. This procedure will be followed again after the 2010 Survey.

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. Timeline: Summer-Fall 2010.