West Coast Aerial Sardine Survey

2011

Application for Exempted Fishing Permit

Applicant:

Northwest Sardine Survey, LLC
(Jerry Thon, Principal)

Science Advisor:

Tom Jagielo
Tom Jagielo, Consulting

Scientific Field Leader:

Ryan Howe

May 9, 2011

Table of Contents

Introduction ……..…….. 3
Survey Design …….....…….. 4
Survey Logistics …… …….. 8
Conclusion ……..…. 11
Literature Cited …….……..…. 11
Appendix I - Field Operational Plan ……..…….. 13
Appendix II – NMFS CPS EFP Requirements ……. 51

I. 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 (Jagielo et al. 2009). The results from that 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 survey was expanded again in 2010 with transect coverage extending further southward, into the southern California Bight. The 2010 results were reviewed by a STAR panel in September 2010 and were approved for use in the 2010 Pacific sardine stock assessment (Jagielo et al. 2010).

The present EFP application is for survey work proposed in 2011 by NWSS. It uses the same methodology employed in the 2009 and 2010 aerial sardine surveys. While work is not proposed for California in 2011, survey coverage could potentially be extended northward into Canada -- if Canadian governmental approvals can be obtained.

The purpose of this application is to document how the proposed survey meets the NMFS requirements for the approval of a Coastal Pelagic Species (CPS) 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), and 3) a point by point discussion of how this EFP application follows the NMFS guidelines for preparation of an EFP application (Appendix II).

This EFP application is submitted to NMFS in order to obtain access to 2,700 mt of sardine which is requested to be withheld from the directed fishery management measures for the West Coast sardine OY for the purpose of funding and conducting the survey in 2011. The request of 2,700 mt of sardine in 2011 represents an increase of 600 mt over that requested for the Washington/Oregon area in 2010. The additional amount of EFP sardine will provide 1) increased funding to allow for a third survey airplane to conduct the additional transects planned for 2011 in a timely manner, and 2) an increased

sample size of point sets to help reduce the variance of the survey biomass estimate.

The NWSS-LLC will conduct aerial survey work and point sets from the Canadian border to the Oregon-California border (survey area). 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.

Scientific oversight for the Aerial Sardine Survey will be provided again in 2011 by Mr. Tom Jagielo. Mr. Jagielo will have the primary responsibility to analyze the survey data 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. Mr. Ryan Howe will be responsible again in 2011 for oversight of scientific sampling in the field. Mr. Jerry Thon (NWSS) will oversee the day to day logistic activities of the survey, including deployment of vessels and aircraft as needed to accomplish the projects objectives. Mr. Chris Cearns (NWSS) will serve as the West Coast Aerial Survey project Single Point of Contact (SPC), to comply with NMFS reporting requirements for the survey.

II. Survey Design

The 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 2011. Logistical details of the survey are provided in Appendix I (West Coast Aerial Sardine Survey - 2011 Field Operational Plan).

Stage 1: Aerial Transect Survey

Logistics

The 2011 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 41 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. 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

35 statute mile transect data. Photographs from the shoreward segment will be used primarily to evaluate the potential need for future modification of the survey design.

For 2011, transect spacing will differ in two separate strata. In the northern portion of the survey area (From Cape Flattery, WA southward to approximately Tillamook, OR), transects are spaced 7.5 nautical miles apart. For the southern portion of the survey area (southward to the Oregon-California border) transects are spaced 15 nautical miles apart, as they have been previously. This stratification scheme follows from the observation that, in our previous surveys (2009-2010), this portion of the survey area accounted for 96% of the schools observed, and 99% of the sardine surface area measured.

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 and data acquisition system that was used in the 2009 and 2010 aerial sardine surveys (Aerial Imaging Solutions; Appendix I, Adjunct 1). This integrated system will be used again to acquire digital images and to log transect data. The system records altitude, GPS position, and spotter observations, which are directly linked to the time stamped quantitative digital imagery. At the nominal survey altitude of 4,000 feet, the approximate width-swept by the camera with a 24 mm lens is 1,829 m (1.13 mi). Digital images will be collected with 60% overlap to ensure seamless photogrammetric coverage along transects.

A Transect Flight Log Form will be kept during the sampling of each transect for the purpose of documenting the observations of the pilot (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.

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 1,000 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 3.0* 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 CS5-Extended*. Transect width will be determined from the digital images using the basic photogrammetric relationship:

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

and solving for *GCS*:

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

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

Data Analysis

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

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

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

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

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

As in 2010, three replicate sets of transects (SET A, SET B, and SET C) will be completed and thus three estimates of $\hat{B}$ will be calculated: $\hat{B}_A$, $\hat{B}_B$, and $\hat{B}_C$, respectively. The point estimate of total biomass for the study area ($\hat{B}_T$) will be obtained by averaging these three estimates of biomass.

Individual School Biomass

The biomass of individual schools observed on the transects (b_i) will be calculated using 1) measurements of school surface area, and 2) the relationship between school surface area and biomass, obtained from point sets (see Stage 2, below). The three parameter

Michaelis-Menten (MM) model assuming log-normal error will again be used to describe the sardine surface area– density relationship

d_i = (yint * cc + asymp * a_i) / (cc + a_i)

where

d_i = school density (mt/m^2)
a_i = school area (m^2)
yint = y intercept
asymp = asymptote as x -> infinity
asymp/cc = slope at the origin .

As noted above, individual school biomass (b_i) will then estimated as the product of school density and surface area ($b_i = d_i a_i$).

Total Biomass Coefficient of Variation (CV)
The CV of the total biomass estimate will again be obtained by employing a bootstrapping procedure implemented with the R statistical programming language (Jagielo et al 2010). The intent of the procedure is to propagate error from the point of school density estimation forward -- to the ultimate goal of total biomass estimation from the three replicate sets of transect data.

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 (Figure 1). Up to four purse seine vessels will participate in the survey under the direction of Mr. Thon. 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). It is anticipated that 2,700 mt of sardine will be available for point sets in 2011; a total of 76 point sets are planned for the Washington/Oregon survey area in 2011 (Appendix I, Table 2).

Biological Sampling of Point Sets

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

III. Survey Logistics

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.

Key Project Personnel: Roles and Responsibilities

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 Coordinator; EFP Applicant: NWSS-LLC

Responsibilities: Oversee day to day logistic activities of the survey, including deployment of vessels and aircraft as needed to accomplish the projects objectives. Coordinatate sale of EFP sardine with participating processors. Administrate EFP funds; direct funds as required to accomplish the projects scientific objectives. Contract with scientists, vessels, pilots, and others as needed to execute the project with scientific oversight from Mr. Jagielo (Science Advisor).

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

Role: Science Advisor

Responsibilities: Develop survey design. Provide scientific guidance and oversight for project execution. Analyze survey data. Provide survey results in a form suitable for use by NMFS/SWFSC in the Pacific sardine stock assessment. Prepare final report. Represent the project in public fora (e.g., PFMC, STAR panels, and SSC) to present and interpret scientific results from the survey.

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

Role: Scientific Field Leader

Responsibilities: Under direction of Mr. Jagielo, coordinate field data collection and ensure scientific validity of field data from the survey. Compile data for analysis. Provide leadership of photogrammetric analysis staff. Assist with survey data analysis, preparation of final report, and presentation of project results as appropriate and/or required.

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, in order 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 up to four vessels per 24 hour period (See Appendix I, Adjunct 3). Participating vessels may make EFP landings in either one or both states (Washington or Oregon).

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

The financial structure of the project is as follows:

1. Funds derived from the capture and sale of the sardine research set-aside will be used to pay for the research to be conducted under this proposed EFP. The costs of the project will be the responsibility of the NWSS-LLC and will be paid for by the sale of the fish captured during the point sets.

2. Fishing vessels will be chartered by NWSS-LLC 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 processor(s) for this project will be chosen after submitting bids. The lowest bid(s) will be accepted.

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

5. Equipment needs and operational costs, including scientific support, will be paid for by the NWSS-LLC from the sale of the 2,700 mt research quota. We anticipate the revenue from the fish sales will be sufficient to cover the costs to capture, process, and conduct the survey.

IV. 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 and 2010 stock assessments, the EFP research study in 2011 will enable us to obtain a third biomass estimate. 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, needed to more precisely and accurately estimate sardine biomass.

V. Literature Cited

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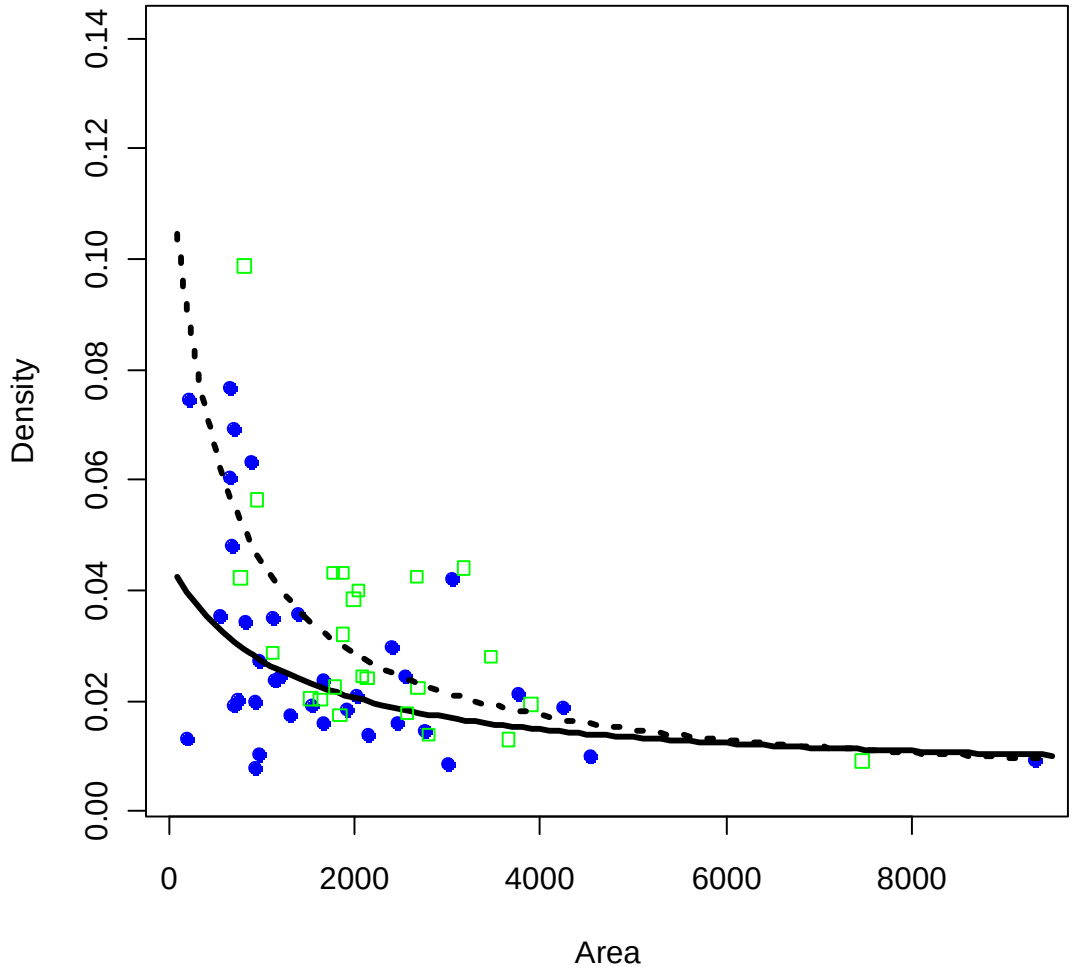
Stehman, S. and D. Salzer. 2000. Estimating Density from Surveys Employing Unequal-Area Belt Transects. Wetlands. Vol. 20, No. 3, pp. 512-519. The Society of Wetland Scientists, McLean, VA.

Wespestad, V., Jagielo, T. and R. Howe. 2008. The Feasibility Of Using An Aerial Survey To Determine Sardine Abundance Off The Washington-Oregon Coast In Conjunction With Fishing Vessel Observation Of Surveyed Schools And Shoals. Report Prepared For: Northwest Sardine Survey, LLC. 12 Bellwether Way, Suite 209, Bellingham, WA 98225.

Figure 1. Relationship of surface area (m^2) (x axis) vs. density (mt/m^2) (y axis) determined from point sets. Legend: solid line: relationship used in the 2009 analysis; dashed line: relationship used in the 2010 analysis; solid circles: 2009 analysis data; open squares: 2010 analysis data.



Appendix I

West Coast Aerial Sardine Survey

2011

Field Operational Plan

Industry Coordinator:

Northwest Sardine Survey, LLC
(Jerry Thon, Principal)

Science Advisor:

Tom Jagielo
Tom Jagielo, Consulting

Scientific Field Project Leader:

Ryan Howe

May 9, 2011

Aerial Transect Survey

Overall Aerial Survey Design

Mr. Jerry Thon will oversee the day to day logistic activities of the survey, including deployment of vessels and aircraft as needed to accomplish the projects objectives. To ensure clear communications among participants and other interested parties, the Single Point of Contact (SPC) person for 2011 survey field work will be Mr. Chris Cearns (NWSS), working under the direction of Mr. Thon.

Scientific field work will be conducted in Washington and Oregon by Mr. Ryan Howe with oversight from Mr. Tom Jagielo. Mr. Howe will lead the digital photograph analysis team and will archive all photographic and biological data.

Mr. Jagielo will be responsible for analyzing the survey data and will report the results to Dr. Kevin Hill, NMFS, SWFSC, in a form suitable for input to the stock assessment model. Mr. Howe will be available to help with data analysis as requested.

The 2011 coastwide aerial survey design consists of 41 transects spanning the area from Cape Flattery in the north to the Oregon-California border in the south (Table 1, Figure 1). Each 41-transect series will be conducted as a SET, and will make up one survey replicate. The 2011 survey will strive to complete three replicate SETS, or 123 transects in total. Survey coverage could potentially be extended northward into Canada -- if Canadian governmental approvals can be obtained.

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. Transect spacing differs in the north (7.5 nautical miles) compared to the south (15 nautical miles) of the survey area. 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 35 statute mile transect data. Photographs from the shoreward segment will be used primarily to evaluate the need for future modification of the survey design.

Aerial Resources
Two Piper Super Cubs and one Cessna 337 will be used to conduct survey transects and point sets. Survey airplanes will be equipped with a Canon EOS 1Ds in an Aerial Imaging Solutions FMC mount system (Adjunct 1), installed inside the fuselage of the plane.

Use of Aerial Resources
Aerial resources will be coordinated by Mr. Thon (NWSS). To conduct a SET, survey pilots will begin with transect number 1 at Cape Flattery in the north and will proceed to the southernmost transect off the southern Oregon coast. When operating together as a team, pilots will communicate 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 Mr. Thon 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 Mr. Thon 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 by Mr. Thon with input from Mr. Jagielo and/or others as requested. Transects will be flown at the nominal survey altitude of 4,000 ft whenever possible. 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 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 41-transect SET in as few days as possible.

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 Scientific Field Project Leader (Mr. Howe) will verify that the camera and data collection system operated properly and that images collected are acceptable for analysis. Mr. Howe will collect data from the pilots and will coordinate the transfer and archival of all aerial survey data.

I. 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 the survey area, in order to distribute the sampling effort spatially. We anticipate that point sets will be landed into both Washington and Oregon ports in 2011.

Point sets will be collected over a range of sizes, as set out in Table 2. The goal is to obtain 76 valid point sets.

Aerial Photography of Point Sets
The detailed protocol for point set sampling is given in Adjunct 4. 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 two 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. The total landed weight of point sets sampled will not exceed 2,700 mt.

Spatial Distribution of Point Sets
In order to distribute point sets spatially, sampling will occur both north and south of the Columbia River. This will be facilitated by landing point sets in both Washington and Oregon ports in 2011. Efforts will be made to distribute the point sets offshore vs. nearshore, as well. Quadrants have been identified to facilitate spatial distribution of the point sets (Figure 2).

Landing Reporting Requirements
Cumulative point set landings will be updated by Mr. Chris Cearns (NWSS), who will report the running 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 2011 survey field work will be Mr. Chris Cearns.

Mr. Cearns (under the direction of Mr. Thon) 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.

II. Calibration and Validation

Aerial Measurement Calibration
Each survey year, routine calibration is conducted to verify aerial measurements. 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.

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 Transect SETs A, B, and C.

Table 1a. SET A

	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	20.000	125	28.49	A1w	124	42.91	A1e	124	39.0	A1s
Washington	N	A1a	48	12.500	125	29.37	A1aw	124	43.90	A1ae	124	40.0	A1as
Washington	N	A2	48	5.000	125	29.24	A2w	124	43.89	A2e	124	40.0	A2s
Washington	N	A2a	47	57.500	125	26.13	A2aw	124	40.88	A2ae	124	37.0	A2as
Washington	N	A3	47	50.000	125	17.01	A3w	124	31.87	A3e	124	28.0	A3s
Washington	N	A3a	47	42.500	125	10.90	A3aw	124	25.86	A3ae	124	22.0	A3as
Washington	N	A4	47	35.000	125	8.78	A4w	124	23.85	A4e	124	20.0	A4s
Washington	N	A4a	47	27.500	125	7.67	A4aw	124	22.84	A4ae	124	19.0	A4as
Washington	N	A5	47	20.000	125	4.55	A5w	124	19.83	A5e	124	16.0	A5s
Washington	N	A5a	47	12.500	124	58.93	A5aw	124	14.32	A5ae	124	10.5	A5as
Washington	N	A6	47	5.000	124	57.32	A6w	124	12.81	A6e	124	9.0	A6s
Washington	N	A6a	46	57.500	124	57.20	A6aw	124	12.81	A6ae	124	9.0	A6as
Washington	N	A7	46	50.000	124	53.09	A7w	124	8.80	A7e	124	5.0	A7s
Washington	N	A7a	46	42.500	124	51.98	A7aw	124	7.79	A7ae	124	4.0	A7as
Washington	N	A8	46	35.000	124	50.87	A8w	124	6.78	A8e	124	3.0	A8s
Washington	N	A8a	46	27.500	124	50.26	A8aw	124	6.27	A8ae	124	2.5	A8as
Washington	N	A9	46	20.000	124	49.66	A9w	124	5.76	A9e	124	2.0	A9s
Washington	N	A9a	46	12.500	124	46.05	A9aw	124	2.25	A9ae	123	58.5	A9as
Oregon	N	A10	46	5.000	124	42.44	A10w	123	58.75	A10e	123	55.0	A10s
Oregon	N	A10a	45	57.500	124	44.33	A10aw	124	0.74	A10ae	123	57.0	A10as
Oregon	N	A11	45	50.000	124	43.22	A11w	123	59.73	A11e	123	56.0	A11s
Oregon	N	A11a	45	42.500	124	42.62	A11aw	123	59.22	A11ae	123	55.5	A11as
Oregon	N	A12	45	35.000	124	42.02	A12w	123	58.71	A12e	123	55.0	A12s
Oregon	N	A12a	45	27.500	124	42.91	A12aw	123	59.70	A12ae	123	56.0	A12as
Oregon	N	A13	45	20.000	124	43.81	A13w	124	0.70	A13e	123	57.0	A13s
Oregon	N	A13a	45	12.500	124	43.71	A13aw	124	0.69	A13ae	123	57.0	A13as
Oregon	N	A14	45	5.000	124	45.61	A14w	124	2.68	A14e	123	59.0	A14s
Oregon	N	A14a	44	57.500	124	46.51	A14aw	124	3.67	A14ae	124	0.0	A14as
Oregon	N	A15	44	50.000	124	49.41	A15w	124	6.66	A15e	124	3.0	A15s
Oregon	N	A15a	44	42.500	124	49.30	A15aw	124	6.66	A15ae	124	3.0	A15as
Oregon	N	A16	44	35.000	124	53.23	A16w	124	6.97	A16e	124	3.0	A16s
Oregon	N	A17	44	20.000	124	56.48	A17w	124	9.99	A17e	124	6.0	A17s
Oregon	N	A18	44	5.000	124	57.74	A18w	124	11.01	A18e	124	7.0	A18s
Oregon	N	A19	43	50.000	125	0.00	A19w	124	13.03	A19e	124	9.0	A19s
Oregon	N	A20	43	35.000	125	3.27	A20w	124	16.05	A20e	124	12.0	A20s
Oregon	N	A21	43	20.000	125	13.54	A21w	124	26.07	A21e	124	22.0	A21s
Oregon	N	A22	43	5.000	125	16.81	A22w	124	29.09	A22e	124	25.0	A22s
Oregon	N	A23	42	50.000	125	24.08	A23w	124	36.11	A23e	124	32.0	A23s
Oregon	N	A24	42	35.000	125	15.37	A24w	124	27.13	A24e	124	23.0	A24s
Oregon	N	A25	42	20.000	125	17.65	A25w	124	29.16	A25e	124	25.0	A25s
Oregon	N	A26	42	5.000	125	9.94	A26w	124	21.18	A26e	124	17.0	A26s

Table 1b. SET B

	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	15.000	125	30.40	B1w	124	44.90	B1e	124	41.0	B1s
Washington	N	B1a	48	7.500	125	30.29	B1aw	124	44.89	B1ae	124	41.0	B1as
Washington	N	B2	48	0.000	125	28.17	B2w	124	42.88	B2e	124	39.0	B2s
Washington	N	B2a	47	52.500	125	21.05	B2aw	124	35.87	B2ae	124	32.0	B2as
Washington	N	B3	47	45.000	125	12.94	B3w	124	27.86	B3e	124	24.0	B3s
Washington	N	B3a	47	37.500	125	8.82	B3aw	124	23.85	B3ae	124	20.0	B3as
Washington	N	B4	47	30.000	125	7.70	B4w	124	22.84	B4e	124	19.0	B4s
Washington	N	B4a	47	22.500	125	6.58	B4aw	124	21.84	B4ae	124	18.0	B4as
Washington	N	B5	47	15.000	125	0.47	B5w	124	15.83	B5e	124	12.0	B5s
Washington	N	B5a	47	7.500	124	57.36	B5aw	124	12.82	B5ae	124	9.0	B5as
Washington	N	B6	47	0.000	124	57.24	B6w	124	12.81	B6e	124	9.0	B6s
Washington	N	B6a	46	52.500	124	54.63	B6aw	124	10.30	B6ae	124	6.5	B6as
Washington	N	B7	46	45.000	124	52.02	B7w	124	7.79	B7e	124	4.0	B7s
Washington	N	B7a	46	37.500	124	50.91	B7aw	124	6.78	B7ae	124	3.0	B7as
Washington	N	B8	46	30.000	124	49.80	B8w	124	5.77	B8e	124	2.0	B8s
Washington	N	B8a	46	22.500	124	49.19	B8aw	124	5.26	B8ae	124	1.5	B8as
Washington	N	B9	46	15.000	124	48.58	B9w	124	4.76	B9e	124	1.0	B9s
Washington	N	B9a	46	7.500	124	42.48	B9aw	123	58.75	B9ae	123	55.0	B9as
Oregon	N	B10	46	0.000	124	42.37	B10w	123	58.74	B10e	123	55.0	B10s
Oregon	N	B10a	45	52.500	124	42.76	B10aw	123	59.23	B10ae	123	55.5	B10as
Oregon	N	B11	45	45.000	124	43.16	B11w	123	59.72	B11e	123	56.0	B11s
Oregon	N	B11a	45	37.500	124	43.05	B11aw	123	59.71	B11ae	123	56.0	B11as
Oregon	N	B12	45	30.000	124	42.94	B12w	123	59.71	B12e	123	56.0	B12s
Oregon	N	B12a	45	22.500	124	43.34	B12aw	124	0.20	B12ae	123	56.5	B12as
Oregon	N	B13	45	15.000	124	42.74	B13w	123	59.69	B13e	123	56.0	B13s
Oregon	N	B13a	45	7.500	124	44.64	B13aw	124	1.68	B13ae	123	58.0	B13as
Oregon	N	B14	45	0.000	124	46.54	B14w	124	3.67	B14e	124	0.0	B14s
Oregon	N	B14a	44	52.500	124	48.44	B14aw	124	5.67	B14ae	124	2.0	B14as
Oregon	N	B15	44	45.000	124	48.33	B15w	124	5.66	B15e	124	2.0	B15s
Oregon	N	B15a	44	37.500	124	48.73	B15aw	124	6.15	B15ae	124	2.5	B15as
Oregon	N	B16	44	30.000	124	49.14	B16w	124	6.64	B16e	124	3.0	B16s
Oregon	N	B17	44	15.000	124	50.94	B17w	124	8.63	B17e	124	5.0	B17s
Oregon	N	B18	44	0.000	124	52.75	B18w	124	10.61	B18e	124	7.0	B18s
Oregon	N	B19	43	45.000	124	55.55	B19w	124	13.60	B19e	124	10.0	B19s
Oregon	N	B20	43	30.000	125	0.37	B20w	124	18.58	B20e	124	15.0	B20s
Oregon	N	B21	43	15.000	125	8.24	B21w	124	26.57	B21e	124	23.0	B21s
Oregon	N	B22	43	0.000	125	12.00	B22w	124	30.55	B22e	124	27.0	B22s
Oregon	N	B23	42	45.000	125	14.82	B23w	124	33.54	B23e	124	30.0	B23s
Oregon	N	B24	42	30.000	125	8.64	B24w	124	27.52	B24e	124	24.0	B24s
Oregon	N	B25	42	15.000	125	7.46	B25w	124	26.51	B25e	124	23.0	B25s
Oregon	N	B26	42	0.000	124	55.29	B26w	124	14.50	B26e	124	11.0	B26s

Table 1c. SET C

	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	10.000	125	31.33	C1w	124	45.89	C1e	124	42.0	C1s
Washington	N	C1a	48	2.500	125	28.21	C1aw	124	42.88	C1ae	124	39.0	C1as
Washington	N	C2	47	55.000	125	25.09	C2w	124	39.88	C2e	124	36.0	C2s
Washington	N	C2a	47	47.500	125	14.97	C2aw	124	29.87	C2ae	124	26.0	C2as
Washington	N	C3	47	40.000	125	9.85	C3w	124	24.86	C3e	124	21.0	C3s
Washington	N	C3a	47	32.500	125	8.24	C3aw	124	23.35	C3ae	124	19.5	C3as
Washington	N	C4	47	25.000	125	6.62	C4w	124	21.84	C4e	124	18.0	C4s
Washington	N	C4a	47	17.500	125	2.51	C4aw	124	17.83	C4ae	124	14.0	C4as
Washington	N	C5	47	10.000	124	58.40	C5w	124	13.82	C5e	124	10.0	C5s
Washington	N	C5a	47	2.500	124	56.78	C5aw	124	12.31	C5ae	124	8.5	C5as
Washington	N	C6	46	55.000	124	55.17	C6w	124	10.80	C6e	124	7.0	C6s
Washington	N	C6a	46	47.500	124	53.06	C6aw	124	8.79	C6ae	124	5.0	C6as
Washington	N	C7	46	40.000	124	50.95	C7w	124	6.79	C7e	124	3.0	C7s
Washington	N	C7a	46	32.500	124	50.34	C7aw	124	6.28	C7ae	124	2.5	C7as
Washington	N	C8	46	25.000	124	49.73	C8w	124	5.77	C8e	124	2.0	C8s
Washington	N	C8a	46	17.500	124	50.62	C8aw	124	6.76	C8ae	124	3.0	C8as
Washington	N	C9	46	10.000	124	44.51	C9w	124	0.75	C9e	123	57.0	C9s
Washington	N	C9a	46	2.500	124	42.40	C9aw	123	58.74	C9ae	123	55.0	C9as
Oregon	N	C10	45	55.000	124	44.29	C10w	124	0.73	C10e	123	57.0	C10s
Oregon	N	C10a	45	47.500	124	44.69	C10aw	124	1.23	C10ae	123	57.5	C10as
Oregon	N	C11	45	40.000	124	41.09	C11w	123	57.72	C11e	123	54.0	C11s
Oregon	N	C11a	45	32.500	124	38.98	C11aw	123	55.71	C11ae	123	52.0	C11as
Oregon	N	C12	45	25.000	124	42.88	C12w	123	59.70	C12e	123	56.0	C12s
Oregon	N	C12a	45	17.500	124	43.27	C12aw	124	0.19	C12ae	123	56.5	C12as
Oregon	N	C13	45	10.000	124	43.67	C13w	124	0.68	C13e	123	57.0	C13s
Oregon	N	C13a	45	2.500	124	46.57	C13aw	124	3.68	C13ae	124	0.0	C13as
Oregon	N	C14	44	55.000	124	46.47	C14w	124	3.67	C14e	124	0.0	C14s
Oregon	N	C14a	44	47.500	124	48.37	C14aw	124	5.66	C14ae	124	2.0	C14as
Oregon	N	C15	44	40.000	124	48.27	C15w	124	5.65	C15e	124	2.0	C15s
Oregon	N	C15a	44	32.500	124	49.17	C15aw	124	6.64	C15ae	124	3.0	C15as
Oregon	N	C16	44	25.000	124	50.07	C16w	124	7.64	C16e	124	4.0	C16s
Oregon	N	C17	44	10.000	124	51.88	C17w	124	9.62	C17e	124	6.0	C17s
Oregon	N	C18	43	55.000	124	53.68	C18w	124	11.61	C18e	124	8.0	C18s
Oregon	N	C19	43	40.000	124	56.49	C19w	124	14.59	C19e	124	11.0	C19s
Oregon	N	C20	43	25.000	125	3.31	C20w	124	21.58	C20e	124	18.0	C20s
Oregon	N	C21	43	10.000	125	9.12	C21w	124	27.56	C21e	124	24.0	C21s
Oregon	N	C22	42	55.000	125	14.93	C22w	124	33.55	C22e	124	30.0	C22s
Oregon	N	C23	42	40.000	125	8.76	C23w	124	27.53	C23e	124	24.0	C23s
Oregon	N	C24	42	25.000	125	8.58	C24w	124	27.52	C24e	124	24.0	C24s
Oregon	N	C25	42	10.000	125	5.40	C25w	124	24.51	C25e	124	21.0	C25s
Oregon	N	C26	41	55.000	124	54.23	C26w	124	13.49	C26e	124	10.0	C26s

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 the 2011 Aerial Sardine Survey. Total Weight is in metric tons.

Size (m^2)	Weight (mt)	Total Weight (mt)	Number of point sets
100	**3.8**	**45.6**	**12**
500	**10.6**	**127.2**	**12**
1000	**17**	**187**	**11**
2000	**26.5**	**291.5**	**11**
4000	**51.9**	**519**	**10**
8000	**70.5**	**705**	**10**
10000	**82.1**	**821**	**10**
		2696.3	**76**

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: Transects 1-8

SET A: Transects 9-16

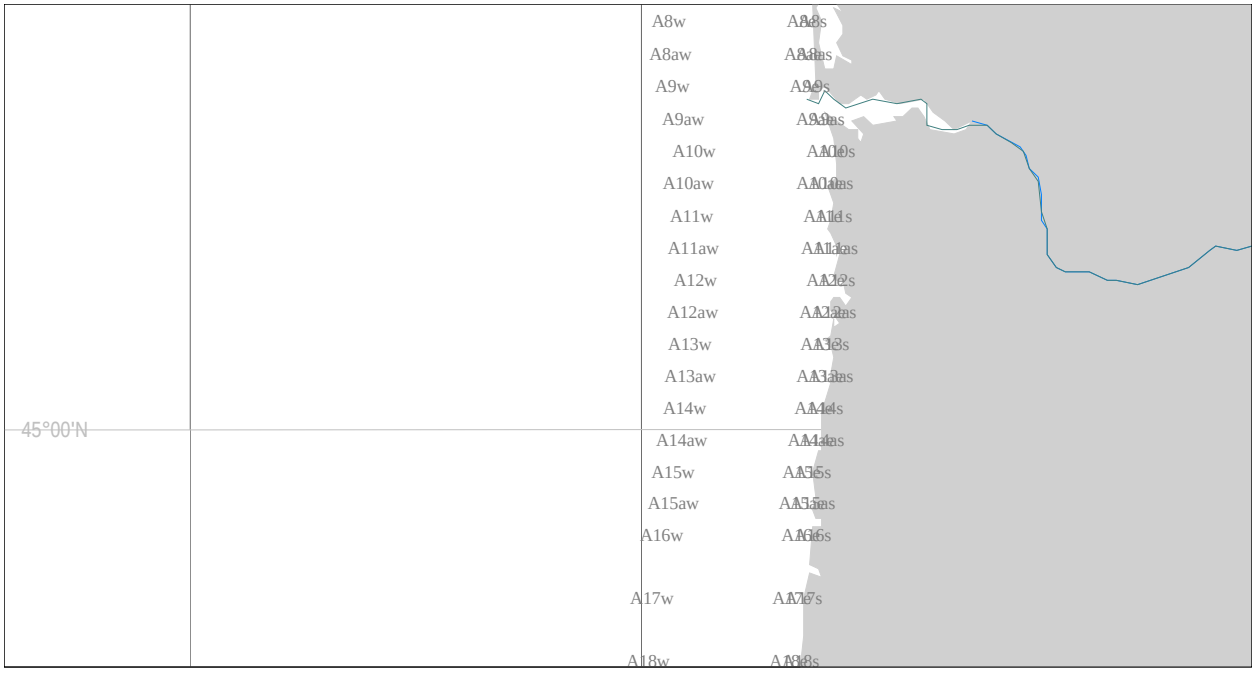


Figure 1a, Continued. Maps showing locations of transects comprising Replicate SET A

SET A: Transects 17-26

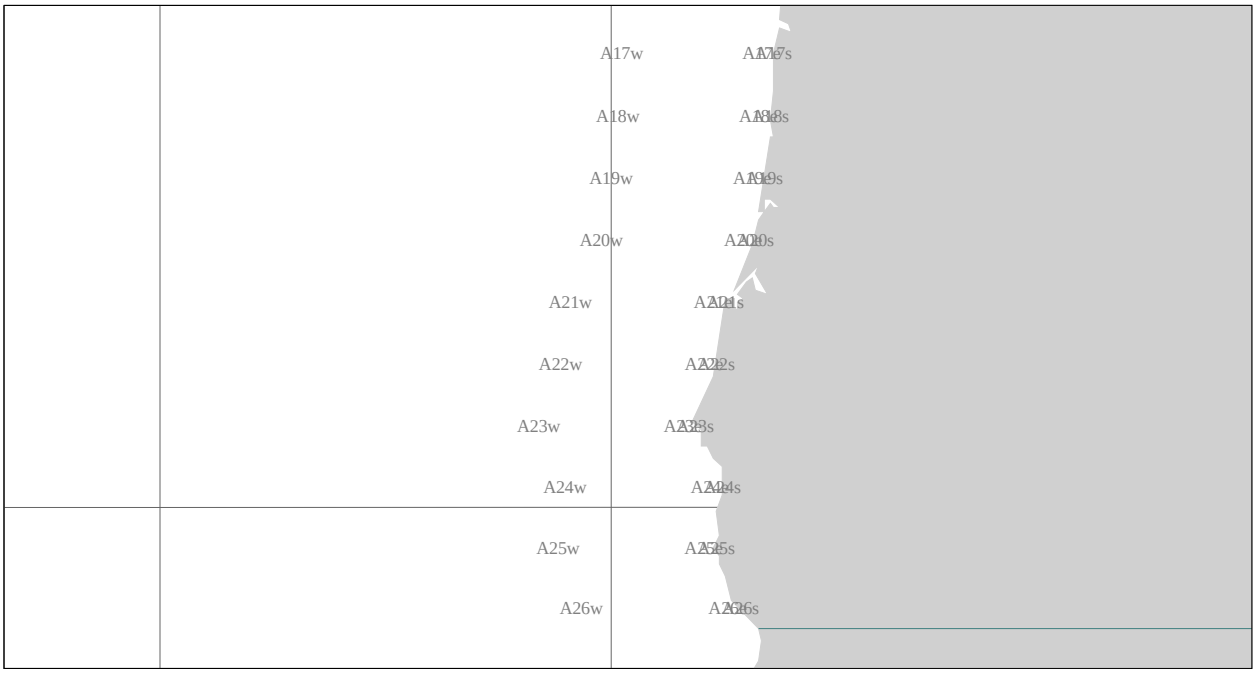


Figure 1b. Maps showing locations of transects comprising Replicate SET B

SET B: Transects 1-8

SET B: Transects 9-16

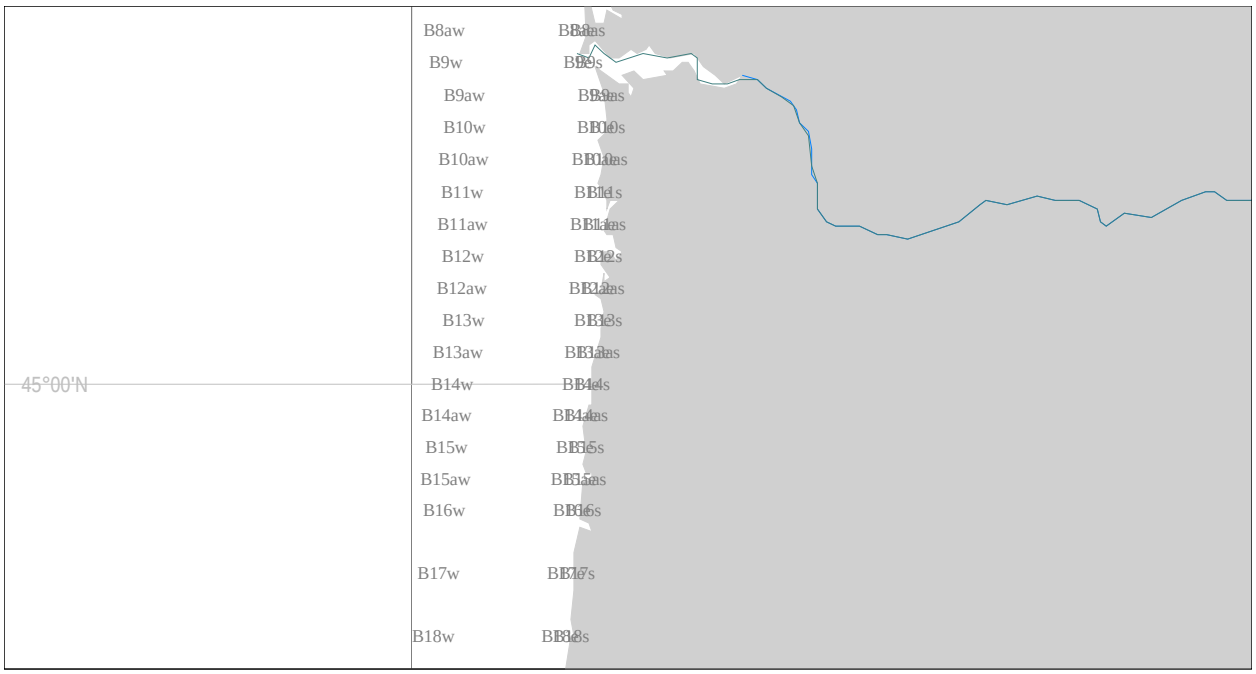


Figure 1b, Continued. Maps showing locations of transects comprising Replicate SET B

SET B: Transects 17-26

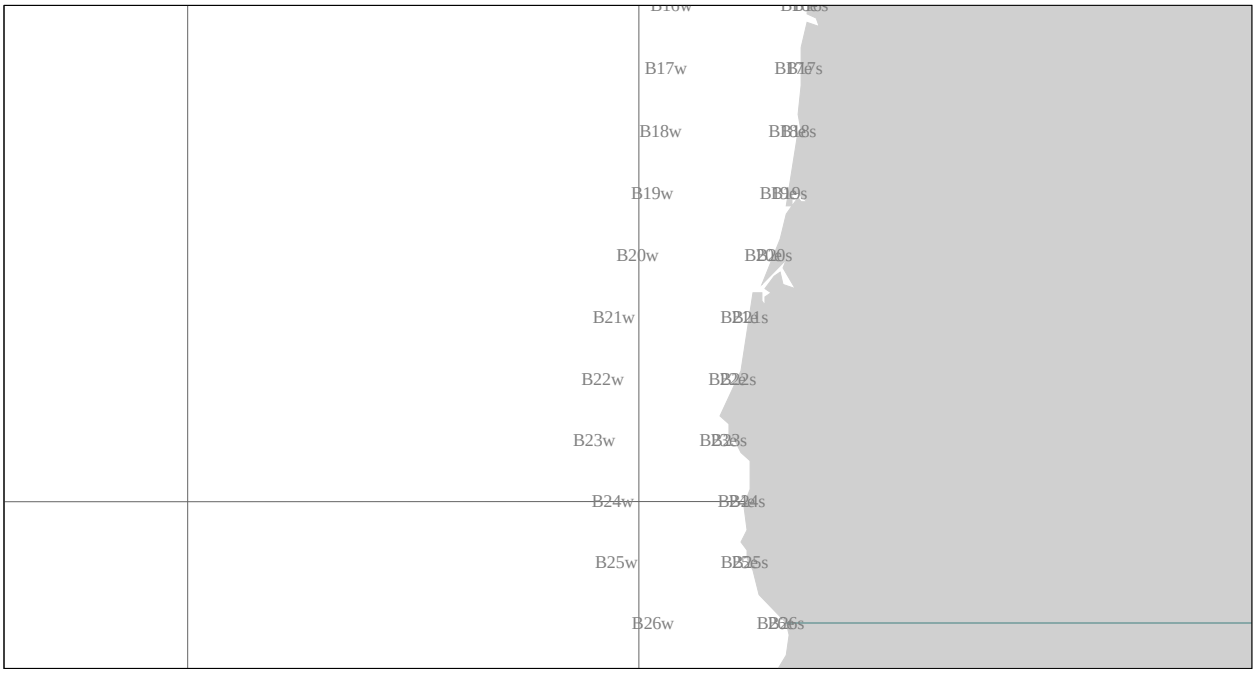
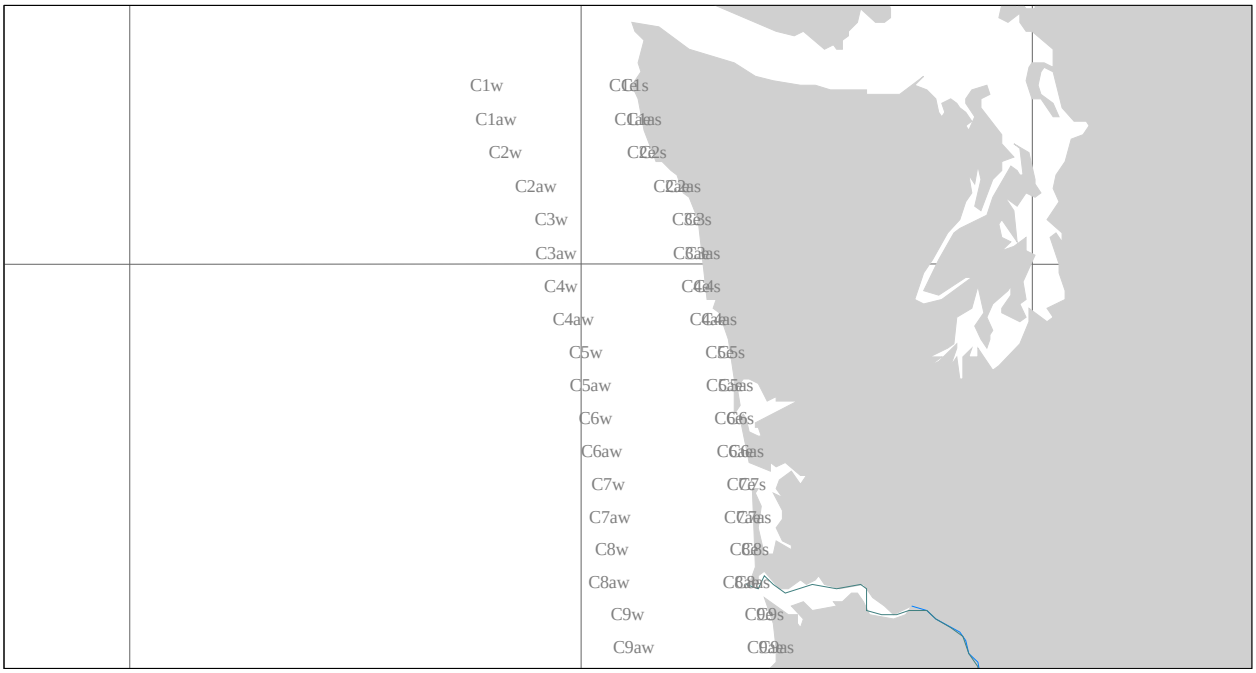


Figure 1c. Maps showing locations of transects comprising Replicate SET C

SET C: Transects 1-8



SET C: Transects 9-16

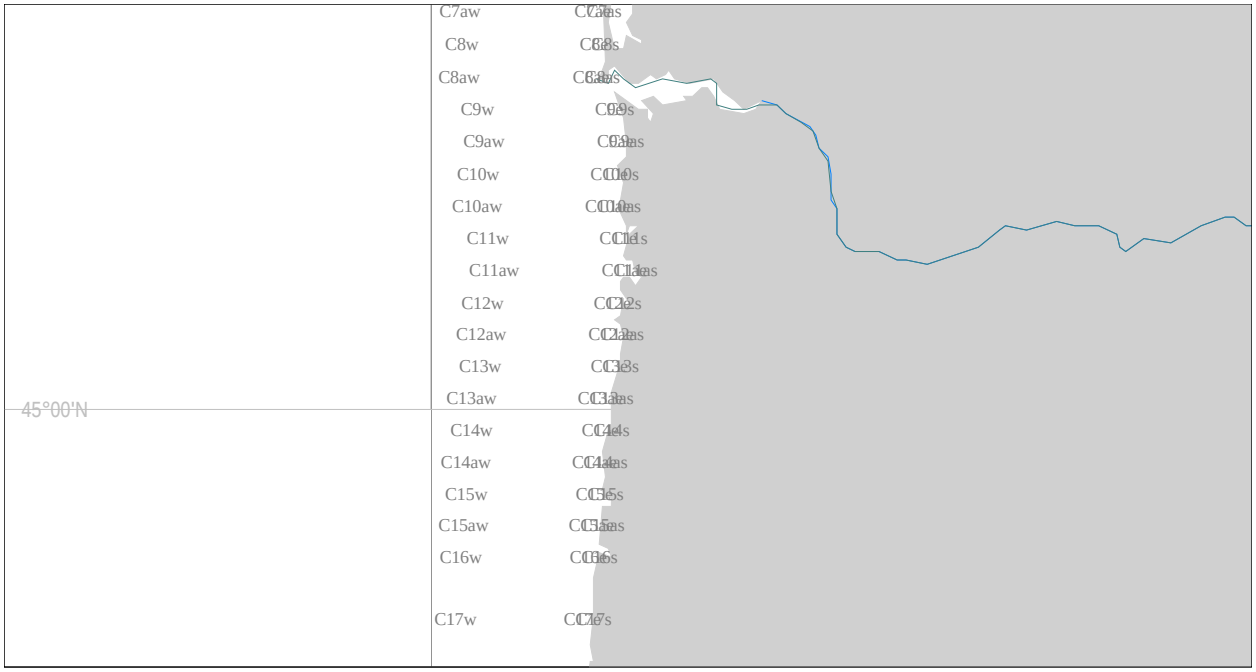


Figure 1c, Continued. Maps showing locations of transects comprising Replicate SET C

SET C: Transects 17-26

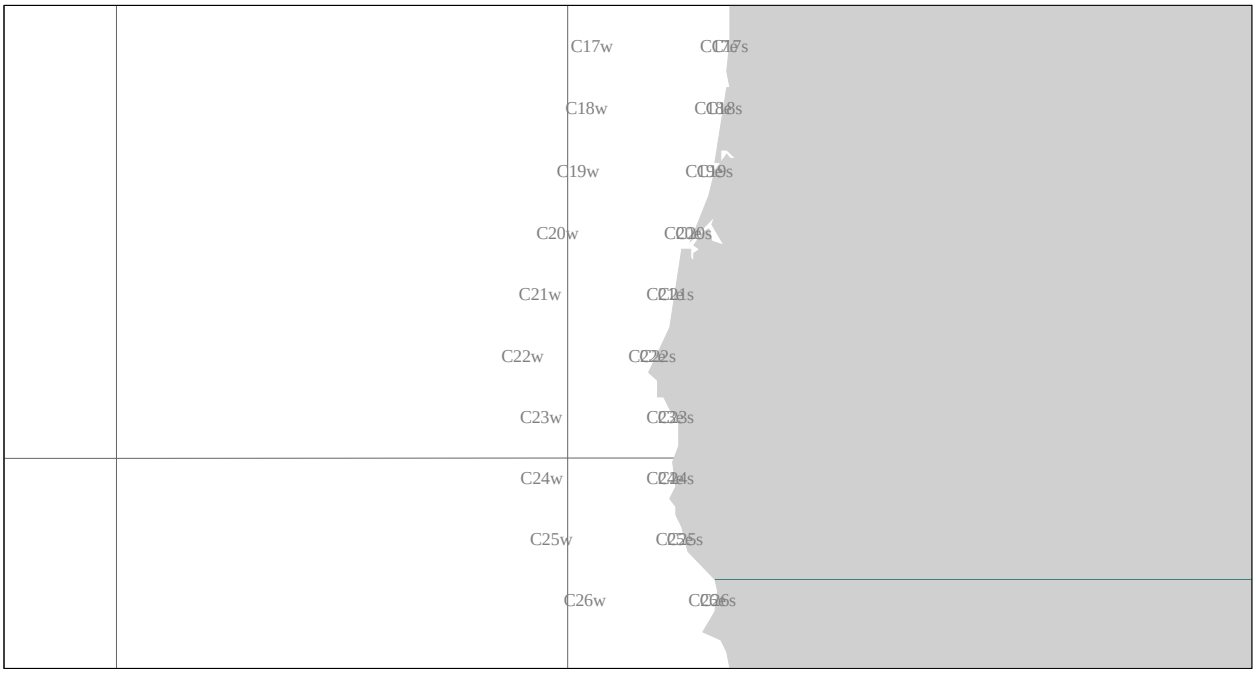
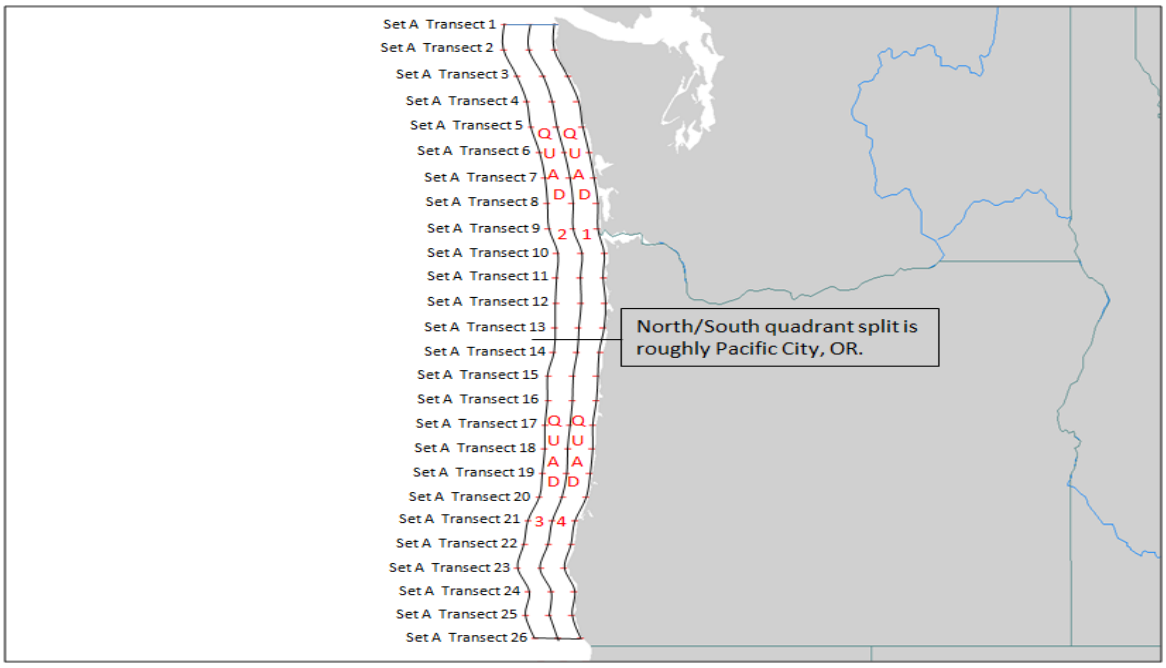
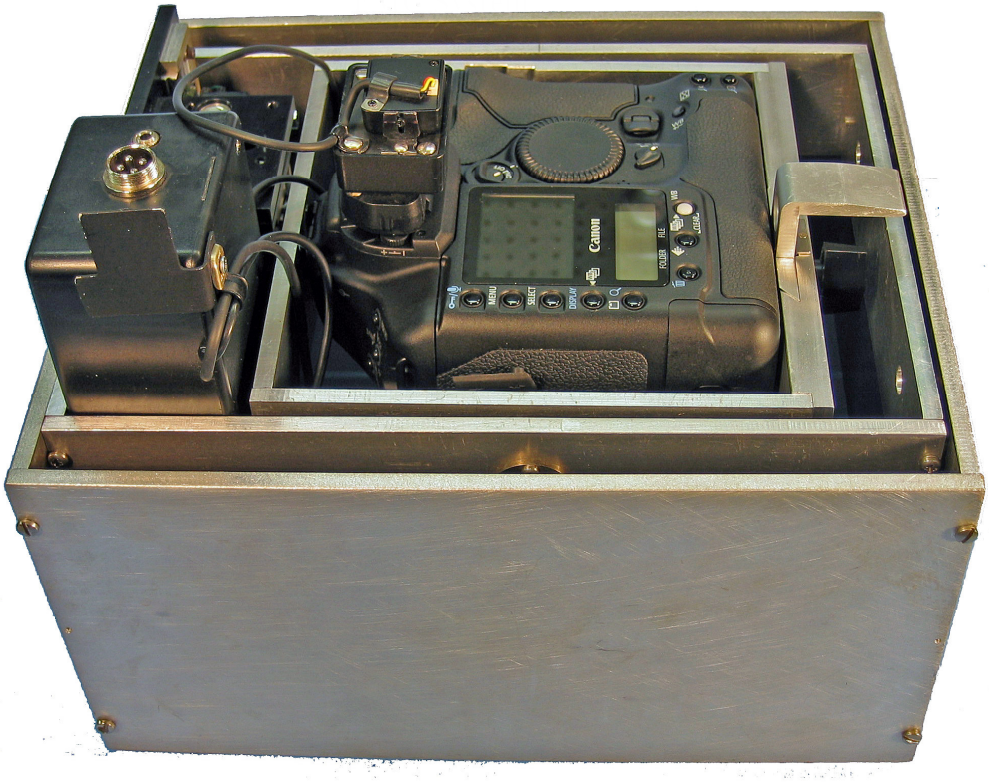


Figure 2. Maps showing quadrants for spatial distribution of point sets.



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.

Appendix I, Adjunct 2. Field Data Forms

West Coast Sardine Survey

Camera Settings for 1Ds Mark III (Bigger Camera)

1. Press the MENU button located in the upper left corner of the camera, just above the LCD monitor.

    a. Turn the dial on the top right of the camera, near the shutter button, to scroll left though the menu tabs at the top of the monitor.

    b. Under the Shooting 1 tab, ensure that the White balance is set to "AWB" and that the Picture style is set to "Standard."

    c. Scroll right and select the Shooting 2 tab. Under the Shooting 2 tab, set the image size to "L."

    d. Scroll right and select the Set-up 1 tab. Set Auto power off to "Off".

    e. Set File numbering to "Auto Reset".

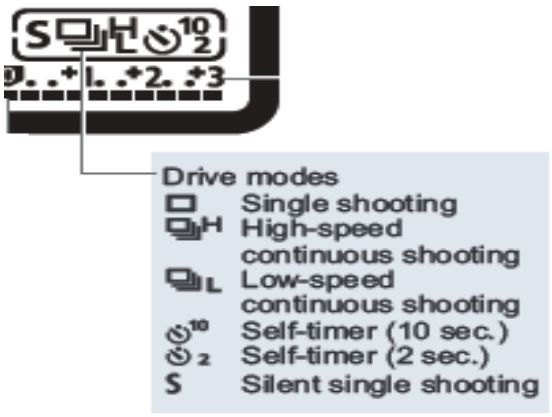
    f. Select Record Function+media/folder sel. and set the camera to "Auto switch media." Set the camera to record first to the CF memory card (card number 1).

    g. Select Live View function settings. Select Live View shoot. Select "Disable".

    h. Finally, select File name setting and change the User 1 setting to read "SP3_" for survey pilot 3, "SP4_ " for survey pilot 4, and so forth. Photos will now be numbered SPx_001, SPx_002, and so on.

2. Set the lens focus mode switch located on the side of the lens to "M" and move the focusing ring toward the camera to engage it.

3. Press the AF DRIVE button located on the top left corner of the camera. Turn the scroll wheel to set the camera to "Single Shot". The icon is a single rectangle, not "S". "S" is silent mode, which will ruin your day! See below:



4. Press the MODE button located above the AF DRIVE button and rotate the scroll wheel to set the camera to "M." Wait for the AF drive display to time out, then turn the scroll wheel to set the Aperture to "4.0." Turn the dial to set the Shutter speed to "2000."

5. Press the ISO button located adjacent to the dial and turn the scroll wheel to set the ISO Speed to "400."

6. Ensure that the 3 cables plugged into the side of the camera are securely connected. The 3 connectors are: flash sync, remote, and mini USB.

   - The flash sync connector screws in. Make sure that it is screwed in all the way. It is ok to use long nosed pliers to tighten it if your fingers are too stubby. Just be gentle.

   - The remote connector is a push-pull locking connector. Press on the top rubber part to engage it. Pull on the silver outer ring to disengage it.

   - The mini USB simply plugs in.

West Coast Sardine Survey

Camera Settings for 5D Mark II (Smaller Camera)

1. Press the MENU button located in the upper left corner of the camera, just above the LCD monitor.

    a. Turn the dial on the top right of the camera, near the shutter button, to scroll left though the menu tabs at the top of the monitor.

    b. Ensure that the White balance is set to “AWB” and that the Picture style is set to “Standard.”

    c. Set the image size to “L.”

    d. Set Auto power off to “Off”.

    e. Set File numbering to “Auto Reset”.

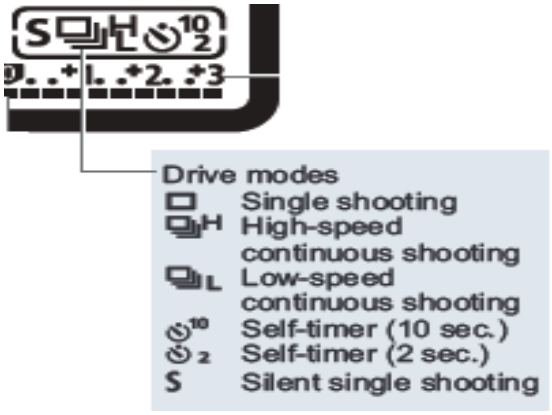
    f. Select Record Function+media/folder sel. and set the camera to “Auto switch media.” Set the camera to record first to the CF memory card (card number 1).

    g. Select Live View function settings. Select Live View shoot. Select “Disable”.

    h. Disable “Silent Mode” shooting.

2. Set the lens focus mode switch located on the side of the lens to “M” and move the focusing ring toward the camera to engage it.

3. Press the AF DRIVE button located on the top left corner of the camera. Turn the scroll wheel to set the camera to “Single Shot”. The icon is a single rectangle, not “S”. “S” is silent mode, which will ruin your day! See below:



4. Press the MODE button located above the AF DRIVE button and rotate the scroll wheel to set the camera to "M." Wait for the AF drive display to time out, then turn the scroll wheel to set the Aperture to "4.0." Turn the dial to set the Shutter speed to "2000."
5. Press the ISO button located adjacent to the dial and turn the scroll wheel to set the ISO Speed to "400."

6. Ensure that the 3 cables plugged into the side of the camera are securely connected. The 3 connectors are: flash sync, remote, and mini USB.

    - The flash sync connector screws in. Make sure that it is screwed in all the way. It is ok to use long nosed pliers to tighten it if your fingers are too stubby. Just be gentle.

    - The remote connector is a push-pull locking connector. Press on the top rubber part to engage it. Pull on the silver outer ring to disengage it.

    - The mini USB simply plugs in.

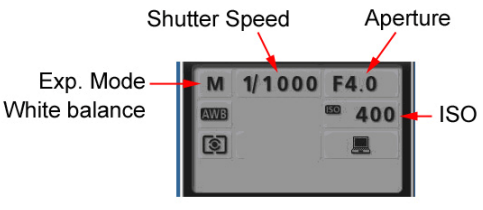
Pilot Checklist

Pre-Flight

1. Check/clean the camera window
2. Check that batteries are fully charged.
3. Ensure that memory cards are installed and have sufficient space.
4. Ensure that a copy of the transect waypoint document is aboard aircraft.
5. Check GPS reading and enter waypoints if necessary.
6. Ensure that all mount system cables are properly connected.
7. Turn on camera, notebook computer, power inverter, and control unit.
8. Ensure the laptop sleep setting is set to "never."
9. Start FMC Mount, Remote Viewfinder, and EOS Utility programs on notebook computer.

   Note: make sure only one window is open for each of the previous programs, having more than one of any program open will cause problems with the camera system.
10. Adjust FMC Mount program settings, as necessary:
    - Altitude: TBD
    - Speed: TBD
    - Overlap: 60%
    - FMC: On
    - Frame count: 0 (Admin->Frame Count->ENTER "0")
11. Ensure that GPS/IMU is functioning.

    Note: the first time the GPS is used in a new location, it may take up to 25 minutes for the GPS to initialize.
12. Ensure that the camera viewfinder is displayed in the Remote Viewfinder window.
13. Check the camera settings using the EOS Utility. See below:



- Look for the rectangle for Drive mode and "MANUAL" for the Focus mode, to verify that the camera is in "Single Shot" mode and is set to manual focus.

- Verify that the Exp. Mode is "M" for manual exposure control and that the Shutter Speed, Aperture and ISO are set for proper exposure - normally, 1/2000, F4.0, and 400, respectively.

- Press "F9" in the FMC Mount program and verify that the camera fires. The frame counter in the FMC program should advance and that the Shots left indicator in the EOS Utility should subtract.

  WARNING: If the Shots left indicator in EOS Utility doesn't change when the camera fires, it indicates that the images are not being saved to the memory card in the camera. Go to "Preferences -> Remote Shooting", in EOS Utility and check the box "Save also on camera's memory card".

14. *The following may be unnecessary:*

    i. *Power OFF the mount system so that power does not spike when the airplane is started.*
    ii. *Start the airplane.*
    iii. *Power ON the mount system.*
    iv. *Verify that the on-screen GPS positions approximately match the pilot's GPS.*
    v. *Press "F9" to take a single photo and verify that all systems are working properly.*

Mid-Flight

Upon approaching the beginning of a transect/point set, press "F5" (AUTO) to begin recording. Occasionally compare the Mount System GPS positions with the pilot's GPS. Also, remember to adjust the Mount System altitude and speed settings as necessary.

Post-Flight

After landing, the survey photos and FMC datalog will need to be downloaded. Please contact Mr. Ryan Howe to coordinate the download and archive for each survey day.

West Coast Aerial Sardine Survey 2011

Transect Flight Log Form

Date:___________ **Set:**__________ **Pilot:**___________ **Observer:**______________ **Plane:**_________________

Transect No.	Time	Start Photo No.	Latitude/Longitude	Altitude (ft)	Species Observed	Est. Tonnage (mt)	End Photo No.

Cloud Cover code	Glare code	Beaufort Wind Scale

Comments:____

Transect No.	Time	Start Photo No.	Latitude/Longitude	Altitude (ft)	Species Observed	Est. Tonnage (mt)	End Photo No.

Cloud Cover code	Glare code	Beaufort Wind Scale

Comments:____

Transect No.	Time	Start Photo No.	Latitude/Longitude	Altitude (ft)	Species Observed	Est. Tonnage (mt)	End Photo No.

Cloud Cover code	Glare code	Beaufort Wind Scale

Comments:____

Transect No.	Time	Start Photo No.	Latitude/Longitude	Altitude (ft)	Species Observed	Est. Tonnage (mt)	End Photo No.

Cloud Cover code	Glare code	Beaufort Wind Scale

Comments:____

Cloud Cover code: **1**- Clear, **2**- Cloud Coverage <50%, **3**- Cloud Coverage >50%, **4**- No Visibility

Glare code: **1**- No glare, **2**- glare <50%, **3**- glare >50%, **4**- Cloud shadows <50%, **5**- Cloud shadows >50%, **6**- No visibility

Beaufort Wind Scale: Refer to attached Beaufort Wind Scale (0-12) to quantify sea state

West Coast Aerial Sardine Survey 2011

Biological Sampling Form

Date Landed:_____ Vessel:_____ Sample No._____ Point Set No._____

Date Sampled:_____ Sampler:_____ Processor:_____ Sample Wt (kg):_____

Fish No.	Weight (g)	Std. Length (mm)	Sex (M/F)	Maturity Code	Otolith Vial No.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Fish No.	Weight (g)	Std. Length (mm)	Sex (M/F)	Maturity Code	Otolith Vial No.
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					

Comments:

West Coast Aerial Sardine Survey 2011

Point Set Flight Log Form

Date:________________ Pilot:________________________ Plane:_______________________

Processor:________________________ Observer:_____________________

Point Set No.	Time	Photo No.	Latitude/Longitude	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments:

Point Set No.	Time	Photo No.	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments:

Point Set No.	Time	Photo No.	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments

Point Set No.	Time	Photo No.	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments:

Point Set No.	Time	Photo No.	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments:

Point Set No.	Time	Photo No.	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% of School Captured	Est. school Tonnage (mt)

Comments:

West Coast Aerial Sardine Survey 2011

Vessel Point Set Log

Date:_____ **Captain:**_____

Vessel:_____ **Processor:**_____

Hydroacoustic Gear

Type	Manufact.	Model	Frequency
Sounder			
Sonar			

Net Dimensions

Net Length (fath)	Net Depth (fath)	Mesh Size

School and Ocean Data

Point Set No.	Time	Latitude	Longitude	Depth to Top of School (fath)	Depth to Bottom of School (fath)	Ocean Depth (fath)	Temp.	Weather Condition

Captains Estimate and Delivery Information **Office Use Only**

Point Set No.	Species Observed	% of school captured	Est. School Tonnage (mt)	Fish Hold (FP, FS, MP, MS, AP, AS)	Other Vessel utilized: Name, est. weight, fish hold	*Delivered Weight (mt)	*Fish Ticket Number

Comments:

West Coast Aerial Sardine Survey 2011

Survey Data Form Overview

The purpose of this document is to help guide us through each of the 2011 sardine survey data forms. If you are still unclear of what a field within a form is asking, please contact Mr. Ryan Howe for further clarification. Please have all survey forms completed and submitted to Mr. Howe 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 Mr. Howe know as early as possible.

Heading Information

- **Date** – Record the date that the transect is flown
- **Set** – Record which replicate SET is being flown
- **Pilot** – Name of pilot flying the transect
- **Observer** – Name of observer on board if any
- **Plane** – Type of aircraft flying the transect

Transect Data

- **Transect No.** – Record the transect number that is flown
- **Time** – Pilots are asked to log the time a fish school is observed along the survey transect
- **Start Photo No. –** 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 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.
- **End Photo No**. – Pilots are asked to log the photo number that corresponds with the last school observed on that transect.

- **Cloud Cover code –** Pilots are asked to record the current cloud cover conditions while flying transects, using the following cloud cover scale: **1**- Clear, **2**- Cloud Coverage <50%, **3**- Cloud Coverage >50%, **4**- No Visibility
- **Glare code** – Pilots are asked to record the current glare conditions on the surface of the water using the following glare scale: **1**- No glare, **2**- glare <50%, **3**- glare >50%, **4**- Cloud shadows <50%, **5**- Cloud shadows >50%, **6**- No visibility
- **Beaufort Wind Scale**: Pilots are asked to refer to the Beaufort Wind Scale (0-12) to quantify sea state conditions during transect flights.
- **Comments** – Please write any additional information or notes in this section

Biological Sampling Form

During the 2011 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 Mr. Howe with any questions or for further clarification.

Heading Information

- **Date Landed**– Record the date the point set was landed at the processing plant
- **Vessel** – Record the vessel name that delivered the point set catch
- **Sample No.** – Record the sample number consecutively as they occur during the 2011 season
- **Point Set No.** – Record the point set number that the biological sample corresponds to
- **Date Sampled** – Record the date the biological sample was worked up
- **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 No.** - 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 **PS23F37-11** which again refers to **P**oint **S**et **23** and **F**ish number **37** of 50 collected in 20**11**.

- **Comments –** Please write any additional information or notes in this section.

Point Set Flight Log Form

During the 2011 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 setting the vessel for point sets
- **Plane** – Type of aircraft flying for point sets
- **Processor** – Name of the fish processing plant that the catch will be delivered to
- **Observer** – Name of observer onboard airplane if any

Point Set Flight Log Data

- **Point Set No.** – Number the point sets consecutively as they occur during the 2011 season
- **Time** – Record the time when the point set is attempted
- **Photo No.** - Pilots are asked to log the photo number that corresponds with the point set school that is identified and being targeted
- **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.

Vessel Point Set Log Form

During the 2011 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 Mr. Howe.

*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

Vessel 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 No. –** Number the point sets consecutively as they occur during the 2011 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 Vessel Point Set Log form for 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.

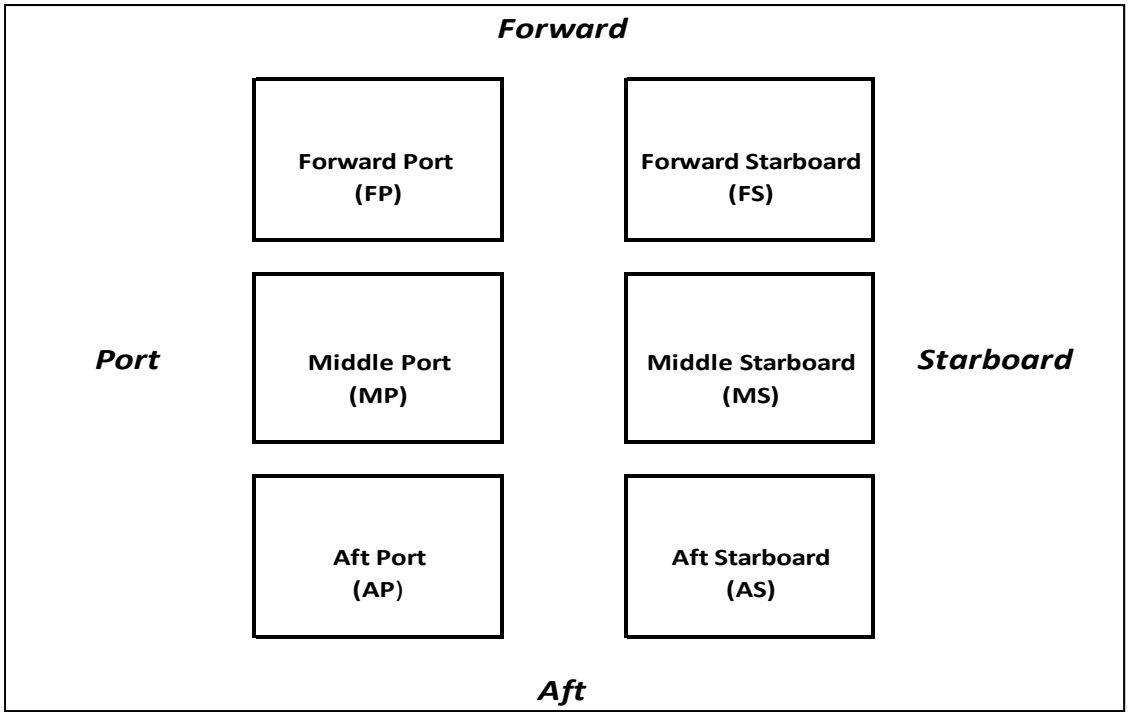


Diagram of fish hold abbreviations to be used on Fisherman's Log Form

- **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.

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)
Pacific Pursuit	Keith Omey	Pacific Pursuit, LLC	OR873ABY	30920	73'	86	4	80
Lauren L. Kapp	Ryan Kapp	Mt. Hood Holdings LLC	OR072ACX	57008	72'	74	4	70
Evermore	Arnold Burke	Gulf Vessel Management	248555	57009	82'	120	4	50
Pacific Journey	Leaf Nelson	Stan Nelson	OR661ZK	36106	71'	98	4	78

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

In Washington and Oregon, participating fish processors were established by a bid process using the same procedure as in 2010. Processors for 2011 will be Ocean Gold (Westport, WA), and Astoria Holdings (Astoria, OR).

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 two 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 Scientific Field Project Leader 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 to Mr. Howe daily.
15) The total landed weight of point sets taken will not exceed the EFP allotment.
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), 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 II

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

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 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 continue the time series of data collection started in 2009 that provided information 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 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 2011 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;

[TBD]

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 9 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 2011 survey field work will be Mr. Chris Cearns (NWSS).

<See also: 1) Survey Logistics; Project Personnel: Roles and Responsibilities (Page 7 and 8 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. This approach worked well in 2009 and 2010.

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 continue the time series 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.

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 period between the second and third allocation periods in the 2011 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. NWSS is proposing to the PFMC that 2,700 mt of Pacific sardine be deducted from the 2011 Harvest Guideline prior to allocation and set aside for the dedicated sardine research to be conducted under this EFP. If approved, the harvested quantity under this EFP will be limited to this Council recommended 2,700 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 in 2010 to justify the amount of sardine needed to accomplish the survey objectives (See: Sardine EFP Application for 2010 (WCSS 2010): Pages 11, and Appendix III.

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 Scientific Field Project 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 Project 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 2,700 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 Project 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 8 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;

Participating vessels will have the option to operate throughout the entire range of the survey region (from Cape Flattery, WA to the Oregon/California border).

<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]. Fishing was further limited in 2010. 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 the aerial sardine survey is supported enthusiastically by the west coast sardine industry. 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>

Thomas H. Jagielo

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Employment

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

Fisheries Science Consultant *Recent 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.

Jagielo, T.H. 1991. Synthesis of mark-recapture and fishery data to estimate open population parameters. *In* Creel and Angler Surveys in Fisheries Management, American Fisheries Society Symposium 12:492-506.

Jagielo, T.H. 1994. Assessment of lingcod (*Ophiodon elongatus*) in the area north of Cape Falcon (45^0 46' N.) and south of 49^0 N. in 1994. *In* Pacific Fishery Management Council, 1994. Status of the Pacific Coast Groundfish Fishery Through 1994 and Recommended Acceptable Biological Catches for 1995. Appendix I. Pacific Fishery Management Council, Portland, Oregon.

Jagielo, T.H. 1995. Abundance and survival of lingcod (*Ophiodon elongatus*) at Cape Flattery, Washington. Trans. Amer. Fish. Soc. 124(2).

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.

Jagielo, T.H. 1999. Rebuilding analysis for lingcod. Report prepared for the Pacific Fishery Management Council, Portland, OR.

Jagielo, T.H. 1999. Movement, mortality, and size selectivity of sport and trawl caught lingcod (*Ophiodon elongatus*) off Washington. Trans. Amer. Fish. Soc. 128:31-48.

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

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Ryan A. Howe

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

Education:

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

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

Work Experience:

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

- Coordinate 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 (*Sardinops sagax*)
- Enhancement and analysis of digital photos using Adobe Photoshop CS5 and Adobe Lightroom 3
- Oversee the aerial sardine survey photo analyst staff
- Experience with Canon EOS 1Ds camera in an Aerial Imaging Solutions FMC mount system

Fisheries Technician
Pacific Whiting Conservation Cooperative: Seattle, WA *May 2008 – May 2009*

- Collect biological information daily of Pacific Whiting (*Merluccius productus*) 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 Groundfish Observer
TechSea International Inc.: Seattle, WA *September 2006 – March 2008*

- Collect biological samples for species composition, sex, and weight for catch and bycatch for vessels fishing in the Bering Sea and Gulf of Alaska
- Collect and record fishing effort, location, gear type, and incidental take of prohibited species
- Record fishery interactions with marine mammals and seabirds.
- 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 northwest and southwest Ontario, Canada for a Sea Lamprey (*Petromyzon marinus*) recruitment and population 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*

- Gained communication skills through interaction with hatchery biologists of the Michigan Department of Natural Resources.
- Collect biological samples of Chinook salmon (*Oncorhynchus tshawytscha*) for future genetic analysis and to check for the presence of bacterial kidney disease (BKD).

Appendix II, Adjunct 2.

Estimated NWSS EFP Project Budget - 2011 Draft 5-6-2011

REVENUES:									Extension
Estimated Revenue/mt (FOB container yard):	$ 675.00								
Estimated EFP sardine available (mt):	2,700								
Estimated project revenue:									$ 1,822,500
EXPENSES:							Weather		
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	contingency	Total		
Flying the transects	41	3	$500	$61,500	4	1.25	$307,500		
Processing transect images	41	8	$25	$8,200	4		$32,800		
Point Sets	# Point sets	#Sets/day	$/Day	# Days					
Fishing Point sets on schools	76	3	$12,500	25			$316,667		
	Hours		$/Hr						
Flying the point sets	101		$300				$30,400		($687,367)
Scientific support costs:									
Science Oversight and Staff - compensation							$200,000		
Science Oversight and Staff - expenses							$35,000		
									($235,000)
Supplies and Equipment							$7,000		
									($7,000)
Accounting/bookkeeping							$5,000		
									($5,000)
10% contingency on operations							$92,937		
									($92,937)
PROJECT SUBTOTAL									**$795,197**
Estimated Processing Costs									
Estimated processing Cost/mt:	$ 300.00								**($810,000)**
NET Proceeds									**($14,803)**