West Coast Sardine Survey

Application for Exempted Fishing Permit in 2009

submitted

April 27, 2009

by

Resource Analysts International

and

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for

California Wetfish Producers Association

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This Exempted Fishing Permit (EFP) application is submitted to NMFS to obtain access to the 2,400 mt proposed to be withheld from the sardine OY for research surveys in 2009. The application contains a program description and methodology to be applied coastwise between the US-Canada border and Monterey Bay area. The research proposed is an expansion of a pilot project conducted in 2008 and contains refinements learned from that research. This documentation was prepared by the principal investigators of the 2008 pilot study on behalf of both the Northwest Sardine Survey, LLC (NWSS-LLC), which funded last year's pilot project, and the California Wetfish Producers Association (CWPA) who wish to collaborate with NWSS-LLC and expand the project into Northern and Central California in 2009.

The pilot study conducted in 2008 was a "proof of concept" project to determine if high quality, quantitative digital aerial imagery could be collected and processed on a scale large enough and rapidly enough for a practical fisheries stock assessment application – namely the in-season enumeration and measurement of sardine schools (Wespestad et al. 2008). The project was successful in this endeavor. In approximately one month's time (from late August through late September 2008), over 2000 images were processed by one scientific technician, who discerned and individually measured the surface area of over 3000 sardine schools. Furthermore, every school selected and measured on the digital images was documented and archived to allow for subsequent examination and review by other observers.

Aerial counts of school number and measurements of school surface area (SSA) as collected in 2008 are recognized as useful metrics to begin to develop an index of abundance extending over a period of years for the sardine stock. However, a direct point estimate of biomass is also desired to more quickly characterize the stock status. Our initial work has shown that "point sets" (sardine schools fully captured by purse seine vessels), coupled with quantitative digital imagery, are a promising method to establish the relationship between SSA and biomass for this purpose. Sampling limitations in 2008, however, resulted in too few samples to quantify this relationship with good accuracy or precision. A research set-aside of sardine quota was not available in 2008 and it was necessary to conduct research sampling opportunistically during the fishery. As a result, short and intense fishing periods and poor weather conditions limited our ability to fully test the methodology in our pilot project year. Hopefully with the full research set aside available in 2009, we will develop a much larger data set than in 2008.

The objective of this EFP request is to provide an opportunity to expand the spatial scale of the aerial survey, and to collect more data to evaluate our ability to quantify the relationship between SSA and biomass under controlled conditions and in a directed manner -- separate from the open period of the fishery. The survey design to be employed in 2009 largely follows the plan developed and executed successfully in 2008. The primary differences in 2009 will be: 1) to extend the coverage of the aerial survey northward to the Canadian border, and southward to the Monterey Bay area in California, and 2) to make use of the portion of the sardine quota explicitly set-aside for research (2400 mt), to obtain better estimates of the relationship between sardine SSA and biomass than could otherwise be obtained during the directed fishery.

Sardine harvested under this EFP will be used to help fund the survey research. The sardine research set-aside will be apportioned equally to two survey areas of equal size. The CWPA will conduct aerial survey work and purse seine vessel point sets at-sea from the Oregon-California border to the Monterey Bay area (southern area). Likewise, the NWSS-LLC will conduct aerial survey work and point sets from the Canadian border to the Oregon-California border (northern area).

Both industry groups will work under the direction of the Principal Investigators (PIs), Vidar Wespestad and Tom Jagielo, who will be responsible for scientific accountability. Under the direction of the PIs, Doyle Hanan will oversee the southern area research component; Ryan Howe will oversee the northern area research component and will additionally coordinate coastwide consistency in data collection and data reduction.

Materials and Methods

I. Survey Design

Our survey will take a two-stage sampling approach. Stage 1 will be aerial transect sampling to estimate sardine school surface area (SSA) (in units of m^2); Stage 2 will be at-sea point set sampling to estimate biomass per m^2 of SSA (mt/m^2). Sampling will be closely coordinated by the PIs and synchronized on a coastwise basis. Under the direction of the PIs, NWSS-LLC will be responsible for conducting Stage 1 and Stage 2 sampling in the northern area; CWPA will be responsible for conducting Stage 1 and Stage 2 sampling in the southern area.

Stage 1: Aerial Survey

Logistics

As in 2008, our aerial survey will employ the belt transect method using a systematic random sampling design, with each transect a single sampling unit (Elzinga et al 2001). From a random starting point, parallel transects will be conducted in an east-west orientation, generally parallel to the gradient of sardine schools distributed along the coast. To fully encompass the expected westward (offshore) extent of the sardine school distribution, transects will originate three miles from the shoreline and will extended

westward for 35 miles (possibly further offshore in the southern area, if needed). Transects will be spaced 10 miles apart. In 2008, 10 parallel transects were sampled off the coast of Washington-Oregon near the Columbia River with three replicate surveys. The intention for 2009 is to expand the spatial coverage of the survey northward (to the Canadian border), and southward (to the Monterey Bay area) (Figure 1). Twenty six transects will be conducted in the northern area and twenty six transects will be conducted in the southern (Table 1).

The PIs will strive to schedule survey transect flights such that the northern and southern areas will be sampled in synchrony (as one coastwise survey). The goal will be to conduct sampling on days when coastwide weather conditions permit clear visibility of the ocean surface from an altitude of 8000 ft (2438 m). The coastwide total of 52 transects to be sampled for each replicate of the survey will be completed as a unit in as short a time frame as is practicable (generally within one week or less). Three replicates of the 52 transect coastwide survey will be sampled as close together in time as is practicable.

Data Collection and Reduction

The photogrammetric-aerial digital camera mounting system and data acquisition system used in 2008 will be used to acquire digital images and to log transect data (Aerial Imaging Solutions; Appendix I). The system records altitude, position, and spotter observations, which are directly linked to the time stamped quantitative digital imagery. At the nominal survey altitude of 8000 feet, the approximate width-swept by the camera with a 24 mm lens is 12,000 ft (3,657 m). Digital images will be collected with 60% overlap to ensure seamless photogrammetric coverage of the transects.

In 2008, quantitative aerial photogrammetry was validated by collecting digital imagery of an object of known size (an airplane hangar) at a series of altitudes ranging from 500 ft. to 8000 ft. Additional validation will be conducted in 2009 to determine if a calibration constant should be used to improve accuracy based on this ground-truth information.

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

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

and solving for *GCS*:

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

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

Data Analysis

As described below, we will use the data collected from the aerial survey to estimate: 1) school density, 2) the total number of schools, and 3) school cover (SSA).

School density (number of schools per m^2 of ocean surface). Belt or strip transects represent a special case of quadrat sampling; with the additional consideration that all transects may not be of equal length or area. In our survey, unequal transect areas can result from either 1) variation of transect width (e.g. from a lower visibility causing reduced flight altitude) or 2) variation in transect length (e.g. due to premature transect termination due to fog or other weather conditions). To account for this contingency, we will employ an unequal-area transect density estimator computed by dividing the mean number of sardine schools per transect by the mean transect area (Stehman and Salzer 2000). In this formulation

$$\widehat{D} = \frac{\bar{y}}{\bar{a}}$$

Where $\widehat{D}$ = the sample-based estimator of density, $\bar{y}$ = sample mean number of schools per transect, and $\bar{a}$ = sample mean transect area. The estimated variance of $\widehat{D}$ is derived from standard ratio estimation theory (Thompson 1992) as

$$\hat{V}(\widehat{D}) = \frac{1}{\bar{a}^2}\left(\frac{N-n}{N}\right)\frac{s_e^2}{n}$$

where N = the total number of transects in the region, n = the number of transects sampled in the region, and

$$s_e^2 = \sum_s \left(y - \widehat{D}\, a_u\right)^2 /(n-1)$$

where y_u = the number of schools in transect u, and a_u = the area of transect u. Stehman

and Salzer (2000) note that, while $\hat{V}(\hat{D})$ is an approximation generally valid for a sample size of 30 (Cochran 1977), simulations suggest it may also be valid for smaller sample sizes if the distribution of transect areas is nearly symmetric, or if the correlation between *a* and *y* is close to 1.

Total number of schools. Given the estimate of density $(\hat{D})$ and the total study area (*A*), an estimate of the total number of schools $(\hat{T})$ is

$$(\hat{T}) = (\hat{D})A$$

and its standard error $\widehat{SE}(\hat{Z})$

$$\widehat{SE}(\hat{T}) = \widehat{SE}(\hat{D})A \quad .$$

School surface area (SSA): Cover. Our measurements of the surface area of individual sardine schools from the digital imagery affords us the opportunity to estimate total sardine school cover (SSA). Cover is defined as the vertical projection of an object from the ground as viewed from above (Elzinga et al 2001). Let c_u denote the value for sardine school cover (m^2) on transect *u*. Cover for the entire study area $(\hat{C})$ can then be estimated using the unbiased estimator for a population total, $\hat{C} = N\bar{c}$ with estimated variance

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

where s_e^2 is the sample variance of c.

Stage 2: At-Sea Point Set Sampling

<u>*Logistics*</u>
Fishing taking place under this EFP will occur following the July, 2009 open fishing period. We expect all fishing will be completed by mid to late August, 2009. The EFP fish will be taken in the course of making the research point sets. It is likely that most of the point sets will be conducted harvested in close proximity to the mouth of Columbia River in the northern area, and in close proximity to Monterey Bay in the southern area.

Purse seine vessels operating under the EFP will capture fish from aerially photographed and measured sardine schools. Purse seine point sets conducted under Stage 2 sampling will be the means used to determine the relationship between SSA (as documented with quantitative aerial photographs) and the biomass of fish schools (as measured from the landed weight of fully captured schools). For fully captured schools, the total weight of the school will be recorded and numbers per unit weight will also be determined, based

on biological sampling of the point set hauls. Additionally, school height information will be recorded from vessel sonar or down sounders.

Point set samples will be stratified into two groups based on school size. The sampling strata will be: 1) schools less than or equal to 25 mt in landed weight ("small") , and 2) schools greater than 25 mt in landed weight ("large"). For each size stratum, 32 schools will be sampled, for a total of 64 schools coastwide. Sampling will be distributed between the northern and southern areas such that 32 schools will be sampled in the south (16 small; 16 large), and 32 schools will be sampled in the north (16 small; 16 large).

Biological Sampling

Biological samples of individual point sets will be collected at fish processing plants upon landing. Fishermen participating in the EFP research study will keep research hauls in separate holds upon capture so the tonnage of each aerially photographed and measured point set haul may be determined separately 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.

Length, weight, and maturity from the point set hauls are of primary interest. 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) supplied by Beverly Macewicz NMFS, SWFSC (Table 2).

Sample Size (Number of Point Sets)

The sample size of n = 32 schools per size stratum was arrived at based on 1) the amount of sardine set-aside for research for 2009 (2400 mt), and 2) the distribution of sardine school sizes and information from point sets observed in the 2008 pilot study, as described below.

The size distribution of 3024 schools photographed and measured in the 2008 pilot study is shown in Figure 2. With our Stage 2 sampling technique (purse seine capture) we are logistically capable of sampling schools of up to approximately 95 mt per haul. From the 2008 pilot study, we also found that n = 8 point sets (schools photographed, measured, and captured) averaged 0.027 mt/m^2. Using this information, we defined our Stage 2 sampling frame as schools less than or equal to approximately 3500 m^2. This cut off accounted for approximately 90.25% of schools by number, and 61.65% of schools by estimated weight in the pilot study (Table 3). From the cumulative frequency curve of schools in the sampling frame (<= 3,500 m^2), it was determined that 25 mt was a good break point for the small school/large school stratification: approximately 50% of the schools were less than this size, and 50% were greater than this size (Table 4). Thus, in order to obtain equal sample sizes for the two strata, and to stay within the 2,400 mt sardine research set-aside, a sample size of n = 32 point sets for each strata was selected.

Statistical Power Analysis

We conducted a power analysis to evaluate the utility of the n = 32 sample size to estimate the relationship between sardine school biomass and surface area for both small and large sardine schools. We employed the two-sample t-test of means. The t-test requires that 1) the two sample means are estimated from random samples drawn from normally distributed populations, and 2) the variance of the two populations are equal.

Power analysis is a theoretical "what if" exercise, which asks the question: "If the effect being measured is *this* big, would the test be likely to detect it with *this* sample size?" Effect size can be thought of as the degree to which a phenomenon exists (Cohen, 1988). While the choice of effect size values used for a power analysis are arbitrary, they should be set at some meaningful threshold level, such that if the true effect is less than a given threshold, it would not be important to detect. Usually, the effect size is the quantity being tested, thus it is unknown.

We begin with the sample size (n = 32) as given, based on the amount of sardine available for the EFP research study (described above). Also, in the 2008 Pilot Study, a sample of n = 8 point sets suggested that the ratio of biomass to cover may vary by school size (Figure 3). Given our desire to be able to estimate the relationship between biomass and cover for a wide range of school sizes, a reasonable effect size threshold is the effect size necessary to discern the relationship between biomass and cover if a difference in this parameter exists between small vs. large sardine schools. Thus we construct our hypothesis test as follows:

H_0: $m_s = m_l$; no difference in the mean biomass per unit cover between small and large sardine schools.

H_A: $m_s \neq m_l$; a difference in the mean of biomass per unit cover between small and large sardine schools.

Statistical power (i.e. the probability of correctly rejecting a false null hypothesis) is inversely related to the significance criterion (α) and is positively correlated with sample size and effect size (Peterman, 1990). The significance criterion is the rate of rejecting a true null hypothesis (the probability of Type I error) and was fixed at 0.05 for our analysis. Given a significance level and sample size, power is a function of the effect size we require to be detectable.

In our power analysis we used the approximation

$$Z_{1-b} = \frac{d(n-1)\sqrt{2n}}{2(n-1)+1.21(Z_{1-a}-1.06)} - Z_{1-a} \qquad [1]$$

(Dixon and Massey, 1957; Cohen, 1988)

where

Z_{1-b} = the percentile of the unit normal which gives power,

Z_{1-a} = the percentile of the unit normal for the significance criterion; for a two-tailed test, $\alpha = \alpha_{(2)}/2$,

d = the standardized effect size index for the two-tailed t-test; calculated as

$$d = \frac{|m_s - m_l|}{s_p} \qquad [2]$$

where m_s and m_l are the true densities for small and large schools, respectively, and s_p^2 is the true pooled variance. By design, our study will draw independent samples of equal size (n = 32) from each of the two school size strata, and

$$s_p^2 = (s_s^2 + s_l^2)/2 \ .$$

The power approximation procedure is convenient to use, in lieu of an exact method, as it is only dependent on the effect size index (*d*) and sample size. Note that *d* is unitless, and is cast in terms of the variability under consideration; it is effectively equal to the number of standard deviations of the distribution of interest.

Using the power approximation equation [1], we can iteratively solve for the detectable effect size given the desired sample size, power, and alpha values for the two sample test of means. For example, when n = 32, power = 0.8, and alpha = 0.05, we obtain a detectable effect size of d = 0.71 (Table 5). Thus, we could expect to detect a difference in means on the order of 71% of the standard deviation. Figure 4 shows the power curve for values of *d* from 0.1 to 1.2 .

From our 2008 pilot study, we have a first look at the variability we might expect to see in the SSA to biomass relationship. With n = 8 point sets, the pilot study sample standard deviation was 0.022389, the mean was 0.026954 mt/m^2 and the values ranged from 0.009 to 0.077 mt/m^2 (Table 6). Using the standardized effect size equation [2]; substituting 0.71 for *d*, and the pilot study standard deviation 0.022389 for s_p we obtain

$$0.71 = \frac{|m_s - m_l|}{0.022389}$$

Solving for $|m_s - m_l|$, we get 0.16 . Thus, we could expect to be able to detect a difference between small and large sardine schools on the order of 0.16 mt/m^2.

Data Analysis

Using samples collected from the two school size strata (small and large) we employ the stratified random sampling estimator of the population mean to estimate mean biomass per unit cover

$$\bar{y}_{st} = \frac{1}{N}(N_s\bar{y}_s + N_l\bar{y}_l)$$

with estimated variance

$$\hat{V}(\bar{y}_{st}) = \frac{1}{N^2}\left(N_s^2\left(\frac{N_s - n_s}{N_s}\right)\left(\frac{s_s^2}{n_s}\right) + N_l^2\left(\frac{N_l - n_l}{N_l}\right)\left(\frac{s_l^2}{n_l}\right)\right)$$

where

$N =$ number of sampling units in the population,

$N_s \; and \; N_l =$ number of sampling units in the small and large school strata, respectively,

$n_s \; and \; n_l =$ sample size taken in the small and large school strata, respectively,

$\bar{y}_s \; and \; \bar{y}_l =$ sample means of biomass per unit cover in the small and large school strata, respectively, and

$s_s^2 \; and \; s_l^2 =$ sample variance of biomass per unit cover in the small and large school strata, respectively.

Estimation of Biomass from Stage 1 and Stage 2 Sampling

An estimate of sardine biomass can be obtained as:

$$\hat{B} = \hat{C}\left(\widehat{\frac{b}{a}}\right)$$

where

$\hat{B} =$ estimate of total biomass of the survey area (mt)

$\hat{C} =$ estimate of sardine cover for the survey area (from Stage 1 sampling)

$\left(\widehat{\frac{b}{a}}\right) =$ estimate of biomass per unit cover ($\bar{y}_{st}$) (from Stage 2 sampling)

Our pilot study in 2008 demonstrated that reasonably good estimates of sardine cover $(\widehat{C})$ may be obtained using the aerial survey methodology (CV = 0.23); however, we do

not yet know if an estimate of biomass per unit cover $\widehat{\left(\frac{b}{a}\right)}$ may be obtained with acceptable precision. With our proposed method, the error of estimating each of these two quantities will propagate through to the estimation of biomass $(\widehat{B})$. Thus, our success in estimating $\hat{B}$ will depend on our results from both Stage 1 and Stage 2 sampling in 2009.

School Classification

In our 2008 pilot study, we began to explore the utility of measuring certain school morphometric (shape and size) parameters to better understand ways of classifying sardine schools for the purpose of improving variance estimation on the survey parameters. For example, it would be very useful if a relationship could be established between school height, school surface area (cover), school shape (e.g. circularity), and school biomass -- for the purpose of classifying schools on a morphological basis. One possible hypothesis is that it may be possible to classify schools into two broad categories: 1) semi-stationary "feeding" schools, and 2) transitory "migrating" schools. If possible, such a classification scheme may serve to reduce the variability in estimation of sardine biomass.

Hydroacoustic Measurement of School Height

In 2009, vessels equipped with echo sounders will be employed to measure the height of schools (distance from the top of the school to the bottom of the school in the water column), and position in the water column relative to the surface. Two vessels in both the northern and southern survey area will be equipped with a Simrad ES 60 recording echo sounders and connected to the ships 50/200 mHz single beam transducers. This configuration allows registration of fish in an 11 degree band under the vessel. The sounders employed are not capable of quantitative acoustic echo integration, so we are not estimating biomass via echo integration; rather, our primary use of the sonar registrations is to record the vertical distribution of schools that will be used with simultaneous aerial estimates of surface area.

The California survey will have one or two vessels with full echo integration capability and will attempt to perform estimation of biomass of schools to compare with the aerial survey- seine set density abundance estimates.

As in 2008, echo sign will again be recorded continually throughout the season; however, in 2009, a directed effort will also be made during the EFP portion of the fishery to collect paired echo sign and aerial survey observations. The recorded echo sign will be analyzed using Simrad Bergen Integrator software to measure school parameters.

If time and funding permit we may try to run short 5-10 mi transects to compare acoustic and aerial detection of sardine in order to try and quantify the relationship between aerial observation and acoustic registrations. This combined work may also provide some information on vessel avoidance.

II. Survey Logistics

Project Contacts: Roles and Responsibilities

Scientific Contacts (see Appendix II for Resumes and Curriculums Vitae):

Name: Vidar Wespestad, PhD
Affiliation: Resource Analysts International
Address: 21231 8th Pl. W., Lynnwood, WA 98036
Email: vidarw@verizon.net
Role: Co-Principal Investigator
Responsibilities: Co-design and direction of EFP sardine survey and related research. Ensure appropriate use of available funds to accomplish projects scientific objectives. Provide scientific guidance and oversight for project execution. Analysis of data and preparation of final report. Represent project in public fora (e.g. PFMC, STAR panels, SSC) to present and interpret scientific results.

Name: Tom Jagielo, MSc
Affiliation: Tom Jagielo, Consulting
Address: P.O. Box 93, Copalis Beach, WA 98535
Email: TomJagielo@msn.com
Role: Co-Principal Investigator
Responsibilities: Co-design and direction of EFP sardine survey and related research. Ensure overall appropriate use of available funds to accomplish projects scientific objectives. Provide scientific guidance and oversight for project execution. Analysis of data and preparation of final report. Represent project in public fora (e.g. PFMC, STAR panels, SSC) to present and interpret scientific results.

Name: Doyle Hanan, PhD
Affiliation: Hanan & Associates, Inc.
Email: drhanan@cox.net
Role: Scientific Field Lead, California (southern area)
Responsibilities: Under direction of Co-PIs: Ensure appropriate use of available funds to accomplish projects scientific objectives specific to the southern area. Coordinate collection of scientific data and project execution specific to the southern area. Assist with data analysis and preparation of final report. Present project results as appropriate and/or required.

Name: Ryan Howe, BSc
Affiliation: Consultant
Email: ryanhowe9@yahoo.com
Role: Scientific Field Lead, (northern area)
Responsibilities: Under direction of Co-PIs: Ensure appropriate use of available funds to accomplish projects scientific objectives specific to the northern area. Coordinate collection of scientific data and project execution specific to the northern area. Additionally, coordinate consistency of data collection coastwide (from both northern and southern areas). Assemble data from both northern and southern areas and perform data reduction for analysis. Assist with data analysis and preparation of final report. Present project results as appropriate and/or required.

Industry Contacts:

Name: Diane Pleschner-Steele
Affiliation: Executive Director, California Wetfish Producers Association
Address: PO Box 1951, Buellton, CA 93427
Email: dplesch@earthlink.net
Phone: (805) 693-5430
Role: Industry EFP Co-Lead: CWPA (southern area)
Responsibilities: Coordinate sale of EFP sardine from southern area with participating processors. Administration of EFP funds collected in southern area; direct funds to project PIs as required to accomplish project scientific objectives in the southern area. Contract with vessels, pilots, and others as needed to execute project in the southern area under direction of project PIs.

Name: Jerry Thon
Affiliation: Principal, Northwest Sardine Survey, LLC
Address: 12 Bellwether Way, Suite 209, Bellingham, WA 98225
Email: jthon2@msn.com
Phone: (360) 201-8449
Role: Industry EFP Co-Lead: NWSS-LLC (northern area)
Responsibilities: Coordinate sale of EFP sardine from northern area with participating processors. Administration of EFP funds collected in northern area; direct funds to project PIs as required to accomplish project scientific objectives in the northern area. Contract with vessels, pilots, and others as needed to execute project in the northern area under direction of project PIs.

EFP Requirements

A point by point discussion of EFP criteria is given in Appendix IV.

At the March 2009 meeting of the PFMC, the Council approved for public review two EFP proposals for an industry-sponsored Pacific sardine research survey in 2009, and

furthermore requested that Pacific sardine industry representatives work to provide a detailed single proposal that addresses the recommendations of the SSC and the Coastal Pelagic Species Management Team (CPSMT). The present document is a result of this synthesis. A STAR panel meeting is scheduled for early May, where the survey methodology presented herein will receive a detailed evaluation.

Sardine to be harvested under the EFP are accounted for in the PFMC OY allocation process. Also at the March meeting, the Council recommended National Marine Fisheries Service (NMFS) adjust the research set-aside for this effort from 1200 metric ton (mt) to 2400 mt.

EFP Purse Seine Vessel Selection

Our priorities for selecting vessels to participate under this EFP include: 1) vessels which have installed the necessary electronic equipment or have the capacity to install this equipment, and 2) vessels having the ability to separate the point sets into different hatches.

With the narrow time window for sampling it is desirable to have a field of boats we can draw on. The main reason to have several boats in this period is to maximize the number of point sets we can bring in. These boats will only be used for point sets. Some vessels do not have recording sounders, but 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 following list and reporting the vessels that will be operating at any given time to local enforcement will help to meet the EFP goals.

Vessels: Northern area

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

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

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

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

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

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

1. Vessel: King Philip
   Skipper: Anthony Russo (alt. Paul Morse)
   Owner: Sea Wave Corp. – Sal Tringali
   USCG Doc. No. 1061827
   CPS Limited Entry Permit #9
   Length 79 feet, GRT 156.9

2. Vessel: Barbara H
   Skipper: David Haworth
   Owner: F/V Barbara H Inc.- David Haworth
   USCG Doc. No. 643518
   CPS Limited Entry Permit #4
   Length 64.9 feet, GRT 121.1

3. Vessel: Ocean Angel IV
   Skipper: David Tibbles
   Owner: Ocean Angel LLC
   OR Reg No. 868ADK
   CPS Limited Entry Permit #22
   Length 60.5 feet, GRT 63.5

4. Vessel: Trionfo
   Skipper: Aniello (Neil) Guglielmo
   Owner: Aniello Guglielmo
   USCG Doc. No. 625449

CPS Limited Entry Permit #45
Length 63.8 feet GRT, 79.2

Disposition of fish harvested under the EFP

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

Budget

An itemized budget is provided as Appendix III. At this juncture 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 firmed up. On the cost side, we have detailed components of the project that will be required to complete the work proposed. Field work always includes uncertainty (weather, fish availability, etc.) and contingency amounts have been included to attempt to address some of this uncertainty.

The financial structure of the project is as follows:

1. Funds derived from the capture and sale of the sardine research set-aside will be used to pay for the research to be conducted under this proposed EFP. The costs of the project in California will be the responsibility of the CWPA from their 1200mt portion and in the Northwest will be the responsibility of the NWSS-LLC from their 1200mt portion. Costs will be paid for by the sale of the fish captured during the point sets.

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

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

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

5. Equipment needs, and operational costs including scientific support will be paid for by the CWPA and the NWSS-LLC from the sale of their individual 1200 mt research quotas. Joint expenses of the PIs to design the research plan, attend STAR panel and Scientific Team Meetings before during and after the survey period will be borne by each side equally. The PIs will invoice the CWPA and the NWSS- LLC for 50% of such joint administration costs. Costs by the PIs to deal specifically with CWPA or the NWSS-LLC will be billed directly to that group only. We anticipate the revenue from the fish sales will be sufficient to cover the costs to capture, process, and conduct the survey.

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 pilot survey work conducted in the 2008, the EFP research study in 2009 will enable us to obtain critical information needed to convert aerial survey measurements of sardine school surface area into estimates of sardine biomass. Our efforts to accomplish this in 2008 were hampered without a set-aside of sardine OY for research. 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 open access fishery. This will enable us to obtain a larger and more representative sample of point-sets to more precisely and accurately estimate sardine school density – an important parameter needed for sardine biomass estimation using the aerial survey method

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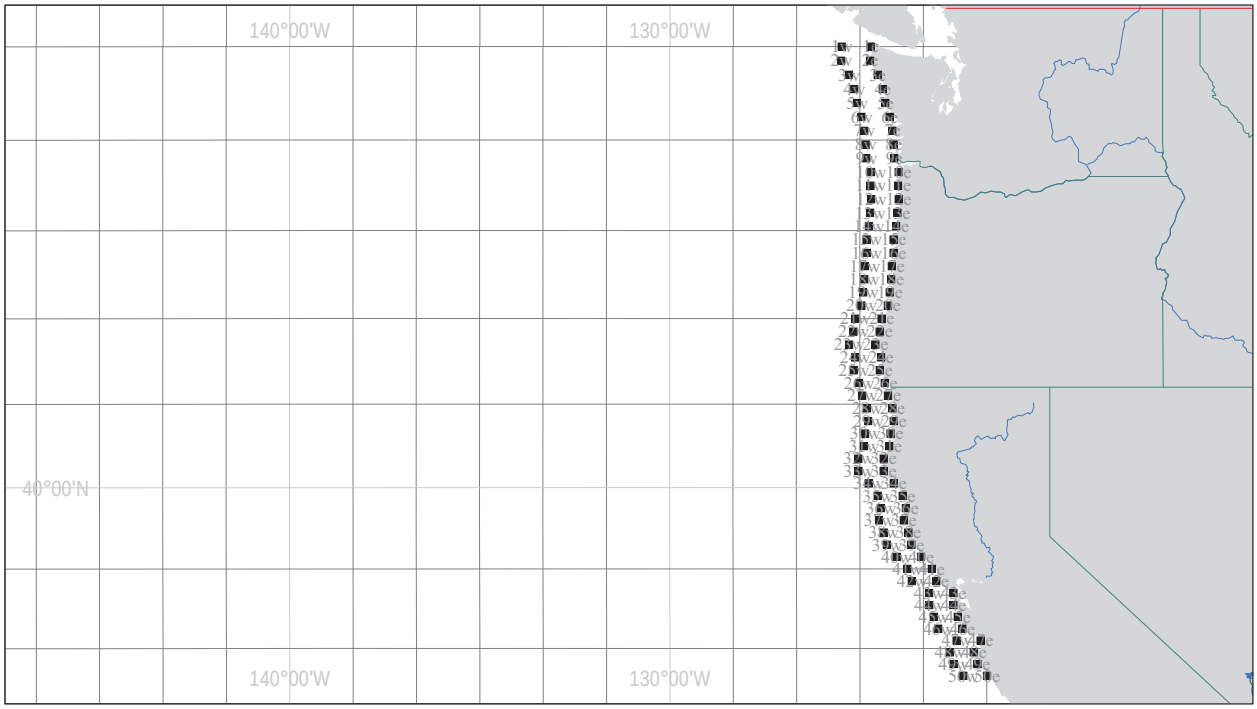


Figure 1. Transect Locations for 2009 Sardine EFP Survey – Full Coast

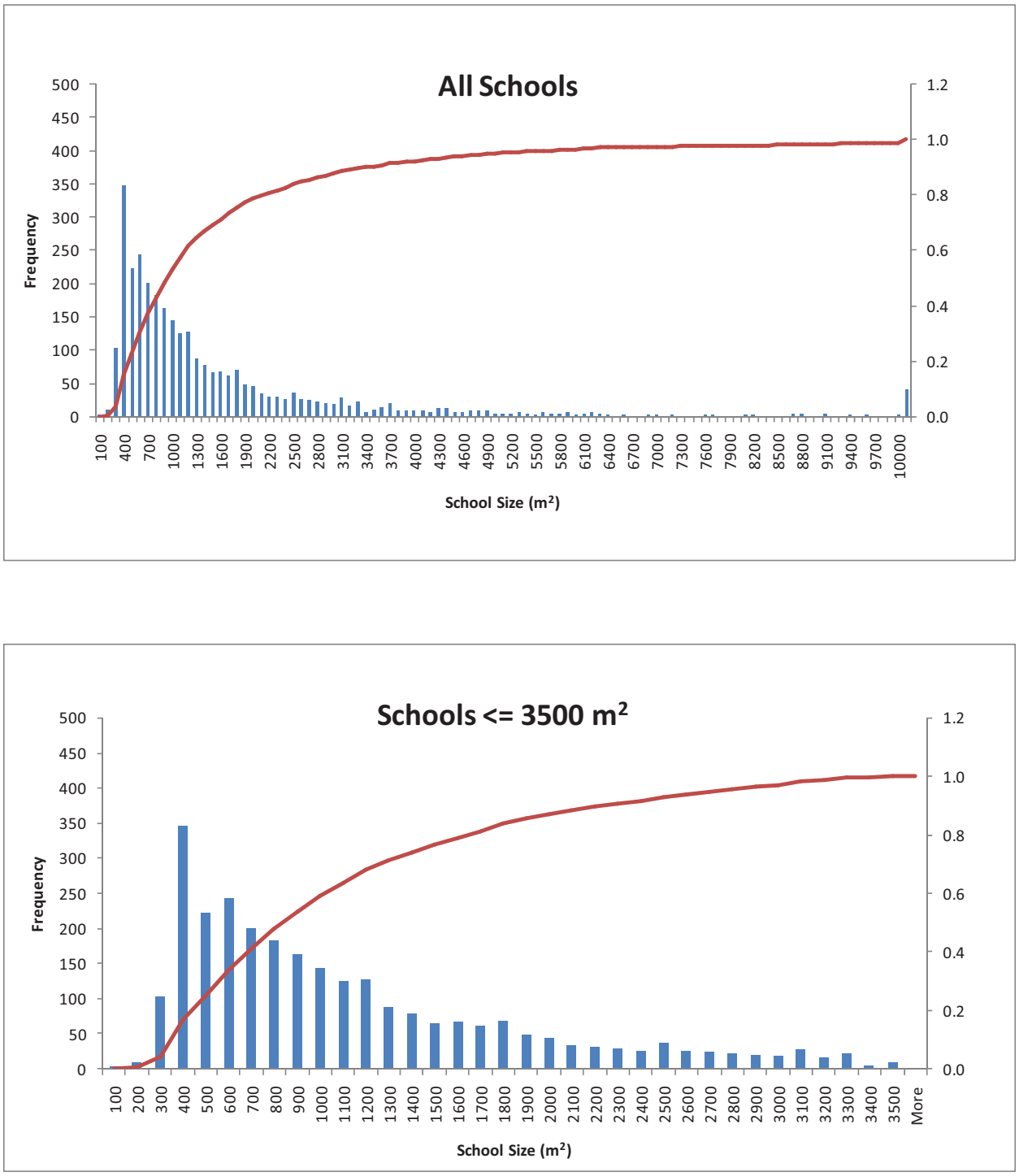


Figure 2. Size distribution of sardine schools measured in 2008 Pilot Study. Top: Distribution of all schools measured. Bottom: Distribution of schools that measured less than 3,500 m^2.

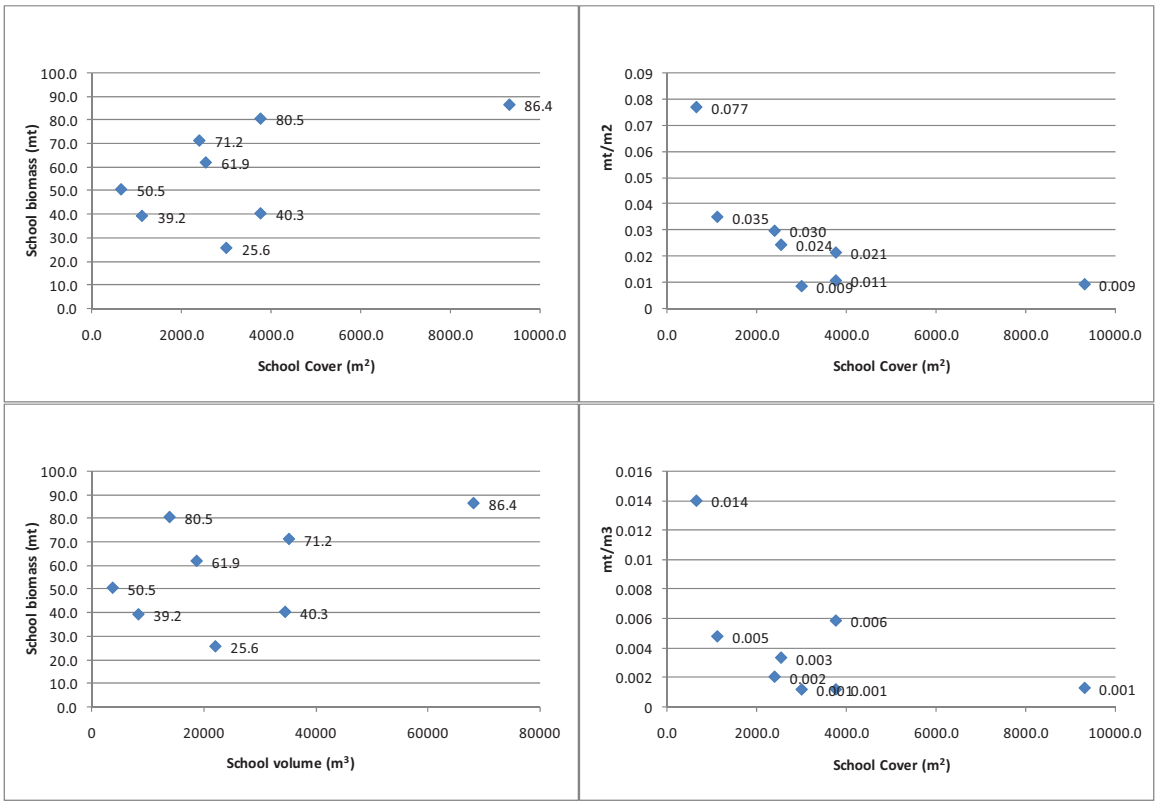


Figure 3. Sample of n = 8 point sets taken during 2008 Pilot Study. Top Left: school biomass (mt) as a function of school cover (m^2). Top Right: biomass to cover ratio (mt/m^2) as a function of school cover (m^2). Bottom Right: biomass to volume ratio (mt/m^3) as a function of school cover (m^2). Bottom Left: biomass as a function of school volume (m^3). Note: school volume was approximated as the volume of a cylinder: i.e. the product of school surface area and school height.

Figure 4. Statistical power as a function of the standardized effect size index (*d*) for a two-sample t-test of means with sample size n = 32 (alpha = 0.05).

Table 1. Example of transect locations for 2009 Sardine EFP survey.

Location	Survey Area	Transect Number	Transect Latitude		West End			East End		
			Lat Deg	Lat Min	Long Deg	Long Min	Way Point #	Long Deg	Long Min	Way Point #
Washington	N	1	48	20.000	125	28.49	1w	124	42.91	1e
Washington	N	2	48	5.000	125	29.24	2w	124	43.89	2e
Washington	N	3	47	50.000	125	17.01	3w	124	31.87	3e
Washington	N	4	47	35.000	125	8.78	4w	124	23.85	4e
Washington	N	5	47	20.000	125	4.55	5w	124	19.83	5e
Washington	N	6	47	5.000	124	57.32	6w	124	12.81	6e
Washington	N	7	46	50.000	124	53.09	7w	124	8.80	7e
Washington	N	8	46	35.000	124	50.87	8w	124	6.78	8e
Washington	N	9	46	20.000	124	49.66	9w	124	5.76	9e
Oregon	N	10	46	5.000	124	42.44	10w	123	58.75	10e
Oregon	N	11	45	50.000	124	43.22	11w	123	59.73	11e
Oregon	N	12	45	35.000	124	42.02	12w	123	58.71	12e
Oregon	N	13	45	20.000	124	43.81	13w	124	0.70	13e
Oregon	N	14	45	5.000	124	45.61	14w	124	2.68	14e
Oregon	N	15	44	50.000	124	49.41	15w	124	6.66	15e
Oregon	N	16	44	35.000	124	49.20	16w	124	6.65	16e
Oregon	N	17	44	20.000	124	52.00	17w	124	9.63	17e
Oregon	N	18	44	5.000	124	52.81	18w	124	10.62	18e
Oregon	N	19	43	50.000	124	54.62	19w	124	12.60	19e
Oregon	N	20	43	35.000	124	57.43	20w	124	15.59	20e
Oregon	N	21	43	20.000	125	7.25	21w	124	25.57	21e
Oregon	N	22	43	5.000	125	10.06	22w	124	28.56	22e
Oregon	N	23	42	50.000	125	16.88	23w	124	35.54	23e
Oregon	N	24	42	35.000	125	7.70	24w	124	26.53	24e
Oregon	N	25	42	20.000	125	9.52	25w	124	28.51	25e
Oregon	N	26	42	5.000	125	1.35	26w	124	20.50	26e
California	S	27	41	50.000	124	56.17	27w	124	15.49	27e
California	S	28	41	35.000	124	49.00	28w	124	8.47	28e
California	S	29	41	20.000	124	46.84	29w	124	6.46	29e
California	S	30	41	5.000	124	51.67	30w	124	11.45	30e
California	S	31	40	50.000	124	53.50	31w	124	13.43	31e
California	S	32	40	35.000	125	2.34	32w	124	22.42	32e
California	S	33	40	20.000	125	2.18	33w	124	22.41	33e
California	S	34	40	5.000	124	46.02	34w	124	6.40	34e
California	S	35	39	50.000	124	31.87	35w	123	52.38	35e
California	S	36	39	35.000	124	26.71	36w	123	47.37	36e
California	S	37	39	20.000	125	29.56	37w	124	50.36	37e
California	S	38	39	5.000	124	22.41	38w	123	43.35	38e
California	S	39	38	50.000	124	17.26	39w	123	38.34	39e
California	S	40	38	35.000	124	2.11	40w	123	23.32	40e
California	S	41	38	20.000	123	44.97	41w	123	6.31	41e
California	S	42	38	5.000	123	37.83	42w	122	59.30	42e
California	S	43	37	50.000	123	10.68	43w	122	32.29	43e
California	S	44	37	35.000	123	10.55	44w	122	32.28	44e
California	S	45	37	20.000	123	3.40	45w	122	25.27	45e
California	S	46	37	5.000	122	56.27	46w	122	18.26	46e
California	S	47	36	50.000	122	27.13	47w	121	49.25	47e
California	S	48	36	35.000	122	38.00	48w	122	0.24	48e
California	S	49	36	20.000	122	31.87	49w	121	54.23	49e
California	S	50	36	5.000	122	16.74	50w	121	39.22	50e
California	S	51	35	50.000	122	16.74	50w	121	39.22	50e
California	S	52	35	35.000	122	16.74	50w	121	39.22	50e

Table 2. 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	

Table 3. Frequency distribution of all schools measured in the 2008 Pilot Study

School Size (m^2)	Frequency	Cumulative Frequency	mt/school	mt	Cumulative mt	Cumulative mt (%)
500	685	0.2250	13.5	9231.9	9231.9	0.0585
1000	934	0.5317	27.0	25175.4	34407.2	0.2181
1500	484	0.6906	40.4	19568.9	53976.1	0.3422
2000	292	0.7865	53.9	15741.3	69717.5	0.4420
2500	158	0.8384	67.4	10647.0	80364.4	0.5095
3000	113	0.8755	80.9	9137.5	89502.0	0.5675
3500	82	0.9025	94.3	7735.9	97237.9	0.6165
4000	60	0.9222	107.8	6469.0	103706.9	0.6575
4500	46	0.9373	121.3	5579.6	109286.5	0.6929
5000	37	0.9494	134.8	4986.6	114273.0	0.7245
5500	22	0.9567	148.2	3261.5	117534.5	0.7452
6000	24	0.9645	161.7	3881.4	121415.9	0.7698
6500	21	0.9714	175.2	3679.3	125095.2	0.7931
7000	7	0.9737	188.7	1320.8	126416.0	0.8015
7500	4	0.9750	202.2	808.6	127224.6	0.8066
8000	8	0.9777	215.6	1725.1	128949.7	0.8176
8500	5	0.9793	229.1	1145.6	130095.2	0.8248
9000	10	0.9826	242.6	2425.9	132521.1	0.8402
9500	8	0.9852	256.1	2048.5	134569.7	0.8532
10000	5	0.9869	269.5	1347.7	135917.4	0.8617
10500	2	0.9875	283.0	566.0	136483.4	0.8653
11000	5	0.9892	296.5	1482.5	137965.9	0.8747
11500	2	0.9898	310.0	620.0	138585.9	0.8787
12000	0	0.9898	323.5	0.0	138585.9	0.8787
12500	1	0.9901	336.9	336.9	138922.8	0.8808
13000	4	0.9915	350.4	1401.6	140324.4	0.8897
13500	0	0.9915	363.9	0.0	140324.4	0.8897
14000	3	0.9924	377.4	1132.1	141456.5	0.8969
14500	1	0.9928	390.8	390.8	141847.3	0.8993
15000	2	0.9934	404.3	808.6	142656.0	0.9045
15500	3	0.9944	417.8	1253.4	143909.3	0.9124
16000	0	0.9944	431.3	0.0	143909.3	0.9124
16500	1	0.9947	444.7	444.7	144354.1	0.9152
17000	0	0.9947	458.2	0.0	144354.1	0.9152
17500	1	0.9951	471.7	471.7	144825.8	0.9182
18000	0	0.9951	485.2	0.0	144825.8	0.9182
18500	1	0.9954	498.7	498.7	145324.4	0.9214
19000	1	0.9957	512.1	512.1	145836.6	0.9246
19500	1	0.9961	525.6	525.6	146362.2	0.9280
20000	0	0.9961	539.1	0.0	146362.2	0.9280
20500	0	0.9961	552.6	0.0	146362.2	0.9280
21000	1	0.9964	566.0	566.0	146928.2	0.9316
21500	0	0.9964	579.5	0.0	146928.2	0.9316
22000	0	0.9964	593.0	0.0	146928.2	0.9316
22500	1	0.9967	606.5	606.5	147534.7	0.9354
23000	0	0.9967	620.0	0.0	147534.7	0.9354
23500	1	0.9970	633.4	633.4	148168.1	0.9394
24000	0	0.9970	646.9	0.0	148168.1	0.9394
24500	1	0.9974	660.4	660.4	148828.5	0.9436
25000	1	0.9977	673.9	673.9	149502.4	0.9479
25500	0	0.9977	687.3	0.0	149502.4	0.9479
26000	0	0.9977	700.8	0.0	149502.4	0.9479
26500	0	0.9977	714.3	0.0	149502.4	0.9479
27000	0	0.9977	727.8	0.0	149502.4	0.9479
27500	0	0.9977	741.2	0.0	149502.4	0.9479
28000	0	0.9977	754.7	0.0	149502.4	0.9479
28500	1	0.9980	768.2	768.2	150270.6	0.9527
29000	0	0.9980	781.7	0.0	150270.6	0.9527
29500	0	0.9980	795.2	0.0	150270.6	0.9527
30000	0	0.9980	808.6	0.0	150270.6	0.9527
30500	0	0.9980	822.1	0.0	150270.6	0.9527
31000	0	0.9980	835.6	0.0	150270.6	0.9527
31500	0	0.9980	849.1	0.0	150270.6	0.9527
32000	0	0.9980	862.5	0.0	150270.6	0.9527
32500	0	0.9980	876.0	0.0	150270.6	0.9527
33000	0	0.9980	889.5	0.0	150270.6	0.9527
33500	0	0.9980	903.0	0.0	150270.6	0.9527

School Size (m^2)	Frequency	Cumulative Frequency	mt/school	mt	Cumulative mt	Cumulative mt (%)
33500	0	0.9980	903.0	0.0	0.0	0.0000
34000	0	0.9980	916.4	0.0	0.0	0.0000
34500	0	0.9980	929.9	0.0	0.0	0.0000
35000	0	0.9980	943.4	0.0	0.0	0.0000
35500	0	0.9980	956.9	0.0	0.0	0.0000
36000	0	0.9980	970.4	0.0	0.0	0.0000
36500	0	0.9980	983.8	0.0	0.0	0.0000
37000	1	0.9984	997.3	997.3	997.3	0.0063
37500	0	0.9984	1010.8	0.0	997.3	0.0063
38000	0	0.9984	1024.3	0.0	997.3	0.0063
38500	0	0.9984	1037.7	0.0	997.3	0.0063
39000	0	0.9984	1051.2	0.0	997.3	0.0063
39500	0	0.9984	1064.7	0.0	997.3	0.0063
40000	0	0.9984	1078.2	0.0	997.3	0.0063
40500	0	0.9984	1091.7	0.0	997.3	0.0063
41000	0	0.9984	1105.1	0.0	997.3	0.0063
41500	1	0.9987	1118.6	1118.6	2115.9	0.0134
42000	0	0.9987	1132.1	0.0	2115.9	0.0134
42500	0	0.9987	1145.6	0.0	2115.9	0.0134
43000	0	0.9987	1159.0	0.0	2115.9	0.0134
43500	0	0.9987	1172.5	0.0	2115.9	0.0134
44000	0	0.9987	1186.0	0.0	2115.9	0.0134
44500	0	0.9987	1199.5	0.0	2115.9	0.0134
45000	1	0.9990	1212.9	1212.9	3328.9	0.0211
45500	0	0.9990	1226.4	0.0	3328.9	0.0211
46000	0	0.9990	1239.9	0.0	3328.9	0.0211
46500	1	0.9993	1253.4	1253.4	4582.2	0.0291
47000	1	0.9997	1266.9	1266.9	5849.1	0.0371
47500	0	0.9997	1280.3	0.0	5849.1	0.0371
48000	0	0.9997	1293.8	0.0	5849.1	0.0371
48500	0	0.9997	1307.3	0.0	5849.1	0.0371
49000	0	0.9997	1320.8	0.0	5849.1	0.0371
49500	0	0.9997	1334.2	0.0	5849.1	0.0371
50000	0	0.9997	1347.7	0.0	5849.1	0.0371
50500	0	0.9997	1361.2	0.0	5849.1	0.0371
51000	0	0.9997	1374.7	0.0	5849.1	0.0371
51500	0	0.9997	1388.1	0.0	5849.1	0.0371
52000	0	0.9997	1401.6	0.0	5849.1	0.0371
52500	0	0.9997	1415.1	0.0	5849.1	0.0371
53000	0	0.9997	1428.6	0.0	5849.1	0.0371
53500	0	0.9997	1442.1	0.0	5849.1	0.0371
54000	0	0.9997	1455.5	0.0	5849.1	0.0371
54500	0	0.9997	1469.0	0.0	5849.1	0.0371
55000	0	0.9997	1482.5	0.0	5849.1	0.0371
55500	0	0.9997	1496.0	0.0	5849.1	0.0371
56000	0	0.9997	1509.4	0.0	5849.1	0.0371
56500	0	0.9997	1522.9	0.0	5849.1	0.0371
57000	0	0.9997	1536.4	0.0	5849.1	0.0371
57500	0	0.9997	1549.9	0.0	5849.1	0.0371
58000	0	0.9997	1563.4	0.0	5849.1	0.0371
58500	0	0.9997	1576.8	0.0	5849.1	0.0371
59000	0	0.9997	1590.3	0.0	5849.1	0.0371
59500	1	1.0000	1603.8	1603.8	7452.9	0.0473
60000	0	1.0000	1617.3	0.0	7452.9	0.0473
				0.0		

Table 4. Frequency distribution of schools that measured <= 3500 m^2 in the 2008 Pilot Study.

School Size (m^2)	Frequency	mt/school	mt	Cumulative Frequency	Stratum Avg mt	Stratum n
100	3	2.7	8.1	0.00	12.1	32
200	10	5.4	53.9	0.00		
300	103	8.1	832.9	0.04		
400	346	10.8	3730.5	0.17		
500	223	13.5	3005.4	0.25		
600	243	16.2	3929.9	0.34		
700	200	18.9	3773.6	0.41		
800	183	21.6	3946.1	0.48		
900	163	24.3	3954.2	0.54	59.3	32
1000	145	27.0	3908.4	0.59		
1100	125	29.6	3706.2	0.63		
1200	128	32.3	4140.2	0.68		
1300	88	35.0	3083.6	0.71		
1400	78	37.7	2943.4	0.74		
1500	65	40.4	2628.1	0.77		
1600	68	43.1	2932.6	0.79		
1700	62	45.8	2841.0	0.81		
1800	69	48.5	3347.7	0.84		
1900	48	51.2	2458.2	0.86		
2000	45	53.9	2425.9	0.87		
2100	34	56.6	1924.5	0.88		
2200	31	59.3	1838.3	0.90		
2300	30	62.0	1859.9	0.91		
2400	26	64.7	1682.0	0.92		
2500	37	67.4	2493.3	0.93		
2600	27	70.1	1892.2	0.94		
2700	24	72.8	1746.6	0.95		
2800	23	75.5	1735.9	0.96		
2900	20	78.2	1563.4	0.96		
3000	19	80.9	1536.4	0.97		
3100	28	83.6	2339.6	0.98		
3200	16	86.3	1380.1	0.99		
3300	22	88.9	1956.9	0.99		
3400	6	91.6	549.9	1.00		
3500	10	94.3	943.4	1.00		

Table 5. Statistical power of the two sample t-test of means given sample size (n) , significance level (a), and effect size (d).

For a two-sample t-test for means, this tool calculates power (1-b), given sample size (n) for each sample, significance level (a), and effect size (d).

Type of Test (1=one sided, 2=two sided):	2		
Alpha level:	0.05	**Z1-a**	1.960
Standardized Effect Size Index (d):	0.71		

n	Z1-b	Power
5	-0.97	0.17
6	-0.85	0.20
7	-0.74	0.23
8	-0.64	0.26
9	-0.55	0.29
10	-0.46	0.32
11	-0.38	0.35
12	-0.30	0.38
13	-0.23	0.41
14	-0.16	0.44
15	-0.09	0.46
16	-0.02	0.49
17	0.04	0.52
18	0.10	0.54
19	0.16	0.57
20	0.22	0.59
21	0.28	0.61
22	0.34	0.63
23	0.39	0.65
24	0.44	0.67
25	0.49	0.69
26	0.55	0.71
27	0.60	0.72
28	0.64	0.74
29	0.69	0.76
30	0.74	0.77
31	0.79	0.78
32	0.83	0.80
33	0.88	0.81
34	0.92	0.82
35	0.96	0.83
36	1.01	0.84
37	1.05	0.85
38	1.09	0.86
39	1.13	0.87
40	1.17	0.88

Table shows: Power at alpha=0.05 for a range of sample size (n) and effect size (d) for a two-sided t test.

n \ d =	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
5	0.034319	0.046321	0.061482	0.080267	0.103095	0.130307	0.162123	0.198609	0.23965	0.284929
6	0.035634	0.049721	0.067932	0.090909	0.119203	0.153205	0.193084	0.23873	0.289722	0.345315
7	0.036852	0.052947	0.074172	0.101352	0.135151	0.175965	0.223827	0.278328	0.338596	0.403314
8	0.04	0.06	0.08	0.11	0.15	0.20	0.254307	0.31724	0.38596	0.458466
9	0.03909	0.059058	0.086265	0.121908	0.1668	0.221162	0.284454	0.355302	0.431549	0.510444
10	0.040136	0.061993	0.092187	0.132092	0.182546	0.243573	0.314191	0.392367	0.475161	0.559045
11	0.041145	0.064869	0.098053	0.142238	0.198245	0.265823	0.343443	0.428312	0.516646	0.604167
12	0.042123	0.067697	0.103876	0.152357	0.213895	0.287882	0.372142	0.463035	0.555909	0.645799
13	0.043074	0.070485	0.109666	0.162454	0.229488	0.309718	0.400225	0.496458	0.592898	0.683992
14	0.044002	0.073239	0.115431	0.172533	0.245014	0.331301	0.42764	0.528522	0.627596	0.718852
15	0.04491	0.075966	0.121175	0.182594	0.260464	0.352602	0.454343	0.559189	0.660021	0.750521
16	0.045799	0.078668	0.126903	0.192637	0.275827	0.373595	0.480295	0.588436	0.690215	0.779171
17	0.046673	0.081349	0.132618	0.202662	0.291092	0.394256	0.505469	0.616256	0.718238	0.804986
18	0.047532	0.084012	0.138321	0.212667	0.306249	0.414563	0.52984	0.642652	0.744167	0.828165
19	0.048378	0.086659	0.144016	0.222649	0.321286	0.434498	0.553392	0.667641	0.768093	0.848905
20	0.049212	0.089293	0.149703	0.232607	0.336195	0.454043	0.576116	0.691246	0.79011	0.867408
21	0.050035	0.091914	0.155384	0.242537	0.350966	0.473185	0.598004	0.713498	0.810322	0.883865
22	0.050849	0.094524	0.161058	0.252438	0.365589	0.491911	0.619056	0.734436	0.828833	0.898463
23	0.051653	0.097125	0.166727	0.262305	0.380058	0.510211	0.639276	0.754101	0.845751	0.91138
24	0.052449	0.099718	0.17239	0.272136	0.394363	0.528076	0.658669	0.772539	0.861179	0.922781
25	0.053237	0.102303	0.178048	0.281929	0.408499	0.545501	0.677246	0.789799	0.875223	0.932822
26	0.054017	0.104881	0.183701	0.291681	0.422457	0.56248	0.695019	0.805931	0.887982	0.941646
27	0.054791	0.107453	0.189348	0.301388	0.436233	0.57901	0.712004	0.820987	0.899555	0.949384
28	0.055559	0.11002	0.19499	0.311048	0.449821	0.595089	0.728216	0.83502	0.910034	0.956157
29	0.05632	0.112582	0.200626	0.320658	0.463216	0.610718	0.743675	0.848082	0.919507	0.962075
30	0.057076	0.11514	0.206257	0.330216	0.476413	0.625896	0.7584	0.860224	0.928059	0.967237
31	0.057827	0.117694	0.21188	0.339719	0.48941	0.640626	0.772413	0.871497	0.935767	0.971731
32	0.058573	0.120244	0.217497	0.349164	0.502201	0.654911	0.785735	0.881953	0.942706	0.975638
33	0.059314	0.122791	0.223107	0.35855	0.514785	0.668754	0.798389	0.891638	0.948943	0.979029
34	0.060051	0.125335	0.228708	0.367874	0.527159	0.68216	0.810399	0.900601	0.954544	0.981969
35	0.060784	0.127876	0.234302	0.377135	0.53932	0.695135	0.821786	0.908887	0.959566	0.984513
36	0.061513	0.130415	0.239887	0.386329	0.551268	0.707683	0.832576	0.916539	0.964064	0.986712
37	0.062238	0.132952	0.245463	0.395455	0.563	0.719813	0.842791	0.923599	0.968088	0.98861
38	0.06296	0.135487	0.251029	0.404511	0.574515	0.731531	0.852455	0.930107	0.971685	0.990247
39	0.063678	0.13802	0.256585	0.413496	0.585814	0.742845	0.86159	0.936101	0.974896	0.991657
40	0.064393	0.140551	0.26213	0.422408	0.596895	0.753762	0.87022	0.941616	0.97776	0.992869

Table 6. Summary data from n = 8 point sets taken during 2008 Pilot Study.

School Cover (m^2)	School Biomass (mt)	Biomass:Cover mt/m^2	School Height (m)	School Volume (m^3)	Biomass:Volume mt/m3
3763.9	80.5	0.021	3.7	13767	0.006
2543.9	61.9	0.024	7.3	18609	0.003
3763.8	40.3	0.011	9.1	34416	0.001
1121.7	39.2	0.035	7.3	8206	0.005
9308.4	86.4	0.009	7.3	68092	0.001
657.4	50.5	0.077	5.5	3607	0.014
3001.9	25.6	0.009	7.3	21959	0.001
2399.8	71.2	0.030	14.6	35110	0.002

West Coast Sardine Survey

Application for Exempted Fishing Permit in 2009

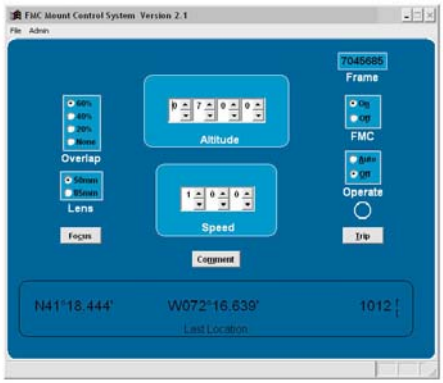
Appendix I: Aerial Imaging Solutions FMC Mount System

AERIAL IMAGING SOLUTIONS
FMC MOUNT SYSTEM

DESCRIPTION

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

AERIAL IMAGING SOLUTIONS
FMC MOUNT SYSTEM



TECHNICAL SPECIFICATIONS

Cameras Accepted

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

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

Contents of System

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

West Coast Sardine Survey

Application for Exempted Fishing Permit in 2009

Appendix II: Scientific Personnel Curriculums Vitae

Vidar G. Wespestad
21231 8th Place W.
Lynnwood, WA 98036
Telephone:425 672-7603
E-mail: Vidarw@verizon.net

2002-present Adjunct Professor, University of Alaska, Fairbanks.

1998- present **Fisheries Consultant**
Current and recent projects

Development of combined aerial and acoustic survey of Pacific sardine off Washington and Oregon.
Developing and supervising research for the Pacific Whiting Conservation Cooperative including conducting annual cooperative assessment of Pacific whiting prerecruit abundance;
Science consultant to American Fisheries Research Foundation for North Pacific albacore data and population models;
Assisting in stock assessments of marine fishes in central Chile;
Modeling and forecasting Bering Sea walleye pollock recruitment using biophysical data for the Alaska Fish. Sci. Center.
European Fish Ageing Network – consultation on length based stock assessment methodology
Reviewer and consultant to the Norwegian Research Council on fisheries assessment and management.
U.S. delegate to International Albacore Stock Assessment Working Group
Member, NOAA National MPA implementation Team
Member, Pacific Fisheries Management Council, Scientific and Statistical Committee.

1992-1997: Supervisory Fisheries Research Biologist, National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way N. E. Seattle, WA 98115. In charge of stock assessment task for the Bering Sea. I also served as a scientific advisor, delegate or representative to: Coastal Pelagic Working Group, PICES, Northeast Arctic Working Group, ICES
1977 – 1992: Fisheries Research Biologist, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, 7600 Sand Point Way N. E. Seattle, WA 98115.

Education
Doctor of Philosophy in Fisheries Science, 1991, University of Washington, Seattle, WA 98195
Master of Science in Fisheries Science, 1975, Colorado State University, Fort Collins, CO 80521
Bachelor of Science (cum laude), 1973, Colorado State University, Fort Collins, CO 80521

Professional and honorary society memberships
American Association for th Advancement of Science
American Institute of Fishery Research Biologists
American Fisheries Society:
Co-chair, World Fishery Congress (Athens, 1992) Steering Committee
International Fisheries Section, President 1989-91
Colorado State Chapter, President 1972-73
Marine Fisheries Section,
Gamma Sigma Delta
Xi Sigma Pi

Awards
NOAA Special Achievement, 1979
Full-time long term university training, 1982
NOAA Outstanding Performance, 1983
Honorable Mention for Best Paper in Fishery Bulletin, 1983
Senior Scientist Fellowship, Norwegian Fishery Research Council, 1986

Norwegian Marshall Fund, Research Fellowship, 1991.
American Fisheries Society Distinguished Service Award, 1992
Rockefeller Foundation Scholar-in-Resident, Bellagio Center, Bellagio, Italy, 1996.

Membership on Symposia Organizing Committees
International Herring Symposium, Anchorage, AK, 1980
International Hydroacoustic Symposium, Seattle, WA 1987
International Pollock Symposium, Anchorage, Ak 1988
International Herring Symposium, Anchorage, AK, 1990
World Fisheries Congress (Co-chair), Athens, Greece, 1992
International Symposium on Ocean Ranching, Arendal, Norway, 1993
International Forage Fish Symposium, Anchorage, AK 1996
Third World Fisheries Congress, Beijing, China 2000
Resiliency of Gadid Stocks to Fishing and Climate Change, 24th Lowell Wakefield Fisheries Symposium

Publications
Professional papers 40
Refereed journal papers 30

Recent Publications and Presentations

Botsford, Louis D, R. Brumbaugh, C. Grimes, J. B. Kellner, John Largier, Michael R. O'Farrell,S.Ralston, E. Soulanille and V. Wespestad. 2008. Connectivity, sustainability, and yield: bridging the gap between conventional fisheries management and marine protected areas Rev. Fish Biology and Fisheries

A. Phillips, V. Wespestad, R. Emmett, N. Lo, S. Ralston, R.Brodeur 2007. Northern Shift in the Location of Spawning and Recruitment of Pacific Hake (Merluccius productus) in the California Current. Calcofi Vol 48, 2007.

Keith M. Sakuma, Stephen Ralston, and Vidar G. Wespestad. 2006. Interannual and Spatial Variation in the Distribution of Young-of-the-year Rockfish (Sebastes spp.): expanding and coordinating a survey sampling frame. CalCOFI Rep., Vol. 47, 2006

Fleischer, Guy, Rebecca Thomas, Patrick Ressler, Ken Cooke, Stephen Pierce, John Holmes, Stephen de Blois, Lawrence Hufnagle, Thomas Helser and Vidar Wespestad.. 2006. Distribution and Abundance of Adult and Juvenile Pacific Hake (Merluccius productus) off the West Coast of North America in 2005. 14th Western Groundfish Conf, Newport, OR.. http://oregonstate.edu/heppell/groundfish/pdfs/wgcprogram.pdf

Ressler, Patrick, Guy Fleischer1 and Vidar Wespestad. 2006. Recent Acoustic and Video Observations Used in the Development of a Commercial Vessel-Based Survey Methodology for Widow Rockfish (Sebastes entomelas). 14th Western Groundfish Conf., Newport, OR. .http://oregonstate.edu/heppell/groundfish/pdfs/wgcprogram.pdf

Fleischer, G.W. , Ressler, P.H. , Thomas, R.E., de Blois, S.K. , Cooke, K.D. , Holmes, J.A., Hufnagle, L.C. , Helser, T.E. , and Wespestad, V.G. 2004. The distribution and abundance of adult and juvenile Pacific hake (Merluccius productus) off the west coast of North America in 2003. Proceedings West. Groundfish Conf., Victoria, B.C.

ICES Annual Science Meeting, Tallinn, Estonia October, 2003. "Rebuilding west coast groundfish, how do you know when you get there when you don't know where you are, or where you are going." Symposium on stock rebuilding.

Dorn, M. W. Karp, J. Ianelli, T. Quinn, and V. Wespestad. 2002 (Poster). Using fishing vessels to collect acoustic data for scientific purposes: preliminary results from midwater trawlers in the Eastern Bering Sea walleye pollock fishery. ICES International Acoustics Symposium, Montpelier, France, June 2002.

Thomas H. Jagielo

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Copalis Beach, Washington 98535
(360) 791-9089
Email: TomJagielo@msn.com

Employment

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

Fisheries Science Consultant

- Recent Projects include: Feasibility of using an aerial survey to estimate sardine abundance off the coast of Washington-Oregon.
- Pacific Islands Regional Office, NMFS: Evaluation of Annual Catch Limits and accountability measures for WPFMC.
- Environmental Defense Fund: Evaluation of Morro Bay groundfish – past, present and projected ABC's and OY's.

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

Senior Research Scientist

- Principal Investigator on projects including: *Groundfish Stock Assessment* – Developed work products used by Pacific Fishery Management Council for management of the Washington, Oregon, and California Continental Shelf marine fish resources; *Undersea Manned Submersible Research* – NURP; Developed 3-Beam quantitative laser survey tool with engineers from Harbor Branch Oceanographic Institution; *Groundfish Survey Design* - Tagging studies for estimation of 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

- Pacific Fishery Management Council Scientific and Statistical

Committees

Committee: Chairman (2002-2003); Vice Chairman (2000-2001); Member: (1992-2008).

- US/Canada Groundfish Technical Subcommittee: Chairman (2003, 1987-1988); Member 1986-2008.

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.

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

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

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

Jagielo, T.H., Hoffmann, A., Tagart, J. and M. Zimmermann 2003. Demersal Groundfish Densities in Trawlable and Untrawlable Habitats off Washington: Implications for Estimation of the Trawl Survey Habitat Bias. Fish. Bull. July, 2003(In Press).

Doyle A. Hanan

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Education:

PhD, Biology 1996
University of California
Los Angeles

MA, Marine Biology 1976
California State University
Long Beach

BA, Biology 1969
California Lutheran University
Thousand Oaks

Affiliations and panel experience:

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

Professional Experience:

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

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

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

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

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

USMCR 1969-1975
Sergeant E-6 Honorable discharge

Personal **publication history** includes 27 peer-reviewed papers and 60+ contract or administrative reports.

Dissertation: Dynamics of abundance and distribution in the Pacific harbor seal, *Phoca vitulina richardsi,* on the coast of California

Doyle A. Hanan

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

Ryan Anthony Howe

Ryanhowe9@yahoo.com · (989) 941-2241 · 1425 NE 7th Ave. Portland, OR 97232

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

Education:

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

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

Educational Experience:

Ichthyology	Environmental Fish Physiology
Population Analysis	Ecological Problem Solving
Human Dimensions	Wildlife Biometry
Wetland Ecosystem Mgt.	Aquatic Ecosystem Mgt.

Work Experience:

Fisheries Technician
Northwest Sardine Survey LLC: Bellingham, WA July 2008 – Present

- Assisted with structure and methodology for 2008 Northwest Sardine Survey
- Interaction with state and federal agencies and private and public stakeholders
- Collect biological information routinely of sardine from fishing vessels and fish processing plants (i.e. otolith, scale, sex/length/weight, maturity)
- Daily data entry using Microsoft Excel
- Enhancement and analysis of digital photos using Adobe Photoshop CS3 and Adobe Lightroom 2
- Experience with Simrad ES60 hydro acoustics echo sounder

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

- Collect biological information daily of Pacific Whiting along with 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
- Coordinate with NOAA research vessel David Starr Jordan during project
- Assist in Seabird CTD operations (conductivity, temperature, depth)
- Work with vessel operator and crew to accomplish project tasks

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

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

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

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

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

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

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

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

West Coast Sardine Survey

Application for Exempted Fishing Permit in 2009

Appendix III: Estimated Budget

Appendix III

Estimated EFP Project Budget - April 2009

CALIFORNIA (SOUTH): Revenues projected from the sale of research quota are based on the following formula, for the purpose of constructing this budget: $700 mt delivered Asia * 1,200 mt = $840,000. Estimated processing cost for 20 kilo polywrap = approx. $400/mt. Proceeds (exclusive of cost of fish) = approximately $300/mt. Net revenue projected = $360,000.

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

EXPENSES - CA:								
Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	Weather contingency	Total	Extension
Flying the transects	26	1	$250	$6,500	3	1.5	$29,250	
Processing transect images	26	4	$20	$2,080	3		$6,240	
Point Sets	# Point sets	#Sets/day	$/Day	# Days				
Point sets on schools	32	2	$4,000	16			$64,000	
	Hrs/Day		$/Hr	# Days				
Flying the point sets	8		$250	16			$32,000	$131,490
CA Scientific staff - hours							$63,750	
CA Scientific staff - expenses							$2,900	
CA Sample collection & coordination							$16,000	
								$82,650
Equipment								
FMC Camera System	$38,000.00						$38,000	
FMC Support	$3,000.00						$3,000	
ES 60 Sounders (2)	$30,000.00						$30,000	
Biosonics DT-X Mod.Transducer	$4,500.00						$4,500	
Biosonics Field Oversight	$4,900.00						$4,900	
Laptop (2)	$3,300.00						$3,300	
								$83,700
50:50 Share - PI Planning & Oversight								
Scientific staff - hours							$64,125	
Scientific staff - expenses							$7,050	
								$71,175
Accounting/bookkeeping							$5,000	
Office equipment, software & misc. expense							$1,800	
10% contingency on operations							$29,212	
								$36,012
PROJECT SUBTOTAL - CALIFORNIA								**$405,027**

Appendix III, Continued

Estimated EFP Project Budget - April 2009

PACIFIC NORTHWEST (NORTH): Revenues projected from the sale of research quota are based on the following formula, for the purpose of constructing this budget: $800 mt FOB container yard * 1,200 mt = $960,000. Estimated processing cost for _____
Proceeds (exclusive of cost of fish) = approximately _____/mt. Net revenue projected = _____.

EXPENSES - PNW:

Aerial Transects	# Transects	Hrs/transect	$/hr	Total/Set	Replicates	Weather contingency	Total	Extension
Flying the transects	26	1	$250	$6,500	3	1.5	$29,250	
Processing transect images	26	4	$20	$2,080	3		$6,240	
Point Sets	# Point sets	#Sets/day	$/Day	# Days				
Point sets on schools	32	1	$4,500	32			$144,000	
	Hrs/Day		$/Hr	# Days				
Flying the point sets	8		$250	16			$32,000	$211,490
PNW Scientific staff support - hours							$32,000	
PNW Scientific staff - expenses							$14,600	
								$46,600
Equipment								
FMC Camera System (2)	$76,000.00						$76,000	
ES 60 Sounders (2)	$45,000.00						$45,000	
Laptop	$1,100.00						$1,100	
								$122,100
- PI Planning & Oversight								
Scientific staff - hours							$64,125	
Scientific staff - expenses							$7,050	
								$71,175
Accounting/bookkeeping							$5,000	
Office equipment, software & misc. expense							$1,800	
10% contingency on operations							$33,607	
								$40,407
PROJECT SUBTOTAL - PACIFIC NORTHWEST								**$491,772**
TOTAL Estimated PROJECT COST (California plus Pacific Northwest)								**$896,798**

West Coast Sardine Survey

Application for Exempted Fishing Permit in 2009

Appendix IV: Exempted Fishing Permit Criteria

1. Applicant Contact Information

Name:	Vidar Wespestad
Affiliation:	Resource Analysts International
Address:	21231 8th Pl. W., Lynnwood, WA 98036
Email:	vidarw@verizon.net
Phone:	(206) 619-2449
Role:	Co-Principal Investigator

Name:	Tom Jagielo
Affiliation:	Tom Jagielo, Consulting
Address:	P.O. Box 93, Copalis Beach, WA 98535
Email:	TomJagielo@msn.com
Phone:	(360) 791-9089
Role:	Co-Principal Investigator

Name:	Diane Pleschner-Steele
Affiliation:	Executive Director, California Wetfish Producers Association
Address:	PO Box 1951, Buellton, CA 93427
Email:	dplesch@earthlink.net
Phone:	(805) 693-5430
Role:	Industry EFP Co-Lead: CWPA (Southern Area)

Name:	Jerry Thon
Affiliation:	Principal, Northwest Sardine Survey, LLC
Address:	12 Bellwether Way, Suite 209, Bellingham, WA 98225
Email:	jthon2@msn.com
Phone:	(360) 201-8449
Role:	Industry EFP Co-Lead: NWSS (Northern Area)

2. Purpose, Goals, And Arrangements For Disposition Of All Harvested Species Under The EFP

This proposal requests an EFP for 2009 to permit participating vessels to catch Pacific sardine under a PFMC recommended 2400 mt HG set-aside (pending NMFS rulemaking approval) for sardine research during the closed periods between seasonal allocations, in order to perform a synoptic survey of the sardine biomass off the U.S. West Coast. The intent is that (pending approval at a STAR panel review) this survey will provide an additional data source to be included in the Pacific sardine stock assessment to be used by PFMC to estimate sardine abundance. The PFMC has scheduled the STAR Panel review for May 4-8, 2009. If the survey methodology is approved, and the survey is conducted successfully during the summer of 2009, the results will be available for review at the Pacific sardine assessment STAR panel scheduled for September 21-25, 2009.

In recent years, the Pacific sardine stock assessment has indicated that stocks are in decline, which has resulted in significant harvest guideline reductions for 2008 and 2009. This conclusion, however, does not reflect the observations of fishermen and spotter pilots who instead report an apparent increase in biomass.

In the November, 2008 PFMC briefing book, it is noted that "… although the advisory bodies that participated in the October meetings all shared concerns with the level of uncertainty in the assessment of Pacific sardine, there was disagreement on the validity and application of the 2008 assessment update for use in managing the fishery in 2009…" and "…the majority of the CPSAS expressed substantial concerns with the assessment model and the data upon which it is based."

In 2008, members of the Pacific Northwest sardine industry, along with a panel of experts, began looking into an alternative methodology for the survey of Pacific sardine stock abundance. Subsequently, the NW Sardine Survey, LLC was formed, and, with the help of scientific advisors Vidar Wespestad and Tom Jagielo, performed a pilot survey of the sardine biomass off a section of the Oregon and Washington Coast to test the new methodology. This survey demonstrated the feasibility of using aerial survey data, in conjunction with fishing vessel observation data, to provide a scientifically rigorous alternative survey approach for incorporation into the Pacific sardine stock assessment. The pilot survey report (Wespestad et al 2008), was presented to the SSC and CPS at their October 7th meeting. As noted in the November, 2008 PFMC briefing book, [the pilot survey was] "… favorably received and shows promise of being further developed into a new index of abundance for future assessments."

At the March 2009 PFMC meeting the Council recommended that an additional 1,200 mt of Pacific sardine be added to the 1,200 mt approved in 2009 management measures, providing a total 2,400 mt for sardine research, and that the additional research set aside be deducted proportionately from the 2009 harvest allocation for summer and fall directed fishing. This recommendation is awaiting NMFS rulemaking for approval.

Because of the small size of the 2008 pilot survey, it was possible to conduct limited survey work during the open fishing periods. It will not be possible, however, to conduct the expanded survey proposed for 2009 solely in this fashion. Competition for resources (spotter pilots and fishing vessels) and the short open fishing periods (which were only 38 days and 7 days for the second and third fishing periods in 2008, respectively) preclude an effective survey effort of the scope proposed for 2009 during the open fishing periods alone.

By allowing for sardine harvest during the closed periods, this EFP will enable both Northern and Southern sardine industry participants (each operating under the central direction of the project PI's) to expand the geographical area of survey coverage in 2009. The EFP fishery will allow the survey to be conducted in an orderly fashion, on days best suited for the aerial survey method. It will also permit industry resources (spotter planes and fishing vessels) to be focused on survey objectives without the distraction of economically directed fishing activities. By focusing on survey activities alone, it will be possible for industry participants to achieve the scientific objectives (e.g. obtaining an

adequate survey sample size of point sets) as detailed in the Survey Design section of the main document.

In addition to the survey effort to be held during the EFP fishery, research point sets will also be conducted during open fishing periods, as is practicable, to further increase the survey sample size.

Under this EFP, all species caught within the limits authorized for the EFP will be retained. Participating vessels will deliver all species to participating processing/freezing facilities within the survey area. It is anticipated that these deliveries will occur into the ports of Astoria and Westport in the Northern area, and into the ports of Monterey and Moss Landing in the Southern area. Industry representatives Jerry Thon (Northern area) and Diane Pleschner-Steele (Southern area) will work with participating processing/freezing facilities on the sale of finished products. These sales will be used to aid in funding the survey, along with contributions from industry participants.

3. Justification For The Issuance Of The EFP

Under this EFP, the West Coast Sardine Survey (a consortium of Northern and Southern 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 expand upon the pilot scale work conducted in 2008, to develop an additional index of abundance for potential use in the Pacific sardine stock assessment. As noted above, the PFMC has indicated support for the further development of this work, and has voted to set-aside a research allocation totaling 2400 mt for the project. This recommendation is currently pending NMFS approval.

4. Broader Significance Of The EFP

The research to be conducted under this EFP will further test a new, scientifically rigorous method to survey the Pacific sardine resource, and will potentially 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 has been recommended by the Council and its sub-panels for review and consideration for use in developing an index of abundance for use in future stock assessments.

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 the current stock assessment model. 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 appears promising as 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. It is expected that fishing days will be further limited in 2009. These lost fishing days mean reduced employment for fishing vessel and processing plant crews, and reduced income for coastal communities.

5. Expected Total Duration Of The EFP

This EFP will be valid for one year, allowing for catching of Pacific sardine during the closed periods between seasonal allocations throughout the 2009 season.

6. Number Of Vessels Covered Under The EFP

Up to 8 participating vessels are identified on pages 14 and 15 of the main document. Routine operation of the survey in the Northern area will utilize the first two vessels listed, with the remaining two vessels standing by as back-up participants in the event of unexpected difficulties (e.g. engine failure, etc.). In the Southern area, the four vessels listed will be operating routinely; 2 boats w/ ES 60 capability and deeper nets, and two boats working with the hydroacoustic equipment.

Operating with multiple boats allows the survey to maximize effectiveness and reduce costs by targeting more than two sets per day (possible only if the plane has multiple boats to set). All participating boats will be working under the direction of the field project leaders, as supervised by the PIs; they will not have the opportunity to set at will.

7. Description And Quantity Of Species To Be Harvested Under The EFP

Under this EFP, participating vessels will target Pacific sardine exclusively. At the November 2008 meeting, the Council recommended that 1200mt of Pacific sardine be deducted from the 2009 Harvest Guideline prior to allocation and set aside for the dedicated sardine research to be conducted under this EFP. Subsequently, at the March, 2009 PFMC meeting, the Council modified this recommendation to increase the set aside to 2400 mt. This recommendation is awaiting NMFS rulemaking approval. If approved, the harvested quantity under this EFP will be limited to this Council recommended 2400 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, Loligo squid, and Northern anchovy, may be encountered in small numbers and will be retained if captured. Quantities of these other coastal pelagics species are expected to be nominal, and within the harvest guidelines for those species. No other species are expected to be encountered or harvested under this EFP.

8. Description Of Mechanism To Ensure That Harvest Limits For Targeted And Incidental Species Are Not Exceeded

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 Leader on a daily basis. Daily reporting is necessary to achieve the project objectives as specified in the Survey Design section of the main document. Individual point set catches will be kept in separate vessel holds and will be individually weighed at the dock upon landing. These individual point set catch weights will be tallied by the Scientific Field Leader to monitor the attainment of the project sample size goals which specify that point sets are to be collected in specific size categories (small and large) required under the survey design . This detailed accounting of daily catch will allow for a likewise detailed reporting to NMFS authorities and will ensure that the total sardine set aside amount of 2400 mt will not be exceeded. We propose that survey catch reporting to NMFS could begin on a weekly basis and would shift to a daily basis as the EFP approaches the set aside limit.

Any bycatch of other CPS species will be retained and a tally of the catch by species will be maintained by the Scientific Field Leader and reported to NMFS authorities on a weekly 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.

9. Description Of Data Collection And Analysis Methodology

This information is described in detail in the Survey Design section of the main document.

10. Description Of How Participating Vessels Will Be Chosen

Our priorities for selecting vessels to participate under this EFP include: 1) vessels which have installed the necessary electronic equipment or have the capacity to install this equipment, and 2) vessels having the ability to separate the point sets into different hatches.

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

With the narrow time window for sampling it is desirable to have a field of boats we can draw on. The main reason to have several boats in this period is to maximize the number of point sets we can bring in. These boats will only be used for point sets. Some vessels do not have recording sounders, but 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 provided and then reporting the vessels that will be operating at any given time to local enforcement will help to meet the EFP goals.

11. Approximate Times And Places Fishing Will Occur And Description Of Gear To Be Used For Each Participating Vessel

Under this EFP, participating vessels will have the opportunity to catch Pacific sardine under the Council recommended 2400 mt set-aside for dedicated sardine research (if approved by NMFS) during the closed periods between seasonal allocations.

Fishing will take place along the entire U.S. West Coast.

Participating vessels will use purse seine gear.

All fishing by participating vessels will be done in compliance with state and federal regulations, with the exception of the exemptions granted by this EFP.

Appendix V.
Response to comments following review of the survey design at the May, 2009 STAR Panel

Stage 1: Estimation of sardine school surface area

Species misidentification
Prior to the onset of production scale photo analysis, we will investigate the potential for school misidentification by photo analysis personnel. Images will be collected from areas where sardine are intermixed with other species (e.g. anchovy). Spotter pilots experienced with the problem of discriminating between species in aerial surveys of schooling fishes will aid in the preparation of a reference set of photographs with "known" species images. Photo analysis personnel will be trained to discriminate between species using the reference set of images. A set of test images will be compiled to evaluate within and between reader error in the parameters measured by the photo analysis personnel. The test images will be used in a double-blind experiment to measure variability in the entire process of image analysis, including: image enhancement, species identification, school enumeration, and area measurement. The development of a reference collection of photographs will be made carefully and validated, with the consideration that they will be used by photo analysis personnel for training purposes. Additional photos may be added to the reference collection in future years.

In addition to the above procedures, we will review the available data from other surveys to get a sense of species other than sardine that we may expect to see in our aerial survey. Data sources include: 1) trawl survey data (Emmett et al) and historical spotter data (Squire et al).

We also plan to evaluate the effect of altitude on species identification in the aerial survey. An experiment will be conducted with two airplanes to evaluate the altitude effect. One pilot will fly along a pre-designated test transect at the nominal survey altitude of 8,000 ft. and will keep a log of schools observed, by species. The second airplane will fly at a lower altitude (e.g. 500 ft) with an observer on board for detailed note taking. There will be no communication between pilots regarding schools observed during the transect, in order to keep the two sets of observations independent. Photographs taken from the two airplanes will be analyzed and schools will be identified and compared between the two sets of images on a school by school basis. Pilots will be permitted to use their logbooks and notes made during the transect to assist in analyzing the photographs collected for the comparison. The rate of between-pilot agreement in school identification will be determined from the comparison of the two sets of photographs. To eliminate the pilot effect from the test, the pilots will switch altitude positions and will repeat the procedure on subsequent transects.

School detection
We recognize that an unknown proportion of schools in any given area photographed will be too deep to detect via the proposed aerial survey method, and thus we acknowledge that the method will tend to underestimate total school surface area. Data collected from Stage 2 of the survey will include measurements of school height and vertical distribution in the water column. These data are a sample of schools visible from the aerial survey, and will be photographed at the nominal survey altitude of 8,000 ft. During the fishery, two vessels in each region (north and south) will be operating with ES-60 sounders logging data onto hard disks in continuous-

operation mode. These data will be processed to obtain a sample distribution of school height measurements (location of the top and bottom of the school in the water column). We expect that some of these schools will be distributed below the surface such that they would be too deep for aerial detection. Comparison of these data with the range of school height measurements from the 64 schools captured in Stage 2 point set sampling will give us a qualitative look at the rate of encountering schools not likely to be detected by the aerial survey method.

Weather conditions (e.g. marginal cloud cover, haze, elevated sea state) can conspire to create situations where schools would be likely to go undetected with the aerial survey method. We will determine a range of acceptable conditions for survey commencement (and termination). The survey pilots will judge whether or not conditions are acceptable for conducting surveys on a day to day basis. A detailed log will be kept to document when and why transects are terminated early due to prevailing weather conditions. From the Pilot Study we found that conditions such as glare and scattered cloud shadows over the ocean surface can be handled operationally by increasing the overlap rate of the photographic coverage. We have found that an image overlap rate of 60% is effective for dealing with this issue under most circumstances.

School area determination

Calibration of aerial images to measure the size of known objects was conducted during the pilot study in 2008 and will be continued in the 2009 survey year. We will extend the calibration experiments to evaluate the level of distortion on the periphery of the digital images. It is possible to address this issue by either a theoretical or an empirical approach. For example, a theoretical approach could involve collecting measurements from photographs to determine if objects on the image edge are on average smaller than objects found in the image center, and then deriving a theoretical relationship from this information. Alternately, an empirical approach could involve comparing real-world measurements of objects photographed in the image periphery with the sizes of the same objects as determined from the software analysis procedure.

Stage 2: Estimation of sardine biomass per unit surface area

Comparability to images in Stage 1

To ensure that the surface area measurements collected in Stage 2 are comparable to those collected in Stage 1 of the survey, we will collect the point set images at the same nominal altitude of the survey (i.e. 8,000 ft). Measurements of school surface area for point sets will be taken prior to purse seine vessel approach. Photographs will be taken throughout the point set process to examine potential school responses to the fishing vessel.

Target selection by pilot

Pilots will be given a daily schedule of school sizes to be targeted for capture. The pilots will maintain a logbook which will contain a record of every school identified for point set capture. To ensure Stage 2 sampling frame comparability to the set of images collected in Stage 1 of the survey, pilots will identify point set targets from the nominal survey altitude of 8,000 ft. In the event that the pilot identifies a school for point set capture at 8,000 ft, and the school is subsequently found to be a species other than sardine (e.g. when the pilot descends to a lower altitude for a better look, and after the vessel has approached the school for capture and is

capable of making on the water observations and jigging), this information will be duly recorded and used to estimate the sardine mis-identification rate of pilots in Stage 2 sampling.

Non-linear biomass to area relationship
A simple ratio estimator of biomass is not desirable if a pronounced non-linear relationship is observed in the biomass to area relationship. During the data analysis phase of the survey, we will evaluate the alternative of integrating biomass over the size range of schools observed. It will be important to ensure sufficient contrast in the sizes of schools sampled for this purpose. During the data analysis phase, we will look for non-linearity in the surface are to biomass relationship, and will subsequently make the determination whether a standard regression vs. an errors-in- variables approach is more appropriate for survey data analysis.

Regional differences
We anticipate regional differences will be observed in the parameters associated with both Stage 1 and Stage 2 sampling; however, we have no a priori information for effective stratification beyond a simple north-south treatment at this time. Thus, in this first survey year, we are distributing the sampling effort such that 1) an equal amount of area will be surveyed in the north and the south, and 2) an equal number of point sets will be collected in the north and the south. With the information we seek to collect in 2009, we may be able to reduce the variance on our parameter estimates by alternative stratification schemes going forward.

This survey design is limited to the area extending from Cape Flattery to Monterey Bay and nominally to 35 miles offshore. Sardine distribution is known to extend into Canada to the north, and into Mexico to the south, and may extend further offshore than 35 miles in some areas. Thus, we recognize that the survey will underestimate sardine abundance for this reason. We do not anticipate sampling north or south of the area specified; however, we will examine the east-west distribution by systematically extending a set of transect beyond 35 miles to determine the offshore distribution of sardine and the utility of the 35 mile cut-off for the design of future surveys.

Behavioral patterns
We recognize that sardine behavioral patterns will influence the variability of measurements that we will record during the aerial survey. For example, feeding, spawning, and transiting behaviors can be expected to result in different levels of aggregation/dispersion and thus will increase the variability in the surface area to biomass relationship. We expect that our ability to classify schools by behavioral category will improve as we obtain observations over a period of years and under a variety of conditions. The parameters we will be examining in our 2009 survey that have potential for beginning the development of a school classification scheme include: 1) school height (from ES-60 data) and 2) school shape (i.e. perimeter to area; circularity).

Abundance Estimation

Edge effects – procedure for handling schools not completely within the photograph

Edge effects are not a problem on the top and bottom of the images because image overlap provides for multiple observations of schools in the direction of aircraft travel; however, schools will encountered from time to time on the side edges of the images will cut off (i.e. not photographed in their entirety. This is a problem because of the potential for non-linearity in the surface area to biomass relationship. This situation is not uncommon in quadrat based sampling and methods for dealing with it are available in the survey design literature. We will review the literature and will establish an appropriate procedure for data reduction and analysis to deal with this issue. Two methods were suggested by the STAR panel. One method would involve drawing lines some distance from the edge (e.g. 1 inch) and re-defining the area-swept using the new (reduced) width. This approach allows for empirical measurements of schools straddling the edges. Another method would involve drawing a line down the middle of the image and studying the edge effect by examining schools that are split by the line.

Calculation of total biomass
As noted above, we will evaluate non-linearity in the surface area to biomass relationship. If deemed appropriate, we will integrate biomass over the range of observed school sizes.

Other

Comparison of pilot estimate vs. measured point set tonnage
In the survey logbook to be maintained by the pilots, the estimate of school tonnage prior to each point set will be recorded. This information will be summarized and compared to actual landed point set tonnage.

Quality Assurance

To insure accurate data and prevent operation errors the scientific technical team has devised the following procedures:

1. A vessel contact that sets forth the duties and responsibilities of the vessel and the scientific party. This insures that the vessel is cognizant of the operational plans and interaction with the scientific party and the pilot on data collection and processing. The operational contract will also be the base document for attaching modifications and daily operational instructions. An example of this document is attached.
2. A similar document is being assembled for pilots for operational instructions with equipment checklist and camera operational instructions.
3. A field reference for biological data collection and data handling and processing.

The P.I.s will review project data on a weekly basis to insure that data is collected consistently and in conformity with sampling protocols.

Attachment – Example contract for vessels laying forth operational requirements.

TIME CHARTER AGREEMENT AND VESSEL OPERATING AGREEMENT

This TIME CHARTER AGREEMENT is entered into by and between the vessel operator and NW Sardine Survey LLC with reference to the following facts:

A. Owner owns the fishing vessel _____, Official No. _____ (the "Vessel"). Charterer wishes to hire a fishing vessel to conduct certain research operations in the US EEZ off Oregon and Washington in fulfillment of the Experimental Fishing Permit (EFP) to be issued by National Marine Fisheries Service of the U.S. Department of Commerce ("NMFS") to Charterer in order to assess the abundance of sardine in the region of survey.

B. Charterer distributed that certain Request For Proposals (the "RFP") soliciting bids from fishing vessel owners interested in providing the vessel and services necessary to satisfy Charterer's obligations under the terms of the EFP and this agreement. Owner has reviewed and responded to the RFP, and Charterer is willing to hire Owner and the Vessel to fulfill Charterer's obligations under the EFP, on the following terms and conditions.

Now, therefore, the parties agree as follows:

1. Nature of Charter. On the terms and conditions set forth in this Charter, Owner agrees to let and Charterer agrees to hire the Vessel on a time charter basis. Nothing in this agreement shall be construed as a bareboat charter or demise of the Vessel to the Charterer. Notwithstanding any provision to the contrary herein, as between Owner and Charterer, Owner shall at all times remain in possession, command and control of the Vessel, and shall be solely responsible for all costs related to crew wages and injury claims. Owner shall supply, operate, maintain, repair and insure the Vessel and its equipment, gear and appurtenances, other than as specifically set forth herein. Owner shall pay all costs associated with Vessel operations during the term of this Charter, other than as specifically set forth herein.

2. Vessel Condition and Operations.

a. The Survey Plan is attached hereto as Exhibit 1, and are hereby incorporated into this agreement by reference.

b. Owner warrants that the Vessel and its equipment shall throughout the term of this Charter meet or exceed the requirements set forth in the SURVEY PLAN and EFP. Owner shall provide Coast Guard approved Arctic-type survival suits for the survey crew. Owner shall provide workspace, power for computers.

c. Throughout the term of this Charter, Owner shall staff the Vessel with a crew of not less than 3 individuals, including a Captain with a minimum of three years of seine fishing experience as a master of a comparably sized vessel in Pacific Ocean, and at least three years total experience as a fishing vessel master; a lead fisherman, with experience in seine fishing; a fisherman seine fishing experience.

d. Owner shall operate the Vessel and employ its crew to safely perform Charterer's obligations under the EFP in accordance with the Survey Plan, subject to the directions of the Scientist Staff (Tom Jagiello, Ryan Howe, and Vidar Wespestad) in matters other than navigation and the safety of the Vessel and its crew. Owner acknowledges that seine sets and associated survey crew activity are expected to take up to approximately 12 hours per day, and that the Vessel will frequently be required to travel from survey sites during periods outside of the survey crew's normal 12 hour working day. At the commencement of this Charter, the Vessel shall be ready and waiting at Astoria, Oregon or nearby ports such as Newport, Oregon, and Ilwaco, or Westport, Washington.

(1). During Test Sets the vessel will set on schools as directed by the scientific field party chief. The set determination will be decided between the pilot and the scientist in consultation with the vessel captain. Once a set has been determined the vessel will follow the direction of the pilot during a set. The scientist will direct on deck sampling and stowage of the catch. Prior to starting operations for the day the vessel will be provided with a schedule of hauls that include general size of sets. Set design will be so that a vessel can catch a maximum amount for each trip, but in a manner that insures scientific integrity of each individual haul and avoids mixing samples. All sets will be

segregated to allow accurate weight measurement at a shore plant; unless, the vessel has bin-boards or some other system to physically isolate catches from each set.

(2). Vessel captains will log and provide the scientist or the setting pilot, if there is no scientist on board, the haul information relating to school depth, school height, vessel estimate of school size. The fish will then be stored in a separate hole for total tonnage and biological sampling at a designated processing plant.

(3). Vessels chartered to do ES 60 surveys will be required to run track lines to measure schools. This work may be done in conjunction with aerial test sets, or may require running transects from the coast to offshore and could require remaining at sea for 2 to 3 days. The transects and activities will be developed into specific survey instructions with the Captain in advance of specific transect. In the absence of a scientist on board the crew will be directed to set on schools determined by the pilot for spot sets or species identification.

(4) In all instances all charter vessels will sign and retain a copy of this agreement and all specific daily survey instructions that direct survey operations and sampling protocol. Failure to follow protocols is agreed by both parties to be sufficient ground for termination of this charter agreement.

3. Charter Term. The term of this Charter shall commence as of July 1, 2009 at 0700 hours and shall terminate as of the earlier of the (i) termination by Owner or Charterer in accordance with Section 3.a or 3.b, below, or (ii) September 1, 2009

a. Charterer may terminate this Charter by written notice to Owner upon the occurrence of any one or more of the following:

(1) non-issuance of the EFP for any reason;

(2) the Vessel suffering loss, damage, breakdown, or arrest that the Charterer reasonably concludes will prevent the Vessel from fulfilling the terms of this Charter or the EFP and the Cruise Plan;

(3) failure of Owner to crew, equip, operate, or maintain the Vessel in accordance with the terms of this Charter, the EFP, or the directions of the Scientists identified above;

(4) a breach by Owner of any material term or condition of this Charter or of any of Owner's covenants or warranties given hereunder not cured within ten (10) days of Owner receiving notice of breach from Charterer; or

(5) the filing of a petition in bankruptcy by or against Owner, entry of an order adjudging Owner bankrupt, Owner making a general assignment for the benefit of creditors, appointment of a receiver for Owner of any kind, or filing by Owner of a petition for reorganization under any applicable bankruptcy law.

b. Owner may terminate this Charter by written notice to Charterer upon the occurrence of any one or more of the following:

(1) the Vessel suffering loss, damage breakdown or arrest that Owner reasonably concludes will prevent the Vessel from fulfilling the terms of this Charter or the EFP and survey plan; or

(2) a breach by Charterer of any material term or condition of this Charter not cured within ten (10) days of Charterer receiving notice of breach from Owner.

4. Charter Hire. In consideration for the services to be provided and costs to be borne by the Owner hereunder, The Owner will be paid a daily rate the duration of this contract for the charter based on a term of 12 hour fishing days. Charter may prorate payment to vessels in the event that a full fishing day cannot be achieved due to vessel breakdown. The Hire shall be

paid by the Charterer NW Sardine Survey LLC at a rate negotiated between the owner and the Charterer. Payment will be made within fifteen (15) days of Owner delivering the related invoice to the Charterer.

a. Suspension of Hire. If during the term of this Charter the Vessel for any reason becomes temporarily unable to conduct the operations required under the EFP and the Survey Plan, and Charterer then determines there is a reasonable prospect that the Vessel will be able to resume operations in a period of time acceptable to them, Charterer may, in lieu of terminating this Charter, pay no Hire for the period the Vessel ceases operations.

5. Fuel and Lubrication Oil. Owner agrees to pay the costs of fuel and lubricating oil consumed by the Vessel during the term of this Charter.

6. Gear. NW Sardine Survey LLC has agreed to provide the following gear: all fish sampling gear. Owner shall provide the Vessel equipped with seines, seine skiff, and associated gear needed to set and retrieve a sardine seine, all in good working order, in accordance with the Survey Plan and the EFP.

7. Survey Crew Food. Owner agrees to provide meals on a regular basis.

8. Insurance. Owner shall throughout the full term of this Charter maintain at its own expense insurance protecting Charterer against all claims or liabilities arising out of or related to chartering, owning, operating, or maintaining the Vessel, or conducting any of the activities contemplated under this Charter and the EFP, including but not limited to protection and indemnity insurance, including pollution liability coverage, in an amount not less than Five Million Dollars ($5,000,000.00). Charterer shall be named as additional insured on such policies for the term of the Charter. Owner shall specifically arrange to have all survey personnel aboard the Vessel covered by such insurances. All deductible amounts shall be paid by Owner. A certificate of insurance evidencing the coverages referenced above shall be delivered to Charterer not less than three (3) days before the effective date of this Charter. All insurance maintained under this Section shall require at least thirty (30) days prior written notice to Charterer to be cancelled or modified.

9. Indemnification. Owner shall indemnify, defend and hold NMFS, Charterer and its members, directors, officers, employees, agents and contractors harmless against all claims, demands, actions, damages, liabilities and expenses of whatever nature (including without limitation attorneys' fees and related costs) arising out of or related to (i) any breach by Owner of any provision of this Charter; (ii) any lien of whatever nature arising against the Vessel while this Charter remains in effect; (iii) injuries to or deaths of crew members, including all members of the survey crew; (iv) loss of or damage to any survey gear, equipment or supplies, or personal property of the crew, including the survey crew; and (v) operation of the Vessel while this Charter remains in effect.

10. Governing Law. This Charter shall be interpreted and enforced in accordance with the maritime law of the United States.

11. Entire Agreement. This Charter is the entire agreement among the parties hereto as to the matters addressed herein and supersedes all prior negotiations, representations, or agreements, whether written or oral. In the case of a conflict between this Charter and the EFP, or the SURVEY PLAN, this Charter shall control. This Charter may be amended or modified only by written agreement between the parties.

12. Notices. Any notice to be given pursuant to this Agreement by any party to the other shall be effected either by personal delivery, by mail or by telefacsimile transmission ("fax"). Notices given by personal delivery shall be deemed given when delivered. Notices given by fax shall be deemed delivered when transmitted with receipt confirmation. Notices delivered by mail shall be deemed delivered three (3) business days after being sent prepaid first class mail. Notices shall be delivered as follows:

Owner:

Owner

Address
Address
Phone

Charterer:

Northwest Sardine Survey LLC

13. Effect of Partial Invalidity. A determination that any term or provision of this Charter is invalid or unenforceable shall not affect the validity or enforceability of the remainder of this Charter.

14. Counterparts. This Charter may be executed in counterparts, which, when taken together, shall have the same validity as a fully executed original.

15. Arbitration.

a. Any controversy, claim, or dispute arising out of or relating to this Charter or the breach thereof shall be resolved by arbitration in King County, Washington pursuant to R.C.W. 7.04 et seq., or its successor statute, and judgment upon the award rendered by the arbitrator may be entered in any court adjudication of all matters submitted to arbitration. The arbitrator shall have broad authority to fashion an equitable remedy, including the authority to award specific performance.

b. The parties shall select a single arbitrator within ten (10) days of the date a written demand for arbitration is received by either party from the other. In the event the parties fail to select an arbitrator within said 10-day period, either party may make immediate application to the King County Superior Court for the appointment of an arbitrator. The parties agree to be bound by the Court's appointment of an arbitrator.

c. It is the intent of the parties by this arbitration provision to provide for a speedy and efficient means of resolving disputes.

OWNER:	CHARTERER:
Name.	Northwest Sardine Survey, LLC
By _____	By_____
Its date	Its date