



## CALIFORNIA WETFISH PRODUCERS ASSOCIATION

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Mr. Marc Gorelnik, Chair, and  
Members of the Pacific Fishery Management Council  
7700 NE Ambassador Place #100  
Portland OR 97220-1384

March 15, 2022

RE: Agenda Item E.2      PROPOSAL FOR RENEWAL OF EXEMPTED FISHERY PERMIT (EFP)  
TO ALLOW TAKE OF PACIFIC SARDINE (for POINT SETS) IN 2022-23 NEARSHORE RESEARCH PROGRAM

Dear Mr. Gorelnik and Council members,

On behalf of CWPA and California's wetfish industry, we are submitting for 2022-23 a renewal request for our Exempted Fishery Permit (EFP) that NOAA Fisheries approved in April 2021. The justification remains as stated last year: *"The goal of the Coastal Pelagic Species Nearshore Cooperative Survey (CPS-NCS) research is to continue to develop sampling methodology for estimating CPS biomass in shallow waters that are not accessible to NOAA ships."* Our objective in 2018 - 2021 was to collect sufficient data via point sets to qualify nearshore aerial survey estimates for use in sardine stock assessments. This EFP proposes to build on the work conducted in 2019-2021 to strengthen the aerial observer bias correction factor and continue work in both Monterey and Southern California.

This cover letter prefaces our 2022 EFP request: in summary, our objective in 2022 is again to build on the scientific matrix of point sets established in S.CA., with the intent to develop a comparable matrix of point sets in Monterey. However, we still need point sets of larger sardine schools (Table 1) in S.CA., in addition to work in Monterey. Extended sampling will enable us to provide a bias correction factor for the Monterey-Central Coast area and S.CA, thus qualifying aerial surveys conducted by the California Department of Fish and Wildlife (CDFW) in both areas for use as a nearshore minimum biomass estimate or correction factor.

Survey protocol calls for point set capture of CPS schools of various sizes to validate aerial estimates. Appended to this letter are figures highlighting the valid point sets captured in S.CA. since 2010 through spring 2020, as well as additional valid point sets in Monterey during 2019-21. As of February 28, 2022, we had not yet used the 300 mt allocation provided in 2021. We attempted point sets in Monterey in October 2021, but weather conditions and sardine behavior foiled our efforts during the only week-long time period that the spotter pilot was available. Although the pilot observed sardines in the Monterey - Half Moon Bay area, the schools were located on rocky bottom inaccessible for purse seine capture. If the spotter pilot is available this spring, we may try for large schools in southern CA before our 2021 point set EFP expires on June 30.

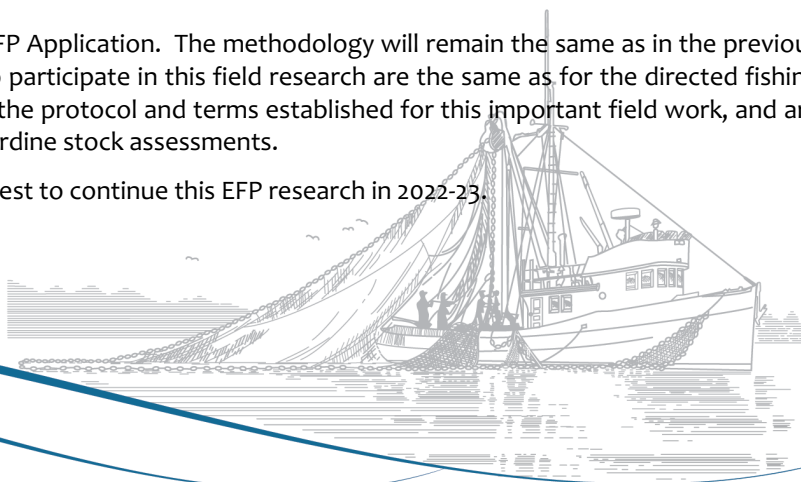
Our EFP allocation request for point sets in 2022-23 **is not to exceed 300 mt sardine**, based on estimated tonnage identified in the scientific matrix to account for larger schools.

I am attaching updated tables along with our 2022-23 EFP Application. The methodology will remain the same as in the previous EFPs. The vessels and processors we have identified to participate in this field research are the same as for the directed fishing EFP. All have prior experience in collecting data under the protocol and terms established for this important field work, and are committed to help improve the science underpinning sardine stock assessments.

Thank you very much for your consideration of our request to continue this EFP research in 2022-23.

Best regards,

Executive Director



**Table 1.** CPS schools by size categories and number of purse seine point sets targeted and realized during 2010 and the 2018-20 NCS survey in southern California (top), and 2019-21 in Monterey (bottom). All sets met the criteria of > 80% of school wrapped. The goal in 2022-23 is to attempt to capture large (i.e. 80-100 mt) pure sardine schools in Southern California, sardine schools of all sizes in Monterey and northern California, as well as mixed CPS schools containing sardine.

Pacific Sardine Point Sets - Southern California					
School Size (mt)	2010	2018	2019	2020	Total
0-10	4	12	0	0	16
10-20	6	4	1	0	11
20-30	3	0	3	0	6
30-40	2	0	0	1	3
40-50	6	0	1	0	7
50-60	0	0	2	0	2
60-70	2	0	0	0	2
70-80	1	0	1	0	2
80-90	2	0	0	0	2
90-100	0	0	0	0	0
100+	0	0	0	0	0
<b>Total</b>	26	16	8	1	51

Pacific Sardine Point Sets - Monterey			
School Size (mt)	2019	2020	Total
0-10	1	1	2
10-20	2	2	4
20-30	1	2	3
30-40	0	0	0
40-50	0	2	2
50-60	1	2	3
60-70	0	0	0
70-80	0	0	0
80-90	0	1	1
90-100	0	0	0
100+	0	0	0
<b>Total</b>	5	10	15

Northern Anchovy Point Sets - S CA	
School Size (mt)	2020
0-10	0
10-20	2
20-30	0
30-40	0
40-50	0
50-60	0
60-70	0
70-80	0
80-90	0
90-100	0
100+	0
<b>Total</b>	<b>2</b>

Northern Anchovy Point Sets - Monterey				
School Size (mt)	2019	2020	2021	Total
0-10	0	0	1	1
10-20	1	0	0	1
20-30	0	0	0	0
30-40	0	0	0	0
40-50	0	0	0	0
50-60	0	0	0	0
60-70	2	1	0	3
70-80	0	0	0	0
80-90	0	0	0	0
90-100	0	0	0	0
100+	0	0	0	0
<b>Total</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>5</b>

## [MODIFIED EFP APPLICATION SUBMITTED FOR 2021 RESEARCH]

- 4a.** Date: March 15, 2022
- 4b.** Applicant: California Wetfish Producers Association (CWPA)  
Diane Pleschner-Steele, Executive Director  
PO Box 1951, Buellton, CA 93427  
(805) 693-5430

On behalf of CWPA and California's wetfish industry, we would appreciate the Council's consideration of and support for the following EFP request:

**Background:** At its June 2017 meeting, the Pacific Fishery Management Council conditionally approved the California Department of Fish and Wildlife (CDFW) / CWPA aerial survey methodology for use in future CPS stock assessments, consistent with recommendations contained in the **Southern California Coastal Pelagic Species Aerial Survey Methodology Review** report (PFMC 2017). The survey data has since been used in the 2020 and draft 2022 Pacific sardine stock assessment models to inform a nearshore biomass correction factor for acoustic-trawl survey data catchability (Q) (Kuriyama et al. 2020).

This research project intends to sample CPS schools using aerial spotter pilots with plane to fly aerial surveys near shore, coupled with qualified purse seine vessels chartered to capture a subset of the schools identified while the pilot photographs the "point sets." The purpose is to address issues identified in the aerial survey methodology review. The 2022 survey is planned for a period from July 1, 2022 through June 30, 2023 (providing flexibility to account for weather delays, especially in Monterey).

- 4c.** The proposed survey plan provides the following explanation of purpose and goals:

#### **Overview and Justification**

*The goal of the Coastal Pelagic Species Nearshore Cooperative Survey (CPS-NCS) research in 2022-23 is to continue developing sampling methodology for estimating CPS biomass in shallow waters that are not accessible to NOAA ships. Current biomass estimated for anchovy and sardine stocks is believed to be negatively biased, in part because substantial fractions of these stocks reside in shallow nearshore waters (< 40m depth) that cannot be surveyed by NOAA vessels. The California Department of Fish and Wildlife (CDFW) and the California Wetfish Producers Association (CWPA) have conducted aerial surveys in nearshore waters of the Southern California Bight (SCB) since 2012, and in the Monterey-San Francisco area since summer 2017. It has been difficult to quantify the uncertainty of estimated biomass, due to lack of replication among other issues. The CPS-NCS survey has collected data since summer 2018 on transect biomass variability, which have been used to revise the design for surveys beginning in 2020, and to achieve the goals of both adequate replication and spatial coverage of coastal water areas. Further, CPS-NCS point sets have also been conducted since summer 2018, and observer estimate and catch data have been used to develop initial calibration curves to validate observer species identifications and biomass estimates (Dorval and Lynn 2019, PFMC 2020). However, there is a need to collect additional data to validate biomass and school composition by region and by species estimated by spotter pilots during the CDFW-CWPA aerial surveys so that bias correction factor can be applied across all regions and species. We aim to further improve methodology for quantifying the level of bias and uncertainty of aerial surveys. Knowledge gained from the CPS-NCS survey could be applied to conduct broader sampling surveys, to account for bias and variance estimation when assessing CPS stocks in the future.*

This research plan seeks to address recommendations identified by the Aerial Survey Methods Review Panel. For example (excerpted from the methodology review report):

- "Point set data are limited and hard to collect ..., but are a core source of information to validate the survey estimate of biomass. Noting the difficulty for collecting point sets, the Panel nevertheless recommends that

*additional point set data be collected (or alternative approaches for ground-truthing survey estimates be applied, such as using the volume of schools combined with estimates of packing density)."*

Please note that since 2017, aerial surveys have been conducted in both the SCB and Monterey areas. The intent of this EFP is to conduct the additional sampling needed to produce a *"minimum estimate of biomass by basing the estimate of biomass only on areas surveyed"* (PFMC 2017). Continuing point sets in Monterey and Southern CA will provide additional data from captured sardine schools (pure or mixed with other CPS) to further develop an independent calibration curve to validate observer species identification and biomass estimates. This will improve future stock assessments by providing a minimum estimate of abundance in the nearshore area in both the Southern California and the Monterey–Central Coast areas.

For aerial point sets, two spotter pilots flying in the same plane will make independent estimates of school size and species composition and record their individual tonnage estimates and species identification on separate log sheets (Dorval and Lynn 2019). For point sets, the pilot will photograph vessels approaching and wrapping the schools. Fishermen will also record on log sheets during the capture process the school depth, shape and density depicted on their sonar and fathometer, along with any other observations. Participating processors will record species composition and weight for each set. Examples of photos and logs are appended to this EFP application (Appendices 1-3).

Attempts will be made to capture entire schools of CPS, to the degree possible, thus adding to the 80+% school capture point set archive currently used in the CDFW / CWPA nearshore aerial surveys. All schools captured will be stored in separate hatches onboard, and will be weighed individually at the dock and sampled for species composition by the participating processors. In addition, biologists will pull samples from the beginning, middle and end of each set and preserve fish on ice for later processing to obtain biological characteristics of the sampled fish.

All fish captured, including sardines requested in this EFP application, will be processed and sold by participating processors, and fishermen will be paid for their catches at the usual rates. Aside from the sale of fish captured in this project, processors are not compensated for the extra labor they will incur in weighing and sampling each school individually, and documenting species composition by school, versus the normal procedure of offloading the entire catch and documenting by load. Point sets must be weighed and sampled by individual set for the point set validation data to be useful. The revenue derived from the sale of the fish captured, including EFP fish, will help offset the extra labor, time and other costs that both fishermen and markets will accrue when participating in this research project. Further, sale of the EFP fish provides a beneficial use of the resource and avoids waste.

**4d. Rationale for issuing the EFP:** In light of the continued closure of the directed sardine fishery in 2022, this EFP will allow fishermen to retain the entirety of any school they are directed to catch without question, including pure sardines or mixed schools exceeding the allowed incidental catch rate. This EFP will facilitate fulfilling the goals and objectives of this research and will avoid wasting a valuable resource. Absent an EFP, fishermen would be limited in targeting observed schools, or risk a violation if the captured schools contained sardine above incidental catch limits.

We suggest that, to facilitate and simplify accounting, the Council follow the protocol established for other EFPs and designate the 300 mt sardine requested in this EFP as a research set aside off the top of the ACL, separate from the incidental catch allowance. Any amount unused would simply be returned at the conclusion of the research period.

The requested amount of 300 mt sardine is based on estimated tonnage expected from collection of a range of school sizes comprising sardine and other CPS. The average of sardine landed from point sets for the previous three complete EFP seasons has been approximately 300 mt per season. This request for 300 mt recognizes the current stock status of the northern subpopulation of Pacific Sardine, and the need for allocation of available tonnage to other fishery sectors.

**4e. Significance of this EFP:** This research is essential to develop useful and cost-effective survey methods to quantify the biomass of CPS in the nearshore area where large NOAA ships cannot survey. The data collected from this study have already been used in the 2020 and draft 2022 Pacific sardine stock assessment models to adjust acoustic-trawl survey catchability (Q) (Kuriyama et al. 2020). The survey methods developed in this project can be expanded to other nearshore areas coast-wide, which would improve the accuracy of future stock assessments. In addition, the collaboration between industry, the scientific community, and federal and state agencies mandated to assess and manage fisheries is a win-win for all, facilitating increased understanding of the uncertainties in quantifying highly variable CPS resources, utilizing fishermen's knowledge of the ocean and providing a practical, efficient method for measuring fishery resources.

**4f. Continuation of this EFP:** The longevity of this EFP is contingent on a number of factors, chief among them sufficient funding to continue and possibly expand the survey, and the status of the sardine fishery in the future. We plan to replicate the nearshore survey research for at least two more years beyond summer 2022, if needed, to obtain an optimal sample size for the survey, improve survey coverage of school occurrence, and meet the recommendations of review panels.

**4g. Participating vessels:**

CWPA has identified 6 vessels that meet the criteria for this research project:

VESSEL NAME	SKIPPER	OWNER	USCG /REG	CPS PERMIT
<b>Southern CA</b>				
*Triton	Pete Ciaramitaro	Triton Fishing Inc.	CF7218UH	14
*Provider	Jamie Ashley	Provider LLC	D572344	1
*Eileen	Nick Jurlin / Corbin Hanson	South Sound Fisheries Inc.	D252749	38
<b>Monterey</b>				
*King Philip	Anthony Russo	Sea Wave Corp	D1061827	9
*Trionfo	Aniello Guglielmo	Neil Guglielmo	D625449	45
* Sea Wave	Andy Russo	Sea Wave Corp.	D951443	10

\* Note: For continuity and experience, the same vessels are listed on the directed fishing EFP renewal request.

**Participating processors:**

Three wetfish processors have been identified – 1 in S.CA. and 2 in Monterey

Tri Marine Fish Company, 220 Cannery Street, San Pedro, CA 90731  
(offloads FV Eileen, FV Provider, FV Triton; Contact: Vince Torre)

Monterey Fish Company, 960 South Sanborn Road, Salinas, CA 93901  
(offloads FV King Philip, FV Sea Wave; Contact Anthony Tringali or Ken Towsley)  
Southern Cal Seafood, Pillar Point Harbor, Half Moon Bay or Monterey; Contact Pete Guglielmo

**4h. Description of species harvested:** Under this project, purse seine vessels will be directed to capture schools of CPS observed by aerial spotter pilot. The schools could contain sardine, anchovy, Pacific or jack mackerel, or other coastal pelagic species. An EFP is necessary because the directed sardine fishery is closed, and will remain closed in 2022-23. There are no constraints on capturing the other CPS other than Annual Catch Limits, which this project will not exceed. No measurable impacts to non-target species are anticipated.

**4i. Justification for EFP request:** This EFP application requests 300 mt be allocated as a research set-aside for a projected 7 to 10 days of research (spread strategically within the July 1 –June 30 study window). Vessels will be directed to capture as many schools as possible in a given day, and will strive for 100 percent capture of individual schools, if possible. In light of recent-year observations of abundant sardine in nearshore waters, particularly in S.CA, the likelihood is that sets will capture sardine, either in pure schools or in mixed schools exceeding the incidental catch of sardine by weight. Without an EFP, such captures would be in violation. The issuance of an EFP also allows the sale of the fish to help offset additional costs incurred by participating fishermen and processors.

**4j. Accounting for EFP fish:** Biologists will take a subset of each set at the dock for later processing to obtain biological characteristics of individual fish. As noted above, all schools captured will be stowed in individual hatches in the hold, and when delivered to market each set will be weighed and sampled for species composition following established protocol. Processors will maintain records of the weight of individual species groups, including sardine, to validate species composition.

CWPA will notify Enforcement approximately 12 hours before vessel(s) go out to inform them of vessel name(s) and location(s) to be surveyed, and processors(s) who will be receiving research fish that day.

CWPA will also maintain a record of the volume / total weight of each species captured and will monitor progress toward attaining the EFP limit. These weights and species composition per set will also be included in the final report.

**4k. Data Collection Methods:** According to the survey plan:

#### *Biological sampling*

*The catch taken from each school will be subsampled throughout the pumping of each haul. CDFW biologists will obtain a 5-gallon subsample of fish at quarterly intervals of pumping each set, using a quantitative bucket sampling method. The four collected fish subsamples will be sorted by species and stored in plastic bags and preserved on ice. Up to 50 fish per species per point set will be collected by a CDFW biologist/sampler upon landing of the daily catches. At the CDFW laboratories these samples will be measured for biological characteristics including length, weight, sex, maturity, and otoliths taken for ageing.*

#### *Statistical analyses*

*Based on the objectives of this research, CPS biomass and associated variances will be estimated from data collected during the aerial and purse seine survey. The sampling unit of the survey will be one transect flown for a number of hours during the day.... Further, purse seine data will be used to validate aerial tonnage estimates, school species composition, and [to obtain] length, and age composition ..., providing additional information to quantify uncertainty surrounding biomass estimated by the pilot and observer. More details regarding the process of biomass estimation from the CPS-NCS are found in Dorval and Lynn (2019).*

Scientific data collection and analysis will be supervised by CDFW and NOAA scientific staff, who will collaborate on procedures to ensure and evaluate data quality during the survey, and data analysis methodology through completion of the project. Weather permitting, we will strive to have multiple replications of each transect, as well as purse seine sets on schools of various sizes (in proportions as depicted in Figure 1), to derive unbiased estimates of biomass and associated variances.

**4l. Vessel selection:** Criteria were established to qualify vessels for participation in this research project. From those requirements CWPA identified six vessels meeting the criteria for vessel size, equipment and skippers' experience, whose skippers, importantly, committed to participate in this research, notwithstanding any other fishing opportunities during the project period. All vessels and processors have had extensive prior experience with fishing for data in this research project.

**4m. Time and Place of Research Fishing:** This project will take place in nearshore waters of Monterey Bay and/or the Southern California Bight, depending on weather constraints. The tentative time frame for the survey window is July 1, 2022 – June 30, 2023. This project will also attempt to coordinate with the 2022 NOAA summer survey, if the NOAA survey vessel is surveying outer waters on schedule. Fishing gear used is purse seine net of suitable mesh size and length for capturing CPS schools observed by aerial spotter pilots (or potentially by acoustic backscatter).

Thank you for your consideration.

Best regards,



Diane Pleschner-Steele  
Executive Director

Attachments:

Appendix 1 - 2010 Point Set Photographs

Appendix 2 - Fishermen's Log Form

Appendix 3 - Flight Log Form

\*Table A1. Sardine point set data collected from 2010 study (Jagiello et al. 2010), and 2018-2020 NCS for Spotter 1.

\*Table A2. Sardine point set data collected from 2018-2020 NCS for Spotter 2.

Figure A1. Linear regression model and parameter estimates, based on aerial school biomass estimated by Spotter 1

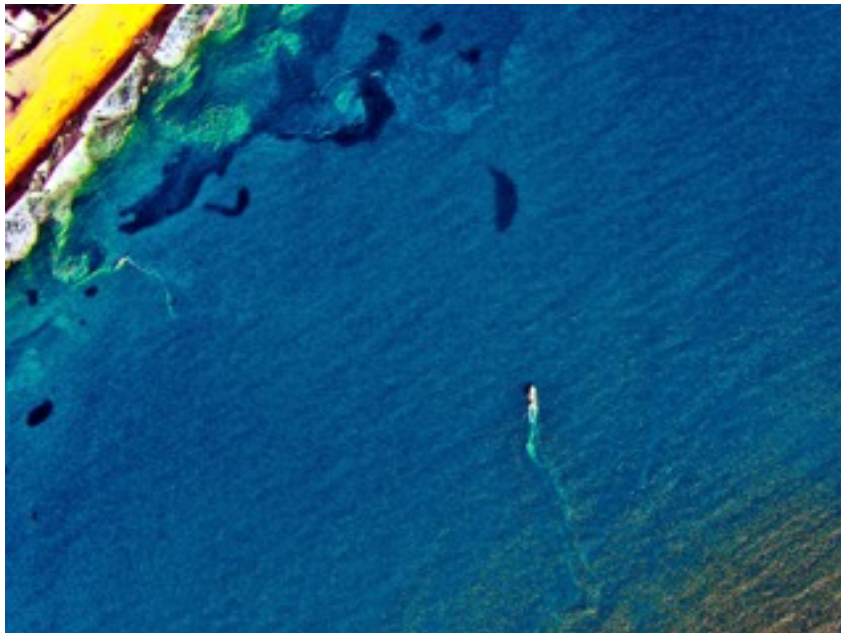
Figure A2. Linear regression model and parameter estimates, based on aerial school biomass estimated by Spotter 2



## References

- Dorval, E. and K. Lynn. 2019. Accuracy and precision of Pacific Sardine (*Sardinops sagax*) and Northern Anchovy (*Engraulis mordax*) biomass estimated from aerial surveys in nearshore waters off California. Progress report. <ftp://ftp.pcouncil.org/pub/CPS/CPSMtOct2019/Documents%20for%20November%202019%20Council%20meeting/>.
- Jagiello, T. H., Hanan, D., Howe, R., and M. Mikesell. 2010. West Coast Aerial Sardine Survey. Sampling Results in 2010. Prepared for Northwest Sardine Survey and the California Wetfish Producers Association. Pacific Fishery Management Council, Portland, OR, October 15, 2010. 51p.
- Kuriyama, P. T., J. P. Zwolinski, K. T. Hill, and P. R. Crone. 2020. Assessment of the Pacific sardine resource in 2020 for U.S. management in 2020-2021. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-628. 171 p.
- Lynn, K, D. Porzio, T. Nguyen, and L. Ryley. 2017. Southern California aerial survey for Pacific sardine (*Sardinops sagax*) and Northern anchovy (*Engraulis mordax*). PFMC June 2017 meeting, Agenda Item D.2.a, CDFW Report.
- PFMC. 2017. Southern California coastal pelagic species aerial survey methodology review. PFMC June 2017 meeting, Agenda Item D.2, Attachment 1, Methodology Review Panel Report.
- PFMC. 2020. Pacific sardine stock assessment review panel meeting report. PFMC April 2020 meeting, Agenda Item D.3, Attachment 2.

**Appendix 1.** 2010 point set photographs. Note the typical schooling pattern of CPS in nearshore waters in CA. Individual schools break away from the shoaling fish for a short period, and often outrun the vessel in the capture attempt.



FV Eileen approaches 20-ton sardine school in 2010 summer aerial survey.



FV Eileen in process of wrapping school. This was a 100% capture point set.

**Appendix 2.** Fisherman's log form.

### CPS Nearshore Cooperative Survey Fisherman's Log Form

Date: \_\_\_\_\_ Captain: \_\_\_\_\_

Vessel: \_\_\_\_\_ Processor: \_\_\_\_\_

**Hydroacoustic Gear**

Type	Make	Model	Frequency
Sounder			
Sonar			

**Net Dimensions**

Net Length {fm}	Net Depth {fm}	Mesh Size {in}

**School and Ocean Data**

Point Set Number	Point Set Start Time	Latitude	Longitude	Top Depth of School {fm}	Bottom Depth of School {fm}	Ocean Depth {fm}	SST {F}	Weather Condition	Picture of Sonar {Y/N}

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

**Captains Estimate and Delivery Information**

Point Set No.	Species Observed	% of School Captured	Total Est. School Tonnage {mt}	Fish Hold {FP, FS, MP, MS, AP, AS}	*Delivered Weight {st}	*Fish Ticket Number

Comments and sonar interpretations:

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## Appendix 3. Flight log form.

**CPS Nearshore Cooperative Survey****Point Set Flight Log Form**

Date: \_\_\_\_\_ Pilot: \_\_\_\_\_

Processor: \_\_\_\_\_ Observer: \_\_\_\_\_

Set #	Time Pre & During	Photo #s Pre & During	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% Species Composition	Est. School Tonnage (st)	% of School Captured

Comments: \_\_\_\_\_

Set #	Time Pre & During	Photo #s Pre & During	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% Species Composition	Est. School Tonnage (st)	% of School Captured

Comments: \_\_\_\_\_

Set #	Time Pre & During	Photo #s Pre & During	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% Species Composition	Est. School Tonnage (st)	% of School Captured

Comments: \_\_\_\_\_

Set #	Time Pre & During	Photo #s Pre & During	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% Species Composition	Est. School Tonnage (st)	% of School Captured

Comments: \_\_\_\_\_

Set #	Time Pre & During	Photo #s Pre & During	Position (Lat/Long)	Altitude (ft)	Vessel	Species Observed	% Species Composition	Est. School Tonnage (st)	% of School Captured

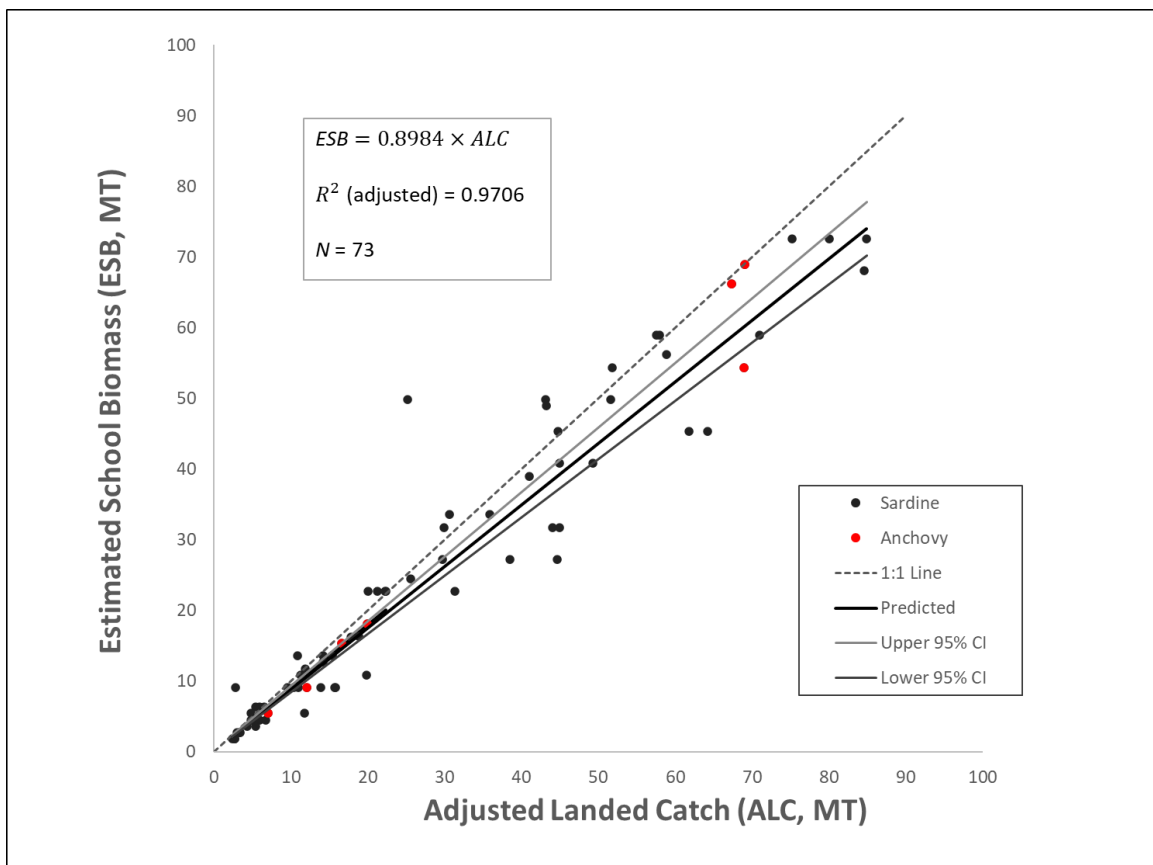
Comments: \_\_\_\_\_

**Table A1.** Sardine point set data collected from 2010 study (Jagiello et al. 2010), and 2018-2020 NCS for Spotter 1.

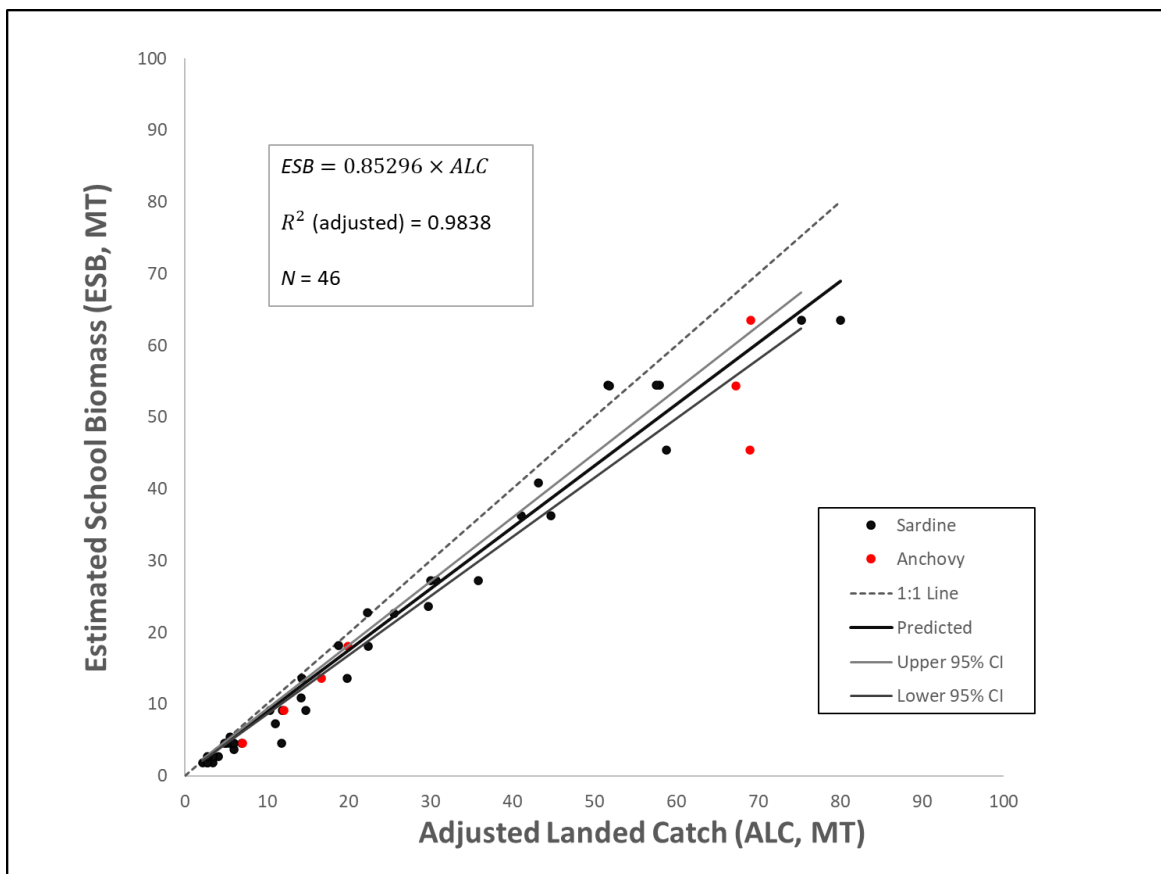
Date	Region	Species	Aerial observation		Purse seine sampling	
			Est. School Biomass (mt)	Est. % School Wrapped	Landed Catch (mt)	Adj. Landed Catch
			$\bar{x}'$		$\bar{y}$	$\bar{y}'$
8/9/10	SCA	Sardine	4.54	100	4.80	4.80
8/12/10	SCA	Sardine	27.22	90	40.20	44.67
8/16/10	SCA	Sardine	27.22	100	38.50	38.50
8/17/10	SCA	Sardine	13.61	100	10.90	10.90
8/18/10	SCA	Sardine	13.61	100	15.40	15.40
8/18/10	SCA	Sardine	9.07	95	15.00	15.79
8/18/10	SCA	Sardine	4.54	100	6.70	6.70
8/18/10	SCA	Sardine	10.89	90	17.90	19.89
8/19/10	SCA	Sardine	9.07	100	2.80	2.80
8/19/10	SCA	Sardine	9.07	100	9.60	9.60
8/22/10	SCA	Sardine	9.07	95	14.90	15.68
8/23/10	SCA	Sardine	22.68	100	20.00	20.00
8/23/10	SCA	Sardine	10.89	95	10.70	11.26
8/31/10	SCA	Sardine	45.36	95	58.70	61.79
8/31/10	SCA	Sardine	22.68	100	31.30	31.30
8/31/10	SCA	Sardine	31.75	100	44.00	44.00
9/1/10	SCA	Sardine	58.97	95	67.40	70.95
9/1/10	SCA	Sardine	40.82	100	45.00	45.00
9/8/10	SCA	Sardine	49.90	90	38.80	43.11
9/8/10	SCA	Sardine	49.90	95	23.90	25.16
9/9/10	SCA	Sardine	40.82	95	46.80	49.26
9/10/10	SCA	Sardine	72.57	100	84.90	84.90
9/12/10	SCA	Sardine	68.04	100	84.60	84.60
9/13/10	SCA	Sardine	22.68	95	20.20	21.26
9/13/10	SCA	Sardine	45.36	100	64.20	64.20
9/13/10	SCA	Sardine	31.75	90	40.50	45.00
8/20/18	SCA	Sardine	2.72	100	3.38	3.38
8/20/18	SCA	Sardine	3.63	95	4.09	4.31
8/21/18	SCA	Sardine	4.54	95	5.70	6.00
8/21/18	SCA	Sardine	4.54	100	5.01	5.01
8/21/18	SCA	Sardine	1.81	100	2.74	2.74
8/22/18	SCA	Sardine	3.63	100	5.38	5.38
8/22/18	SCA	Sardine	16.33	100	18.79	18.79
8/22/18	SCA	Sardine	9.07	100	11.01	11.01
8/22/18	SCA	Sardine	12.70	100	14.20	14.20
8/22/18	SCA	Sardine	11.79	100	11.86	11.86
8/27/18	SCA	Sardine	2.72	100	3.36	3.36
8/27/18	SCA	Sardine	6.35	100	5.45	5.45
8/27/18	SCA	Sardine	1.81	90	2.14	2.38
8/28/18	SCA	Sardine	1.81	100	2.76	2.76
8/28/18	SCA	Sardine	2.72	90	2.76	3.06
8/28/18	SCA	Sardine	5.44	100	4.91	4.91
3/26/19	SCA	Sardine	27.22	100	29.78	29.78
3/26/19	SCA	Sardine	39.01	100	41.02	41.02
3/26/19	SCA	Sardine	13.61	100	15.15	15.15
4/1/19	SCA	Sardine	58.97	100	57.91	57.91
4/1/19	SCA	Sardine	31.75	100	29.97	29.97
4/1/19	SCA	Sardine	49.90	100	51.66	51.66
4/2/19	SCA	Sardine	24.49	100	25.64	25.64
6/28/19	SCA	Sardine	72.57	95	71.49	75.26
8/13/19	Monterey	Sardine	6.35	90	5.88	6.53
8/14/19	Monterey	Anchovy	9.07	90	10.88	12.09
8/15/19	Monterey	Anchovy	66.22	100	67.33	67.33
8/21/19	Monterey	Sardine	5.44	95	11.21	11.80
8/21/19	Monterey	Sardine	33.57	90	27.60	30.67
8/21/19	Monterey	Sardine	9.07	95	13.24	13.93
9/12/19	Monterey	Sardine	54.43	90	62.07	68.97
9/12/19	Monterey	Anchovy	58.97	90	51.82	57.58
4/14/20	Monterey	Anchovy	68.95	100	69.10	69.10
4/22/20	SCA	Sardine	33.57	90	32.21	35.79
6/18/20	SCA	Anchovy	15.42	100	16.62	16.62
6/18/20	SCA	Anchovy	18.14	100	19.93	19.93
10/12/20	Monterey	Anchovy	48.99	100	43.21	43.21
10/12/20	Monterey	Sardine	5.44	100	7.03	7.03
10/13/20	Monterey	Sardine	16.33	100	17.83	17.83
10/13/20	Monterey	Sardine	22.68	100	22.25	22.25
10/14/20	Monterey	Sardine	9.07	100	10.37	10.37
10/14/20	Monterey	Sardine	6.35	100	5.96	5.96
10/15/20	Monterey	Sardine	22.68	100	22.33	22.33
10/15/20	Monterey	Sardine	45.36	100	44.73	44.73
10/15/20	Monterey	Sardine	54.43	100	51.85	51.85
10/21/20	Monterey	Sardine	56.25	100	58.82	58.82
10/21/20	Monterey	Sardine	72.57	100	80.08	80.08

**Table A2.** Sardine point set data collected from 2018-2020 NCS for Spotter 2.

Date	Region	Species	Aerial observation		Purse seine sampling	
			Est. School Biomass (mt)	Est. % School Wrapped	Landed Catch (mt)	Adj. Landed Catch
			x'		y	y'
8/20/18	SCA	Sardine	1.81	100	3.38	3.38
8/20/18	SCA	Sardine	2.72	100	4.09	4.09
8/21/18	SCA	Sardine	3.63	95	5.70	6.00
8/21/18	SCA	Sardine	4.54	100	5.01	5.01
8/21/18	SCA	Sardine	1.81	100	2.74	2.74
8/22/18	SCA	Sardine	4.54	100	5.38	5.38
8/22/18	SCA	Sardine	18.14	100	18.79	18.79
8/22/18	SCA	Sardine	7.26	100	11.01	11.01
8/22/18	SCA	Sardine	10.89	100	14.20	14.20
8/22/18	SCA	Sardine	9.07	100	11.86	11.86
8/27/18	SCA	Sardine	2.72	100	3.36	3.36
8/27/18	SCA	Sardine	5.44	100	5.45	5.45
8/27/18	SCA	Sardine	1.81	100	2.14	2.14
8/28/18	SCA	Sardine	1.81	100	2.76	2.76
8/28/18	SCA	Sardine	2.72	100	2.76	2.76
8/28/18	SCA	Sardine	4.54	100	4.91	4.91
3/26/19	SCA	Sardine	23.59	100	29.78	29.78
3/26/19	SCA	Sardine	36.29	100	41.02	41.02
3/26/19	SCA	Sardine	13.61	100	15.15	15.15
4/1/19	SCA	Sardine	54.43	100	57.91	57.91
4/1/19	SCA	Sardine	27.22	100	29.97	29.97
4/1/19	SCA	Sardine	54.43	100	51.66	51.66
4/2/19	SCA	Sardine	22.68	100	25.64	25.64
6/28/19	SCA	Sardine	63.50	95	71.49	75.25
8/13/19	Monterey	Sardine	4.54	85	5.88	6.91
8/14/19	Monterey	Anchovy	9.1	90	10.88	12.09
8/15/19	Monterey	Anchovy	54.4	100	67.33	67.33
8/21/19	Monterey	Sardine	4.54	95	11.21	11.80
8/21/19	Monterey	Sardine	27.22	90	27.60	30.67
8/21/19	Monterey	Sardine	9.07	90	13.24	14.71
9/12/19	Monterey	Anchovy	45.4	90	62.07	68.97
9/12/19	Monterey	Sardine	54.43	90	51.82	57.58
4/22/20	Monterey	Sardine	27.22	90	32.21	35.79
4/14/20	SCA	Anchovy	63.5	100	69.10	69.10
6/18/20	SCA	Anchovy	13.6	100	16.62	16.62
6/18/20	SCA	Anchovy	18.1	100	19.93	19.93
10/12/20	Monterey	Sardine	40.86	100	43.21	43.21
10/12/20	Monterey	Anchovy	4.54	100	7.03	7.03
10/13/20	Monterey	Sardine	13.6	90	17.83	19.81
10/13/20	Monterey	Sardine	22.7	100	22.25	22.25
10/14/20	Monterey	Sardine	9.1	100	10.37	10.37
10/14/20	Monterey	Sardine	4.5	100	5.96	5.96
10/15/20	Monterey	Sardine	18.1	100	22.33	22.33
10/15/20	Monterey	Sardine	36.3	100	44.73	44.73
10/15/20	Monterey	Sardine	54.4	100	51.85	51.85
10/21/20	Monterey	Sardine	45.4	100	58.82	58.82
10/21/20	Monterey	Sardine	63.5	100	80.08	80.08



**Figure A1.** Linear regression model and parameter estimates, based on aerial school biomass estimated by Spotter 1 and purse seine point sets collected during the 2010 and 2018-20 nearshore NCS off Southern California and Monterey.



**Figure A2.** Linear regression model and parameter estimates, based on aerial school biomass estimated by Spotter 2 and purse seine point sets collected during the 2018-20 NCS off Southern California and Monterey.