

Coastal Pelagic Species Subcommittee of the Scientific and Statistical Committee Review of aspects related to assessment of Pacific Sardine and other CPS Species

The Coastal Pelagic Species Subcommittee of the Pacific Fishery Management Council's (Council) Scientific and Statistical Committee (CPSSC) met remotely on 20 and 21 of March, 2023 to review (a) the results of a stock structure workshop, (b) proposed revised methods for separating northern subpopulation of Pacific sardine stock landings and survey biomass, and (c) a proposed approach to estimate CPS biomasses from the 2022 Summer CPS survey.

Pacific sardine stock structure workshop

The CPSSC discussed the [report](#) from the Pacific sardine stock structure workshop held during November 15-17, 2022. The workshop was held in response to comments received from the SSC about the 2021 catch-only assessment. Dr. Matt Craig of the SWFSC (acting for Dr. Annie Yau) provided an overview of the workshop, which discussed current literature and research efforts to define Pacific sardine stock structure and its delineation for the next full stock assessment in 2024. The habitat model that is used to assign sardine catch and predict potential habitat to the northern subpopulation of Pacific sardine was updated using additional data from recent years. The workshop participants developed an archetypal operational definition of the northern subpopulation for spring and summer during periods of low and high abundance.

The CPSSC discussed Figure 1 of the report, which presents the preferred archetype identified at the workshop. Questions arose regarding the meaning of the green line off Southern California in the lower left panel, which was not mentioned in the legend. This was intended to denote the location of juveniles, which was light blue in the legend. In addition, the lower right panel did not include the location of juveniles as this is more uncertain in the low abundance scenario it describes. The CPSSC recommends denoting the distribution of juveniles provided in the lower figures in a fashion consistent with the upper panels by updating the color scheme in the lower left panel and providing verbiage in the caption explaining the lack of juvenile distribution in the lower right panel.

A long-term request was made that each of the alternative archetypes discussed at the workshop be presented as well for consideration relative to the archetype of the preferred operational definition.

Proposed revised methods for separating northern sardine stock landings and survey biomass

Dr. Juan Zwolinski (SWFSC) presented an updated habitat model to optimize sampling of the northern subpopulation (NSP) of Pacific sardine. This work updates work published by Zwolinski et al. (2011), which provided a habitat model based on high-resolution data on egg presence, and resulted in a model of NSP habitat as a non-linear function of sea surface temperature (SST), log Chlorophyll concentration (CHL), and the gradient of sea-surface height. Demer and Zwolinski (2014) subsequently used temperature alone to separate catches of the northern and southern (SSP) sub-populations of Pacific sardine, with a threshold of 16.4 or 16.7 °C, which ensured that nearly all or all NSP sardine were correctly assigned, while including a small proportion of SSP sardine.

The updated habitat model includes an additional decade of data, during which the abundance of NSP sardine declined and has remained low compared to the period used in the 2014 analysis. The

data also have a wider environmental footprint, especially at the transition SST between the two subpopulations. The modeling approach has not changed, though it is now based on SST and CHL but excludes sea-surface height, and the additional data provides for a more refined model. One important outcome is a reduction in the portion of the resulting probability surface representing NSP habitat that includes the higher temperatures found in 2011 and 2014 (~16 °C and higher).

Catches are assigned by geographic area and month to the NSP or the SSP based on whether more or less than half of the habitat in a fishing area is above or below a threshold for habitat suitability during that month. In order to separate the NSP and SSP, it is necessary to select a threshold for the NSP. This choice involves two considerations. First, it is important that the threshold includes the vast majority of observations of eggs during the spawning period of the NSP, while excluding a substantial portion of the area where no eggs were seen. Secondly, there is confidence that the large 2021 and 2022 catches off Ensenada were from the SSP, and therefore the threshold should exclude those catches from the operational definition of NSP.

A cutoff value of 0.18 for was found to be optimal in that it results in retention of an expected 95% of egg abundance for the NSP while eliminating 50% of the area with no eggs observed, as well as all of the 2021 and 2022 catch off Ensenada (and in fact all Ensenada catch dating back to 2013).

The CPSSC agrees that this is a reasonable approach to this complex problem, and endorses use of the updated habitat model to apportion sardine catch and biomass estimates between subpopulations for use in assessments. The stock structure assumption of the NSP and SSP is a working hypothesis, with supporting evidence, but not a known fact. This approach should work well for current management given the current relative abundances of the NSP and SSP. However, the algorithm should be revisited as more information is gained and there are changes to the abundances of the two subpopulations.

Uncertainty in catch location persists, and having more specific spatio-temporal information about catches would improve the confidence in assignment to subpopulation.

Notes:

The habitat suitability maps are very useful. A variance surface map would be a helpful addition to show where there is a lack of information on habitat suitability. There is uncertainty in temperature and in CHL due to lack of samples/measurement error, and the effects of this uncertainty are not fully understood.

Justification for classifying all 2020 and 2021 catches from Ensenada as Southern stock.

- 1. After the NSP collapse in 2014, the biomass [based on the survey] has remained in the neighborhood of 50 kt (Stierhoff et al 2023).*
- 2. The residual spawning stock has drastically reduced its presence in the typical spring spawning area off California, likely from the contraction of the seasonal migration Zwolinski and Demer, This meeting.*
- 3. In the spring of 2021, the sardine found in the Southern California Bight were considered to be SSP [based upon the previously developed method of assignment].*
- 4. The combined Ensenada and Bahia Magdalena catches increased roughly four times from 2015 to 2020 and 2021, with sardine lengths decreasing during that period, which*

indicates higher than average recruitment success for the spawning occurring south of the US-Mexico border (Enciso-Enciso et al. 2022) (Zwolinski et al., 2023).

5. *There is strong temporal continuity between the monthly landings of the two Mexican ports, and the length composition of the sardine captured below 17°C, comprising ~ 32% of the catch, had a similar length composition of that of the catches that were taken between 17°C and 22°C (Enciso-Enciso et al. 2022).*

Proposed approach to estimate CPS biomasses from the 2022 Summer CPS survey

The CPSSC reviewed a draft document by Dr. Kevin Stierhoff and colleagues (SWFSC) entitled “Distribution, biomass, and demographics of coastal pelagic species fishes in the California Current Ecosystem during summer 2022 based on acoustic-trawl sampling”. The document describes changes to the summer 2022 acoustic-trawl sampling necessitated by an unexpected reduction in the number of days at sea for the *Lasker* research vessel. Most notably, the *Lasker* surveyed only part of the typical latitudinal range of the survey. The remaining portion was surveyed by a commercial fishing vessel (the *Lisa Marie*) and/or two uncrewed surface vessels (Saildrone USVs). Biological compositions associated with acoustic surveys by the *Lasker* came from night-time trawling as is typical for the acoustic trawl survey.

For portions of the survey where the *Lisa Marie* provided compositional data (between the Columbia River and Cape Mendocino), biological data were collected via daytime purse seines. Jack mackerel were observed avoiding these sampling attempts, and the compositional data were deemed non-representative as a result. In addition, purse seines typically capture a single school, whereas night time trawling typically encompasses multiple trawl clusters. Within this area, for sampling events where some sardine were captured, it was assumed that the proportion of sardine in that area could be estimated from a model fitting a GAM to the proportion sardine as a function of latitude in 2018-2021 night-time trawls in the area. The remainder of the fish in these sampling events were assumed to be jack mackerel that avoided capture. This led to the exclusion of other species (e.g., anchovy, herring, Pacific mackerel) from some samples where they were observed. These excluded species generally made small contributions to the assemblages in these areas, although Pacific mackerel had a high contribution to a single purse seine associated with a substantial amount of backscatter.

Overall, the CPSSC found the adjustments to the survey plan and estimation methodologies made in response to this lack of available days at sea reasonable and appropriate, and endorses the approach described in the report as best available science for estimating the biomass of the NSP of Pacific sardine in summer 2022. The CPSSC also supports use of estimates from the 2022 CPS survey for biomass of SSP Pacific sardine (within the sampled area), northern anchovy, and herring. The CPSSC does not recommend using the Pacific mackerel or jack mackerel biomass estimates from the 2022 survey. The estimate of biomass for NSP Pacific sardine for summer 2022 is 69,506 t (CV 0.21).

The CPSSC made four-short term requests related to the 2022 biomass estimates that were satisfactorily responded to during the meeting:

- Provide full documentation of the algorithm used to adjust or replace composition estimates for samples between the Columbia River and Cape Mendocino based on assumed avoidance of daytime purse seine samples by jack mackerel, and describe how the algorithm was (or was not) applied to samples that did or did not include some observed

sardine. The analysts provided full documentation and it will be incorporated into the final report.

- Show the biomass estimates (for each species) resulting from not adjusting composition estimates to reflect assumed jack mackerel avoidance of daytime purse seine samples. Biomass estimates for herring, anchovy, and SSP Pacific sardine were unaffected because they were not encountered in any of the samples that required adjustment. The estimated biomass of NSP Pacific sardine was substantially higher in the absence of an adjustment, but this was likely due to the attribution of backscatter from other species that avoided the purse seines. The CPSSC did not deem the non-adjusted biomass estimate credible. The estimated biomass of Pacific mackerel was substantially higher without the adjustment, owing largely to a single purse seine dominated by Pacific mackerel that was re-attributed to other species under the adjustment. The estimated biomass of jack mackerel was substantially lower without the adjustment and reflected net avoidance by this species.
- Verify that the updated habitat model was used to apportion Pacific sardine biomass between subpopulations (or update the biomass calculations as necessary) and make sure that the updated habitat model is reflected in Figure 12. The analysts verified that the updated model was used, and the final report will include an appropriate version of the figure.
- To better communicate the spatial and temporal coverage of different survey vessels during Leg II of the survey, plot the start and end time and location of the survey transect of each vessel. A plot was provided, which the CPSSC found very helpful. The CPSSC recommends including similar plots in future survey reports, with different line types or colors to distinguish periods of transit versus active sampling.

Although the CPSSC did not expect a response during the course of the subcommittee meeting, the CPSSC also encourages longer-term work leveraging instances of multiple surveys of the same area that occurred this year to generate variance estimates based on repeated sampling. These estimates can then be compared to the variance estimates obtained from the standard survey methods.

The CPSSC (1) suggests future consideration of including a temperature covariate in the model of proportion sardine as a function of latitude, (2) notes that Pacific mackerel may have sufficient swimming ability to avoid daytime purse seines, (3) requests additional detail in the final report on the synchronization of sampling by saildrones and the *Lisa Marie*, and (4) suggests that the final report emphasize that only part of the latitudinal range of SSP Pacific sardine was sampled.

References

- Demer D.A., Zwolinski J.P. 2014. Corroboration and refinement of a method for differentiating landings from two stocks of Pacific sardine (*Sardinops sagax*) in the California Current. *ICES Journal of Marine Science* 71:328-335.
- Enciso-Enciso, C., Cotero-Altamirano, C.E., Álvarez-Trasviña, E. and Peralta-Ramos, J. C. 2022. The coastal pelagic species fishery off the western coast of the Baja California Peninsula, Mexico, fishing season 2021. Oral presentation at the XXII Annual trinational sardine and small pelagics forum, May 2, 2022
- Stierhoff K.L., Renfree J.S., Rojas-González R.I., Vallarta-Zárate J.R.F., Zwolinski J.P., and Demer D.A. 2023. Distribution, biomass, and demography of coastal pelagic fishes in the

California Current Ecosystem during summer 2021 based on acoustic-trawl sampling. NOAA Technical Memorandum NMFS-SWFSC-676. DOI: <https://doi.org/10.25923/77kp-ww39>

Zwolinski J.P., and Demer D.A. This meeting. An updated model of potential habitat for northern stock Pacific sardine (*Sardinops sagax*) and its use for attributing survey observations and fishery landings. *Working document for PFMC CPS Sub-committee meeting, March 20-21, 2023*

Zwolinski J.P., Emmett R.L., and Demer D.A. 2011. Predicting habitat to optimize sampling of Pacific sardine (*Sardinops sagax*). *ICES Journal of Marine Science* 68:867-879.

Zwolinski J.P., Renfree J.S., Stierhoff K.L., and Demer D.A. 2023 Distribution, biomass, and demographics of coastal pelagic fishes in the California Current Ecosystem during spring 2021 based on acoustic-trawl sampling. DOI: <https://doi.org/10.25923/zvzf-3306>.

Excerpts from Enciso-Enciso et al.(2022)



XXII Annual Trinational Sardine and Small Pelagics, May 02, 2022

THE COASTAL PELAGIC SPECIES FISHERY OFF THE WESTERN COAST OF THE BAJA CALIFORNIA PENINSULA, MEXICO, FISHING SEASON 2021.

Concepción Enciso-Enciso, Celia Eva Cotero-Altamirano, Eduardo Álvarez-Trasviña and Julio C. Peralta-Ramos

Centro Regional de Investigación Acuícola y Pesquera (CRIAP- Ensenada). INAPESCA.
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SECRETARÍA DE AGRICULTURA Y DESARROLLO RURAL

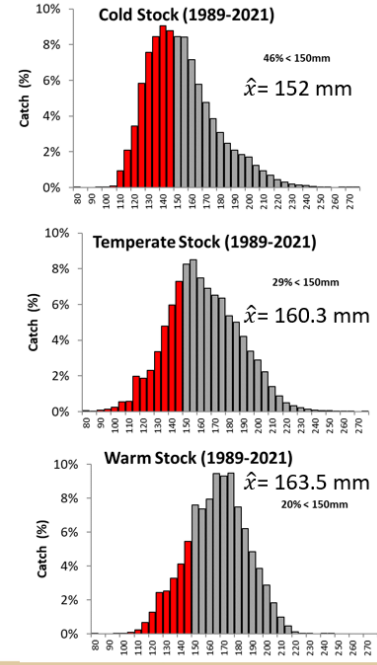
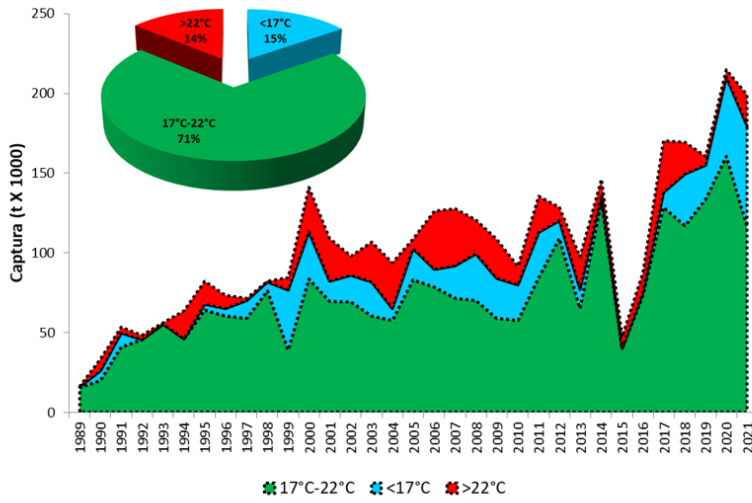


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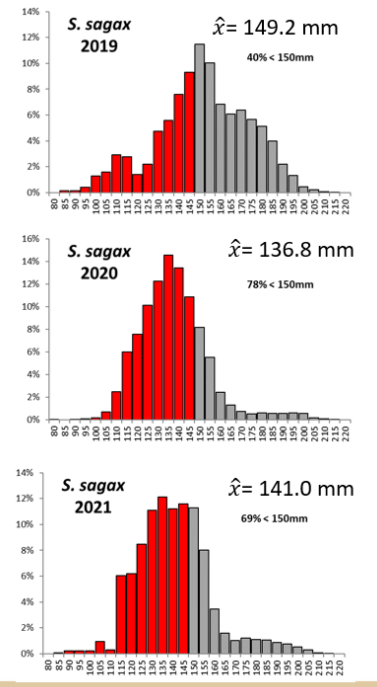
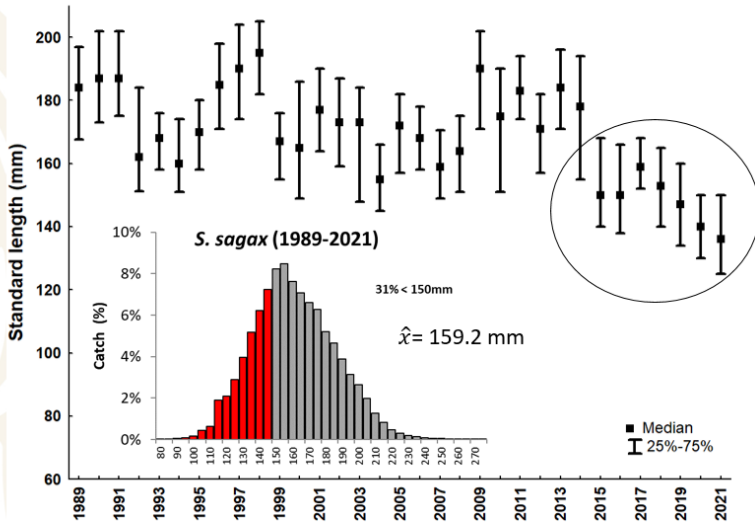
2022 Flores
Año de **Magón**
PRECURSOR DE LA REVOLUCIÓN MEXICANA

Stocks (*Sardinops sagax*)



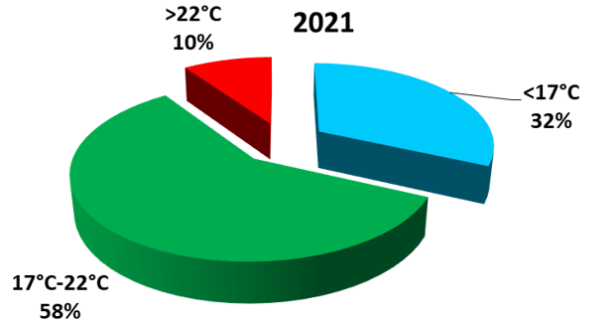
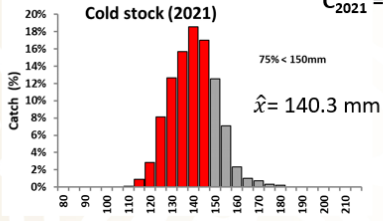
Pacific sardine

Kruskal-Wallis test: $H(32, N=81240) = 33142.06, p=0.000$

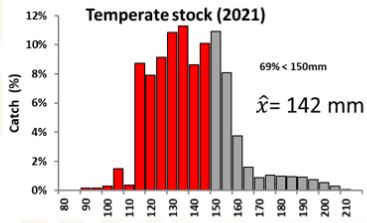


Stocks (*Sardinops sagax*)

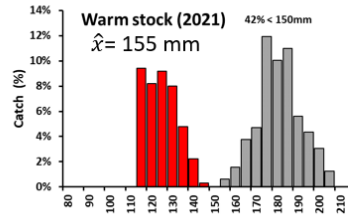
2021 = 199 Ktons



$C_{2021} = 117$ Ktons



$C_{2021} = 20$ Ktons



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 03/29/23