SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON CALIFORNIA CURRENT ECOSYSTEM AND INTEGRATED ECOSYSTEM ASSESSMENT (IEA) REPORT AND SCIENCE REVIEW TOPICS

The Scientific and Statistical Committee (SSC) met with representatives of the California Current Integrated Ecosystem Assessment (CCIEA) team, Drs. Toby Garfield (Southwest Fisheries Science Center) and Chris Harvey (Northwest Fisheries Science Center). The SSC's discussion with the CCIEA team encompassed three topics: 1) the 2021 CCIEA Ecosystem Status Report (IEA Team Reports 1 and 2), 2) the report of the January 2021 SSC Ecosystem Subcommittee (SSCES) meeting, including consideration of the COVID-19 related impacts on the 2021 CCIEA Report (appended to the end of this statement), and 3) topics/analyses for the CCIEA team to present for review at the September 2021 SSCES meeting (Supplemental IEA Team Report 3).

Review of the 2021 CCIEA Ecosystem Status Report

The Ecosystem Status Report provides important information on environmental, biological, social, and economic indicators and provides an ecosystem perspective on West Coast fish stocks, fisheries, and coastal communities for the Council process. The SSC commends the CCIEA team's openness and responsiveness to Council and SSC questions and recommendations, and their continuing efforts to improve the Status Report each year.

One important finding in this year's Ecosystem Status Report is that although oceanographic and climate indicators are coming back to neutral condition after the 2013-2016 Marine Heatwave, the California Current Ecosystem is still experiencing episodes of warm conditions that are not associated with El Niño as they were in the past. In addition, the North Pacific Gyre Oscillation (NPGO) index is at its most negative values ever recorded. These indicators are giving contradictory signals about productivity. We may have to wait a few years to see how these conditions affect ecological outcomes.

The SSC discussed several issues that could affect the interpretation of the indicators in the report including:

- The characterization of salmon escapement numbers as "high" or "low" requires some further elaboration (Figure 4.3.1, page 11). Currently the "high" or "low" designation is based on an average of recent years relative to the long-term average of the time series. These designations are sensitive to the length of the time series used. It is not clear that "high" and "low" are the best descriptors to apply to this comparison. It may be better to base designations on reference points that characterize biologically healthy stocks (e.g., Endangered Species Act listing status or minimum stock size thresholds).

- The discussion of trends in salmon escapement (Section 4.3) is unclear about whether the term "natural" refers specifically to natural-origin fish or to fish counted as spawning in natural areas. Reporting natural-origin abundances when available would be a useful addition to the report and necessary to evaluate the performance of the naturally produced Central Valley Fall Chinook indicator.

- The 2021 report includes a new indicator of groundfish availability at the port level (Section 4.4, p. 13). While the indicator reflects the spatial abundance and distribution of groundfish species, market and social factors will influence the ability of individual communities to utilize specific resources (e.g., physical infrastructure, labor market conditions, prices). Therefore, this may not be a good indicator of social or economic conditions in a port.

- The interpretation of the fisheries participation networks can be confusing (Figure 6.4.1). The size of nodes in the figure are described as being proportional to revenue from a given fishery. However, node size does not relate to overall revenues at those ports for those species. Node size reflects the median percent of individuals' total revenue accounted for by that species for participants in that fishery and port group. Thus, if most participants get most of their revenue from that fishery, the node size can be large even if the absolute revenue for individual participants and in total is small.

Outcomes of the January 2021 SSCES Meeting

The SSCES assessed the effect of COVID-19 on data sources used in the CCIEA report and provided technical comments on two new analyses in this year's report. Data collections for forage indicators were most affected by cancellations, delays, or changes to ocean surveys in 2020 as a consequence of the COVID-19 pandemic (more details on the affected surveys are available in the SSCES report, appended to this statement). The CCIEA report handles the issue of missing or limited data for 2020 appropriately. The SSC recommends that future reports should continue to document the limited data in 2020 since it may affect the calculation of indicator trends. The SSC commends the CCIEA team for their efforts to address data deficiencies and other difficulties this year.

Proposed Review Topics for September 2021

The CCIEA team has proposed two potential topics for review in September 2021 (Supplemental IEA Team Report 3):

1) Threshold relationships between environmental drivers and performance of salmon preseason abundance forecasts. Investigating how environmental indices reported by the CCIEA may indicate conditions that are associated with bias in forecasts could be of value to Pacific Fishery Management Council salmon management and may represent an opportunity for an ecosystem approach to fisheries management.

2) Year class strength and distribution of small groundfish. This analysis is based on recently published work that estimates spatial and temporal patterns of abundance of young age classes of 13 groundfish species. This may provide a leading indicator of incoming strong year classes

relative to when those species recruit into the fishery, as well as locating potential hotspots of valuable juvenile groundfish habitat that may be useful in essential fish habitat determinations.

The SSC agrees with the importance of both proposed topics and recommends they be reviewed at the September SSCES meeting. The SSC also recommends three additional topics for possible review. The first topic is a general review of salmon-related indicators. This topic could include validation of the stoplight indicators and further exploration of the salmon-related issues raised by the SSC at this meeting. The second topic is further development of the krill-based indicators used in the CCIEA report. The interpretation of mean size data in the absence of relative abundance data can be nuanced, although recent publications provide some guidance that may help evaluate the findings provided in the annual CCIEA report. The third topic would be additional review of port-level linkages between fisheries using network analysis that was included in the 2021 CCIEA report.

For the three additional topics for possible review, the CCIEA team and the SSC would need to confirm that analysts are available to develop this work prior to the September meeting. The SSC suggests the SSCES and CCIEA team participate in a non-noticed workload planning meeting in advance of the September review meeting. Consideration of these topics for future (e.g., 2022) reviews is also a reasonable option.

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SCIENTIFIC AND STATISTICAL COMMITTEE'S
ECOSYSTEM SUBCOMMITTEE REPORT

Pacific Fishery Management Council
Via Webinar

January 12, 2021

The Scientific and Statistical Committee's Ecosystem Subcommittee (SSCES) met via webinar January 12 to consult with the National Marine Fisheries Service (NMFS) California Current Integrated Ecosystem Assessment (CCIEA) team on how COVID-19 impacts may affect its annual ecosystem status report to the Council (hereafter CCIEA report). The SSCES reviewed three topics: adjustments to forage time series (A), an expanded analysis of threshold detection in relationships between environmental pressure and biological responses (B), and groundfish availability to ports and impacts to catch portfolios (C). Dr. Kristin Marshall chaired the meeting. Meeting participants are listed in Appendix A.

A. Adjustments to Forage Time Series Analyses to Ensure Consistency with Previous Years' Data

The SSCES received presentations from Drs. Brian Burke (NMFS/NWFSC), Jarrod Santora (NMFS/SWFSC), and Andrew Thompson (NMFS/SWFSC) summarizing the consequences of the COVID-19 pandemic for ocean surveys in 2020 and the impact of survey changes on forage indicators presented in the CCIEA report in 2021. Four surveys were discussed: 1) Newport Hydrographic Line survey, 2) Juvenile Salmon and Ocean Ecosystem Survey, 3) Rockfish Recruitment and Ecosystem Assessment Survey, and 4) CalCOFI Larval Fish Survey.

All of the surveys were delayed or reduced in scope due to the pandemic, though some were affected more than others. When surveys were able to be conducted, National Oceanic and Atmospheric Association (NOAA) scientists were generally unable to be present shipboard and were therefore unable to process samples as they were collected. A consequence of this is that many samples were frozen for later examination in the lab and many samples from 2020 are still being processed at the NWFSC and SWFSC. Reduced sampling and sample processing will result in increased uncertainty about the state of the California Current ecosystem in 2020 in comparison to previous years.

The SSCES commends the CCIEA team for their efforts to provide consistent indicator time series, where possible, and agrees with the approaches outlined by the analysts to present more limited data and explore new methods and data sources to bolster sampling limited by the pandemic in 2020. A brief summary of the four surveys and their 2020 impacts are below.

Newport Hydrographic Line (Dr. Brian Burke)

The Newport hydrographic line provides bi-weekly surveys of ichthyoplankton and copepods across the continental shelf off Newport, Oregon. These surveys contribute to the annual CCIEA Ecosystem Status Report as a component of the salmon stoplight chart and as time-series indices for copepod communities and winter ichthyoplankton. In 2020, only two of the bi-weekly surveys were not conducted, making this the least affected survey. Previous years had also missed similar numbers of survey dates, and so no 2020-specific modifications to the time series are expected in future years.

Juvenile Salmon and Ocean Ecosystem Survey (Dr. Brian Burke)

This survey is typically conducted in Oregon and Washington waters during May and June. It provides information about juvenile salmon abundance and distribution as well as other pelagic forage species including squid. This survey contributes to salmon forecasts, the salmon stoplight chart, and forage time-series indicators in the CCIEA report.

In 2020, the May survey was cancelled and the June survey was conducted without NOAA scientists aboard. Collected samples were frozen and transported to the lab for later analysis. Due to subsequent difficulty delaying sample processing, salmon catch per unit of effort (CPUE) data are not available at present but are expected to be fully processed in 2021. Most non-salmonid species (e.g., squid) have been completely processed and will be represented in the CCIEA report.

Rockfish Recruitment and Ecosystem Assessment Survey (Dr. Jarrod Santora).

This trawl survey targets the pelagic fish community in California waters between April and June. It provides information on rockfish young-of-year, pelagic fish (e.g., anchovies, young-of-year hake, myctophids), and important invertebrate species (e.g., krill, market squid). These indices contribute to stock assessments and ecosystem indicators presented in the CCIEA report.

The 2020 survey began later than usual (June as opposed to late April or early May), was limited to the central California core survey area (Monterey to San Francisco Bay), and sampling within this limited area was further limited to just 15 trawls (approximately 25 percent of the trawls conducted in a typical year). This limited sampling resulted in the SWFSC spending substantial effort developing new model-based indicators for 8 species in the core sampling area, using methodology similar to that already applied to other groundfish surveys. SWFSC staff also developed methods to understand how limited sampling will affect uncertainty bounds for target species, and how historical survey results relate to other data sources. Specifically, they compared survey results with seabird diet data from the Farallon Island and krill data with a krill distribution model developed with oceanographic variables. Each of these analyses provide additional context for the survey, which can support the use of such limited survey effort in describing the pelagic ecosystem. These analyses will not be used to interpolate survey results from other data sources but to find multiple alternative sources of data that qualitatively support assessment of the ecosystem.

California Cooperative Oceanic Fisheries Investigations (CalCOFI) Surveys (Dr. Andrew Thompson)

The CalCOFI surveys sample larval fish communities in southern California and central California. This survey provides indices of spawning stock biomass for a wide range of forage fishes in the CCIEA.

The 2020 CalCOFI winter survey occurred but there was no spring survey due to the pandemic. Data from spring surveys are typically used in the CCIEA report, but analyses based on winter surveys will be used in this year's CCIEA report. Two-thirds of the analyzed forage species have higher abundances in spring than winter, but all species spawn in both winter and spring. The pandemic also limited the ability to process collected samples from the winter surveys. To date, only data from two of the six core survey lines have been processed and data from the remaining survey lines will likely not be available until late 2021. These two survey lines are considered representative of the core area.

B. Environmental Driver: Biological Response Threshold Analysis

Dr. Mary Hunsicker (NMFS/NWFSC) presented an analysis on detecting thresholds in biological responses to environmental drivers. This research is a continuation and expansion of previous material the SSCES reviewed in September 2017 (Samhouri et al., 2017). Several new time series (biological and environmental) and analyses beyond those included in Samhouri et al. 2017 are being considered for inclusion in the 2021 CCIEA report. The CCIEA team is also exploring the potential to use this approach to help fill in information about biological time series that may have missing data in 2020 or 2021 due to restricted sampling caused by the pandemic.

Threshold detection approaches may be useful for identifying ecosystem reference points and developing quantitative risk assessments, based on environmental pressures. The threshold detection approach uses generalized additive models (GAM/GAMM) to identify non-linear relationships between biological states and environmental pressures, and subsequently can identify the value or range of values in pressure variable where the shape of the relationship between the pressure and the biological state shifts. Dr. Hunsicker's analysis expanded the number of environmental pressure time series from 2 to 9, and the biological response time series from 4 to 18, including new data from the Central California Current. Linear and non-linear relationships were found and examples of thresholds of environmental pressures on biology were presented for sardines and sea lion pups.

Many of the recommendations from the SSCES review in 2017 have been addressed in the new analysis. Areas of discussion with the SSCES included potential ways to increase the robustness of the analysis, given concerns about the number of pairwise comparisons (>500) leading to potentially spurious relationships. The SSCES also discussed that using environmental pressures with finer spatial resolution may lead to identifying more proximate drivers and mechanistic relationships. However, the magnitude of the concerns about spurious correlations and the scale of the environmental pressures depends on how the results of this analysis are used. The SSCES suggests this approach is most appropriately applied as a screening tool to identify potential relationships and focus for future finer-scale research.

Recommendations from the SSCES included:

- Explore resampling or randomization tests to address the concern about spurious correlations in the analysis, as well as testing the robustness of relationships by quantifying prediction errors as timeseries length changes. Testing for relationships at implausible lags or for geographically disparate locations (i.e., "placebos") might also provide a sense of the false positive rate. Removing outliers was also suggested, but this might be difficult since the non-linear relationships might depend on some of the more extreme values or skewed distributions.

- Investigating the performance of thresholds during historical cases of ecosystem state change could also validate observed thresholds if the length of the time series allows.

- Consider simplifying the results by reducing the number of environmental variables analyzed, since some are not independent (Pacific decadal oscillation and sea surface temperature, for example).

The SSCES recommends caution in using the relationships fitted using these methods to draw conclusions about ecosystem status in this year's CCIEA report. In particular, using environmental pressures to predict missing biological response data would necessitate more exploration, quantification, and communication of uncertainties in the data and the method (GAM/GAMM), and acknowledging that these relationships are statistical, not mechanistic. The SSCES suggests that combining indicator times series with model predictions in a single figure may cause confusion, and that more qualitative use of any predictions is more appropriate at this time.

C. Groundfish Distribution, Port Availability Shifts, and Impacts to Catch Portfolios

The SSCES received two presentations under this agenda item: 1) "Availability of stock biomass to ports" from Dr. Nick Tolimieri (NMFS/NWFSC) on a method for estimating the distribution of several groundfish species and 2) "Understanding fishing communities through participation networks" from Dr. Jameal Samhouri (NMFS/NWFSC) on linkages between fisheries at the port level. While this agenda item is less directly related to COVID-19 impacts to fishing, expanding stock availability metrics to more species and including participation networks may create opportunities to better track impacts to west coast fisheries from large-scale perturbations (which could include a pandemic).

The method for estimating biomass distribution described by Dr. Tolimieri is based on a recently published paper by Selden et al. (2020). Observations from NMFS shelf-slope trawl surveys from 1980-2017 are used by the VAST model (Thorson 2019) to calculate a spatial distribution index for each stock. This index is then scaled by the Spawning Stock Biomass (SSB) from the latest assessment for each species to calculate an estimated biomass within specified areas. In this case, the areas are circles centered on each port considered in the analysis. This quantity is the biomass available to each port.

Selden et al. (2020) found no relationship between the biomass available and observed landings per fish ticket at specific ports. However, the analysts indicated that this work is useful as an indicator of stock distribution capable of highlighting distributional changes. The analysts also suggested that this port-level stock availability is one measure of ports' capacity or potential to access the resource and may be informative in questions of how to allocate catch.

Much of the discussion focused on the "settings" used to apply the VAST model when generating a spatial biomass distribution index. In the analysis presented here (based on Selden et al 2020), the inputs used in the VAST model differ from how VAST is implemented in PFMC stock assessments (e.g., the time span of the input data, distributional assumptions, units over which catchability is specified, functional form of the model intercept, and size of the cells in the map grid). The SSCES recommends that the analysts use the same settings as the latest stock assessment, which can be implemented using the VASTWestCoast wrapper package written by Kelli Johnson at the NWFSC. Output from VAST can be sensitive to the specified settings and the assessment group will continue to evaluate those sensitivities and maintain and update VASTWestCoast into the future. Therefore, future implementations of the analysis for the CCIEA report can remain consistent with recent stock assessments.

The SSCES also offered input on which species to evaluate. The analysis may not be well-suited for species that primarily utilize rocky habitats since the trawl survey does not sample those habitats effectively. Lingcod, in particular, may not be a good species to include for this reason. The percentage of positive tows by species may be a good metric to use to decide whether to include/exclude particular species.

The SSCES also recommended specifying the port biomass availability as a relative index, rather than in terms of absolute biomass. Not scaling the spatial index by assessment-estimated SSB keeps the result closer to the results estimated from the survey data. Also, there may be issues with scaling the index by SSB in cases with dome shaped selectivity or where recent assessments are not available.

The analysis finds no relationship between the estimated port biomass availability quantity and observed landings per fish ticket at specific ports. The SSCES recommends that this result be investigated further. The work to date does not control for non-biomass factors that may affect catch levels, especially prices, regulations, and technical production relationships between species. Also, the analysis could calculate the change in distribution relative to changes in CPUE or catch, rather than simply reporting the change in port availability in absolute terms. Future work could use observer or logbook data to calculate

catch per tow/set, which may be a more appropriate standardization than catch per fish ticket which is likely to be impacted by average vessel size, trip length and other factors.

The analysis of linkages between fisheries presented by Dr. Samhouri is based on recently published work by Fuller et al (2017) and Fisher et al. (2020). The analysis uses methods from social network analysis and graph theory to develop figures and metrics that measure diversity in fishery participation at the port level. During the discussion of this topic, the SSCES offered the following recommendations and feedback:

- The analysis is a good visualization of participation in fisheries and inter-regional differences in the combinations of fisheries available and complement the diversification indices in the report which use the same fishery definitions.

- It is not clear that the network metrics presented are good indicators of concepts like community vulnerability or resilience. More validation of how these concepts relate to these metrics is needed before the results can be discussed in these terms.

- The CCIEA report, if this work is to be included, could present results for each individual port. If this is not feasible, pick ports where large changes in the network metrics were observed over some time period.

- The results should be shown over time to get a sense of how fishing patterns have changed and to get some context about the observed range of results.

This is a topic to consider for inclusion in the annual CCIEA report. The SSCES recommends discussing this further with the CCIEA team during the March 2021 meeting for consideration at the SSCES meeting in September.

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Appendix A. Meeting Participants

SSC Ecosystem Subcommittee Members Present

Dr. Kristin Marshall (Subcommittee Chair), National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. John Field, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Marisol Garcia-Reyes, Farallon Institute, Petaluma, CA
Dr. Melissa Haltuch, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Michael Harte, Oregon State University, Corvallis, OR
Dr. Dan Holland, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Galen Johnson, SSC Chair, Northwest Indian Fisheries Commission, Olympia, WA
Dr. William Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

CCIEA Team Members Present

Dr. Brian Burke, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Toby Garfield, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Chris Harvey, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Mary Hunsicker, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Jameal Samhouri, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Jarrod Santora, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Andrew Thompson, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Nick Tolimieri, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Others Present

Dr. Jim Anderson, University of Washington, Seattle, WA
Mr. Kelly Andrews, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Kit Dahl, Pacific Fishery Management Council, Portland, OR
Ms. Yvonne de Reynier, National Marine Fisheries Service West Coast Region, Seattle, WA
Mr. John DeVore, Pacific Fishery Management Council, Portland, OR
Ms. Jaime Diamond, Stardust Sportfishing, Santa Barbara, CA
Dr. Michael Drexler, Ocean Conservancy, St. Petersburg, FL
Dr. Michael Harte, Oregon State University, Corvallis, OR
Ms. Theresa Labriola, Wild Oceans, Hood River, OR
Ms. Corey Ridings, Ocean Conservancy, Santa Cruz, CA
Dr. Tanya Rogers, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Tien-Shui Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Mr. Greg Williams, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA