DRAFT
Review of the CCIEA State of the California Current Annual Report by the Scientific and Statistical Committee Ecosystem Subcommittee

The Ecosystem Subcommittee of Scientific and Statistical Committee (SSCES) met with the California Current Integrated Ecosystem Assessment (CCIEA) team to review the annual State of the California Current Ecosystem (SOTCC) Report. The CCIEA team is primarily affiliated with the Northwest and Southwest Fisheries Science Centers. The meeting took place on December 15-16, 2014, at the NOAA Western Regional Center in Seattle, Washington. The meeting was open to the public, and public comments were accepted during the meeting.

The purpose of this meeting was to review the indicators used in the annual State of the California Current Ecosystem Report, which is delivered to the Pacific Fishery Management Council (Council) each March, and to consider how the report might be refined and improved. The first such report was presented to the Council in November 2012. The Council decided to reschedule the report to its March meeting, and received the second report in March 2014. The impetus for this meeting was the concern expressed by both the SSC and the CCIEA team that there was insufficient time during the SSC's review in March to conduct a detailed technical review of the indicators in report. Furthermore, by just focusing on the document at hand, there was no opportunity for the SSC to consider broader issues, such as how ecosystem reports might be improved and utilized in the Council process. The objectives of the meeting were to:

1. Evaluate the technical basis of indicators in the 2014 Annual State of the California Current Ecosystem Report, and make recommendations for their improvement.
2. Evaluate the overall structure and format of the annual ecosystem report, including how the information is summarized, and make recommendations for improving the format of the report.
3. Initiate a process for selection and evaluation of indicators to be included in the report.

It was recognized that this meeting was an initial attempt by the SSC to more thoroughly review the products being developed by the CCIEA team, and that additional reviews, potentially with a different format, might be required in the future.

The review meeting began with overview presentations by Phil Levin (NWFSC) and Chris Harvey (NWFSC), who discussed the goals of the CCIEA and the annual report to the Council. Then the SSCES considered technical criteria for evaluating ecosystem indicators. For the remainder of first day of the meeting, the SSCES received presentations and discussed technical aspects of the indicators in the 2014 report. On the second day, the SSCES received additional presentations on proposed new indicators for seabirds, habitat, and human dimensions. Stephani Zador (AFSC) gave an overview of how ecosystem considerations are included in the North Pacific Council process. The SSCES also discussed broader issues concerning how indicators are selected and evaluated. In an agenda item unrelated to the ecosystem report, Isaac Kaplan discussed and solicited guidance on draft minimum performance standards for end-to-end

models. This was a follow-up topic to the review of the Atlantis model earlier this year.

This report summarizes the SSCES's discussions on the ecosystem indicators, and provides recommendations both on refining ecosystem indicators and on how the ecosystem report is developed and utilized in the Council setting. The report concludes with a list of general comments and recommendations. Appendix 1 lists the participants and their affiliations. Appendix 2 includes a list of the primary and background documents that were provided to the SSCES in advance of the meeting on an ftp site. These documents included sections of the full CCIEA report, various publications in the peer-reviewed literature on indicator development and evaluation, and other supporting documents. The meeting agenda is included as Appendix 3.

The Chair thanks the NWFSC for hosting the meeting, and the participants for the excellent and constructive atmosphere during the review, the results of which should help inform the Council and its advisory bodies determine the best available science for ecosystem-based fisheries management.

A. *Background on the California Current IEA*

Dr. Phil Levin (NWFSC) opened the review by providing background information on both the CCIEA, and the annual STOCC report to the Council. One of the major goals of the CCIEA is to link drivers and pressures to diverse ecosystem components to better understand and ultimately forecast how changing environmental conditions and management actions affect the California Current ecosystem. Thus, the CCIEA focused on three questions: (1) What is a healthy ecosystem?, (2) Is the California Current ecosystem healthy?, and (3) What management strategies can improve or maintain ecosystem health?

In 2011, the CCIEA team, in collaboration with the Council's Ecosystem Plan Development Team, developed the idea for an annual SOTCC report, which would focus on information pertinent to Council's Fishery Management Plans (FMPs). The CCIEA team aims to provide available science, including information on human dimensions, in a way that connects the state of the ecosystem to implications for FMPs. Dr. Levin emphasized that the CCIEA team wants the information in the CCIEA to be used, and thus emphasized the importance of dialogue between the CCIEA team and intended users. The CCIEA team regards the Council as an important recipient of the information in the CCIEA, though the CCIEA by design has a broader scope than fisheries management and other important users.

As of yet, the Council has not fully specified objectives for the California Current ecosystem, so the report is currently based on what the CCIEA team believes may be valuable to the Council. The SSCES emphasized the importance of obtaining input from the Council and its advisory bodies regarding desired indicators or even indicator categories. Otherwise it is difficult to provide guidance to the CCIEA team on what indicators to include in the SOTCC. The indicators of interest to the Council could include those related to factors that management can control (e.g. catch) and those that are not controlled by management but could be used to inform management decisions (e.g. ocean conditions). Dr. Levin noted that the CCIEA team can also aid the Council in developing ecosystem reference points for management, but progress on these issues requires Council engagement.

B. ***Overview: 2014 State of the California Current Report***

Dr. Chris Harvey (NWFSC) introduced the format and an overview of the content of the SOTCC report. The report is intended to fulfill the Council request for a summary and synthesis of environmental, biological, and socioeconomic indicators, and for a given calendar year generally includes information gathered through the previous calendar year. The format for the report was established in November 2012, with an overall length of 20 pages, consistent formatting for data presentation, and highlights of the report given in a box on the front page.

The report is organized into four main sections: (1) climate and ocean drivers, (2) focal ecological components, (3) human activities, and (4) human wellbeing. The CCIEA team hopes to expand the human wellbeing section and add a section on habitat. Dr. Harvey also presented the idea of adding conceptual models to the SOTCC report, which would show the links between different ecosystem components, as way of illustrating the relevance of different indicators. The SSCES agreed that conceptual models are valuable, but space restrictions for the SOTCC report may limit their use to presentations and supplementary materials.

The CCIEA team considered their oral presentation of the report to the Council to be a valuable means of interacting with the Council, complementing the report itself. Tailoring the presentation and report to action items and FMPs will facilitate more engagement by the Council.

C. ***Criteria for Indicator Evaluation***

Mr. Kelly Andrews (NWFSC) presented the methodology for the selection and evaluation of indicators used in the CCIEA. Indicators are used to measure the status and trend of three categories of components: focal ecosystem components (such as ecological integrity and human wellbeing), mediating components (such as habitat and human activities), and drivers and pressures (including climate and ocean drivers and social drivers). Potential indicators were evaluated based on relevance to the goals of NOAA, using a standardized, repeatable, and transparent indicator evaluation process. The goal was the development of a consistent indicator portfolio across the CCIEA with minimal redundancies.

First, a wide range of potential indicators was identified from the literature, and this range was screened and scored based on 18 criteria from Kershner et al. (2011). The scores were then weighted based on an informal survey of managers selected from the NMFS regional office, the West Coast regional office of the National Marine Sanctuary Program, and NMFS headquarters. The final suite of indicators selected was based on those scores and the cumulative information provided by the inclusion of the indicator in the CCIEA portfolio. Data considerations, such as signal-to-noise ratio, are currently assessed in a qualitative rather than quantitative manner. While it may seem parsimonious to use the same indicator in many categories if it scores highly for all of them, the indicator literature suggests that having more indicators in a portfolio increases the likelihood of early warning of ecosystem problems. The selection process can also be used for gap analysis to identify priority data needs.

The SSCES suggested that some criteria be developed to rule out indicators that are inappropriate, either due to poor data quality or because they do not relate to the ecosystem

irrespective of whether they may be identified as relevant by stakeholders. Currently, there is nothing in the screening process that rules out an indicator for consideration.

The SSCES also emphasized the importance of involving the Council and its advisory bodies in the process of selecting indicators for Council use. Indicator selection involves both technical considerations and policy issues. Technical review by the SSC would ensure that candidate indicators meet scientific standards. A workshop or series of workshops could solicit input from management teams and advisory subpanels on indicators that represent the ecosystem objectives expressed in the Council's FMPs and FEP, and are relevant to Council decision-making.

D. *Technical Review of Climate/Ocean Indicators*

Basin-scale Climate Indicators
Dr. Andrew Leising (SWFSC) gave a presentation on the three basin-scale climate/ocean indicators included in the SOTCC report. The Pacific Decadal Oscillation (PDO) measures temperatures across the north Pacific, with a warm state generally linked to low productivity of the California Current Ecosystem (CCE). The North Pacific Gyre Oscillation (NPGO) is an index of transport, with positive values representing transport of nutrient-rich waters from the north, and usually favoring high productivity in the California Current. The Multivariate ENSO Index (MEI) describes the El Nino/Southern Oscillation (ENSO), with positive values indicating El Nino conditions (associated with warmer surface waters and weaker upwelling winds in the CCE) and negative values indicating La Nina conditions (the reverse).

Discussion of these indices suggested that it was unlikely that specific threshold values could be identified for use in fisheries management; rather, a narrative synthesis of the three indicators was necessary to understand the state of the CCE. For example, as of winter/spring 2014 all three indicators were coming into the same "phase" (sign with similar predicted impacts on the CCE), which is distinct from the last several years when the indices have been out of phase. It was also noted that characterizing recent conditions based on a 5-year average or trend ignores a large amount of variability. It was proposed that it would be more informative to look at the current value of indices, the current "regime" (or sign) of the indicators, and time since the last change in sign.

Regional Climate Indicators
Regional scale indicators were discussed only briefly, with most of the discussion focusing on upwelling. It was noted that the Bakun upwelling index presented in the reports (e.g., Figure 2.2 of the 2014 report) is calculated indirectly on the basis of winds, and does not account for the effects of water-column stratification. This is expected to be relatively unimportant for interpretation of conditions in the north, but may be problematic south of approximately 36°N. It was suggested that plots of annual cumulative upwelling (as shown in Dr. Leising's presentation) would be easier to interpret than visually busy plots of monthly anomalies (e.g. Figure 2.2 of the 2014 report). It was noted that the link between upwelling and productivity (e.g. chlorophyll a) is discussed in the CalCOFI State of the California Current report, but not the CCIEA team's 20-page report to the Council.

Northern Copepod Biomass/Richness Anomalies

Ms. Jennifer Fisher (Oregon State University Cooperative Institute for Marine Resource Studies) described the copepod-based indicators presented in the CCIEA. The copepod community in the CCE reflects contributions of both northern species (a relatively species-poor group of relatively large and high-lipid organisms) and southern species (more species rich, but smaller and with lower lipid content). Food chain structure in the CCE is thus affected by changes in transport, with transport from the north resulting in a system characterized by northern species (and thus a large northern biomass anomaly and low species richness) whereas influx of subtropical waters results in a negative northern copepod biomass anomaly and higher species richness.

Several regression analyses were presented showing a positive relationship between northern copepod biomass (as measured at a single oceanographic station off Newport) and Chinook returns two years later, a negative relationship between copepod species richness and Chinook returns, a negative relationship between the northern copepod anomaly and sardine recruitment, and a positive relationship between northern copepod anomaly and sablefish recruitment. None of these analyses explicitly considered sampling error for either the copepod indices or the response variables, and it is recommended that any further analyses to evaluate relationships between copepod indices and response variables incorporate sampling error.

The SSCES noted that the copepod diversity indicator could be confusing to some audiences, since high copepod diversity is associated with low productivity or "poor" conditions in the CCE, whereas high biodiversity is generally considered to be positive attribute of ecosystems. In addition, species richness is a bounded/self-limiting indicator, since the total species pool is fixed. It was suggested that the southern copepod biomass anomaly would be easier to interpret, and likely more closely linked to the mechanistic food web effects of changes in ocean transport and the copepod community.

E. ***Technical Review of Coastal Pelagic Species Indicators***

Dr. Brian Wells (SWFSC) presented on the coastal pelagic species indicators in the CCIEA report. Many of the indicators in this section of the SOTCC report are not meant to characterize the status of managed CPS stocks, but rather to describe the condition of the regional forage base for other species in the CCE. This forage base includes local abundance of some managed stocks, but also includes species that are important as forage. Future versions of the report should make this point explicitly, and to avoid confusion with the unfished forage fish protection initiative, the SSCES suggests using the term "forage base" to refer to the complex of important forage fish, whether fished/managed or not.

Trends in anchovy and sardine larvae (southern CC) or juveniles/adults (central and northern CC) are presented separately for each region (Figure 3.3 of the 2014 report), as are standardized log residuals of multiple forage base species (Figure 3.4 of the 2014 report). This separate presentation is necessitated by the fact that surveys in the different regions use different gear and were designed for different sampling goals. This confounding of region and sampling methodology complicates the interpretation of patterns at the scale of the CCE. Dr. John Field (SSC, SWFSC) noted that for some years the central CCE survey was extended to the southern CCE, and in other years it was extended to the northern CCE. An analysis should be conducted for these years comparing catchabilities across survey designs in common areas and the

coherence of trends across regions in common years evaluated, although this likely would not be a repeated part of the 20-page report.

Other challenges to interpreting the survey data for CPS remain. In all cases, the surveys have limited spatio-temporal coverage and were not designed explicitly for the purpose of enumerating forage fish abundance. It is unclear to what extent apparent changes in abundance (and thus any derived relationships between apparent abundance and environment) reflect true changes in abundance versus changes in catchability. Figure 3.4 of the 2014 report presents anomalies for each species or species group in terms of standard deviations of log-transformed abundance estimates. While standardizing by SD allows for easier visual presentation, it obscures the differential impacts on total forage base due to changes in species with disproportionately high or low abundance and/or variability. The utility of log-transformation was questioned since predators would presumably respond to biomass rather than log biomass available (although other issues, such as catchability, would remain in interpreting the untransformed data). Log transformation was used in part to account for sampling effects and rare events, but either a delta-GLM(/GLMM) or Multivariate Autoregressive State Space (MARSS) approach would be better supported statistically and mechanistically.

Several avenues for future work on incorporating CPS and forage-base considerations into the SOTCC report and the CCIEA process were identified. There was considerable discussion about appropriate ways to summarize total forage availability on the basis of abundance estimates from multiple species. Beyond the issue of log-transformation, it was clear that while biomass of prey would be important to predators, the importance of biomass of different prey species would depend on their respective suitabilities. Suitability would need to be determined using diet data, but it was noted that abundance in diet samples alone does not reflect suitability, which must also account for changes in the availability of different prey species during the time period when diet data are collected. It was suggested that multivariate approaches such as PCA might summarize multispecies data more conveniently, but would not necessarily have a straightforward interpretation, although use of PCA to characterize seabird data in the NPFMC's Ecosystem Considerations document has been well-received.

Further research on how to scale and synthesize outputs from the different regions with different surveys is required, and a more comprehensive sampling procedure applied coastwide would yield much more valuable data. Thought is needed to develop composite indices that would be of potential utility in management, as well as guidance on how the Council might respond to indications of changes in the overall forage base, independent of assessments of particular managed stocks. It would be useful to identify potentially actionable indicators and threshold values that could conceivably lead to discrete responses or be used in control rules. In other words, actionable indicators should be reliable measures of important and understood components of the ecosystem, and should also represent quantities that can be expected to change in response to management actions.

Although not presented in the 2014 report, abundance indicators from stock assessments of Pacific mackerel and sardine were presented at the meeting. If presented in the 2015 report, the results should be shown in arithmetic space (rather than log-transformed) for consistency with groundfish conventions, and the y-axis should start at zero. Similarly, PCA results were not

presented in the 2014 report but were used to characterize several assemblages during the presentation, and the SSCES expressed uncertainty about what these numbers truly represent and how they should be interpreted.

F. ***Technical Review of Groundfish Indicators***

Dr. Jason Cope (NWFSC) presented on the groundfish indicators in the CCIEA report. The report summarized the status of population sizes and population demographic conditions for 36 stocks. Additionally, Dr. Nick Tolimieri (NWFSC) presented groundfish mean trophic level (MTL) as an indicator of changes in trophic structure for groundfish.

Selected indicators of population size were 1) biomass relative to unfished biomass or survey biomass trend, and 2) the number of assessed species under management thresholds. Figure GF1 in the CCIEA report summarizes the status of assessed stocks relative to management thresholds. The SSCES recommends using different labels in the figure for species managed under rebuilding plans. The SSCES also noted the use of "total mortality/ABC" as an overfishing threshold may cause confusion since this threshold differs among species. For population size trends, the SSCES recommends using a consistent starting year on the x-axis.

Mean population age and size were selected as indicators of demographic condition. The SSCES raised several concerns about this indicator.

- It may be redundant to the SPR estimated in the assessment.
- A high value is not always good and a low value is not necessarily bad. For example, during good recruitment years, the values will drop. High values may actually be due to low recruitment.
- No threshold is defined for management use, though the mean age and size corresponding to the default harvest proxies (i.e., $F_{40\%}$) may provide a useful reference value.

For area-weighted ecosystem MTL, the species-specific trophic level information was taken from Fish Base and the species composition was based on the NMFS combo bottom trawl survey data. The SSCES has the following concerns:

- The NMFS combo bottom trawl survey is dominated by groundfish species. An ecosystem MTL should include high trophic level species that are not captured by bottom trawls.
- Trophic levels reported in Fish Base are not always reliable, and should be compared with available diet data.
- A trawl survey MTL is sensitive to changes in the catchability of different species to bottom trawl gear. While it may be informative about changes in the near bottom fish community, it may be less informative about the ecosystem as whole. For example, when spiny dogfish and Pacific hake move up the water column and became unavailable to the trawl, the MTL value will change but this does not necessarily imply a change in the ecosystem.
- As with mean age/size, it is difficult to decide what values are good or bad. No threshold can be defined for management use.

The difficulties in interpreting mean trophic level from the NMFS combo bottom trawl survey indicate that it is not a useful indicator of ecosystem status, and should be removed from the report. The SSCES suggests exploration of aggregate biomass indicators of functional groups, such as a benthic foragers, pelagic foragers, etc. Model-based approaches (i.e., GLMMs) are used routinely with bottom trawl survey data for stock assessment, and could be considered for ecosystem indicator development as well.

G. *Technical Review of Salmon Indicators*

Dr. Brian Wells (SWFSC) presented on Chinook salmon indicators used in the SOTCC report and associated documents. Dr. Thomas Wainwright (NWFSC) and Dr. Thomas Williams (SWFSC) were available via telephone to answer questions. Stocks in the report are characterized on the basis of their escapement (the number of fish returning to spawn), which reflects both natural ecosystem processes and harvest (the human component of the ecosystem). Data on stock-specific production (adding harvested fish back in) were not presented since stock-specific harvest estimates are only available for select stocks. However, presenting production (for select indicator stocks) as well as coastwide escapement would add information on fish abundance in the ocean and their potential contribution to the ecosystem.

The data sources used for escapement of each stock were not well documented, and there appear to be inconsistencies in how the datasets used for different stocks accounted for fish spawning in natural areas versus those returning to hatcheries, and potentially for fish of hatchery origin or natural-area origin. Future versions of the SOTCC report should strive for transparency and consistency across stocks. Since Sacramento River fall Chinook are an important stock but lack estimates of hatchery- versus natural-origin contributions prior to 2010, consistency will require considering total escapement regardless of origin. The SSCES recommends that escapement be calculated as the sum of natural-area spawners and hatchery returns, to reflect the total number of salmon leaving the ocean ecosystem.

In future versions of the SOTCC report, the plot of recent abundance and recent trend (e.g., Figure 3.5 in the 2014 report) should have the axes switched to match the convention used in groundfish (e.g. Figure 3.6 of the 2014 report).

H. *Technical Review of Upper Trophic Level Indicators*

Dr. Jeff Laake (AFSC) presented background on the current indicator for upper trophic levels in the California Current, California sea lion pup production. California sea lions are permanent residents of and migrate throughout the range of the California Current, and therefore their condition can integrate changes in the productivity of the California Current. Long term data available on California sea lions includes 40 years of pup counts, pup mortality pup condition, 30 years of diet and food habits, and 20 years of demographic data on survival, natality, and foraging distribution and behavior. Live pup counts (a proxy for births) and pup growth were chosen for the SOTCC report as they are sensitive to prey availability Live pup counts have generally increased since 1975, but temporary declines have occurred in years associated with El Niño events. Pup growth has been monitored since 1997, and is more sensitive to year to year variations in productivity.

The SSCES noted that if California sea lions are approaching carrying capacity, population fluctuations are expected and may not indicate ecosystem changes as they would during a period of population growth. Pup births and condition likely represent the ecosystem attributes of the foraging range of the mothers, primarily in Central and Southern California, so only part of the California Current is represented. The SSCES would like to see upper trophic level indicators that represent the entirety of the California Current ecosystem. Steller sea lions are a possible alternative or complementary pinniped indicator, but are more difficult to sample so only survival data is currently available. Data are available on male California sea lion survival, and that may better represent the spatial extent of the California Current. Harbor seals trends would also provide a wider geographical range, although each population would reflect local nearshore conditions. The SSCES recommends that more diversity in upper trophic level indicators be included in the SOTCC report, and discussed reproductive indices for seabirds, harbor seal trends by state, and southern resident killer whale population trends as potential indicators. SSCES recognizes that limitations on data quality and quantity may restrict the number of upper trophic level indicators that can be added to the SOTCC report.

I. *Technical Review of Human Dimensions Indicators*

Fleet Diversity

Dr. Dan Holland (NWFSC) gave a presentation on fishery income diversification and risk for West Coast fishermen and fishing communities. This analysis and indicator are intended to examine variations in fishery income to vessels and ports attributed to the number of fisheries in which vessels participate. Changes in income result from changes in both landed catch and ex-vessel prices. Diversification of fishery participation decreases inter-annual variability of total vessel (port) income as income from different individual fisheries becomes less correlated.

Diversification is measured via the Herfindahl-Hirschman Index (HHI) using data from 1981-2012. Since many vessels that fish off the West Coast also participate in Alaska fisheries, the analysis uses data from both regions. Over 28,000 vessels that fished from 166 ports are included. West Coast species were grouped into 17 categories, and Alaska species were grouped into 23 categories. The results show that, in general, the West Coast fleets have become less diversified over time. An examination the most recent participants (2012) by state indicates diversification has also decreased over time in all three West Coast states. The decrease in diversification is a general trend, and there is a fair degree of inter-annual variation. The most recent years of analysis show that diversification has increased from its historical lows in Washington and California. The California fleet tends to be the least diversified. The analysis also shows that larger vessels and those with more annual revenue tend to be more diversified than smaller vessels and those with less annual revenue. The port level diversification analysis shows considerable variation over time for particular ports, and a great deal of variation across ports.

Using a non-linear regression model, the analysis estimates the relationship between income variation (measured by the CV for income) and the HHI. The estimated non-linear function is then used to show the relationship between diversification and income variability. At both the vessel and port level, greater diversification is estimated to decrease the variability of annual income.

There were several comments about the analysis.

- The diversification index is a useful indicator as it may show which fleets or ports are at less risk to annual changes in income.
- It is not known whether changes in income are driven more by changes in harvest or changes in ex-vessel prices, and to what degree those quantities are collected. An understanding of this would provide more context to understand what is driving the income variation.
- It would be helpful to consider diversification in terms of gear as well as species, given the effect of gear configuration on the versatility of fishing vessels.
- It may be incorrect to assume that more diversification is always better. The analysis is based on gross revenue, so it does not include variable or fixed costs. Diversification does have costs in terms of gear switching, perhaps altering the configuration of a vessel, and in the catch share fisheries purchasing quota. Diversification may also lower efficiency due to lack of specialization. These costs may outweigh potential gains of less income variability.
- It is important to note that the port measures are for the port of landing, and not all income stays in that port, or even initially accrues to that port.
- It would be useful to extend the analysis to determine whether particular management measures have increased or decreased diversification. These measures include license/permit limitations, catch shares, and seasonal fishery closings.
- Using longer than annual blocks or a moving average would be a useful exploratory analysis to determine if it reveals a more stable trend.
- In order to update the indicator for subsequent reports, it will be necessary for NWFSC economists to collaborate with AFSC economists, both for data access and modeling.

Personal Use

Dr. Melissa Poe (NWFSC) gave a presentation on personal use of landings by commercial operators in Washington and California (Oregon data are not available). The data were derived from PacFIN fish ticket records for personal use using the "human food" code for product use. The indicator is tons of personal use over time by tribal and non-tribal designations in Washington, while separate tribal and non-tribal data are not available in California. This indicator is being developed because personal use is important in coastal communities, and the data are the only available time series. In theory, the indicator provides important and useful information. However, questions were raised about the quality of the data in terms of its completeness and consistency both over time, and between tribal and non-tribal sectors. The SSCES recommends continued investigation into the collection and reporting of the data. Regulations and reporting requirements concerning personal use may differ by agency, and should also be investigated.

J. *Technical review of other indicators (e.g., anthropogenic pressures, seabirds, HMS, as needed)*

Dr. Tom Good (NWFSC) presented information about plans to include information about seabirds. Trend information on seabirds would be a useful addition to the SOTCC report because seabirds have diverse foraging behavior and often prey on forage species that are important to fisheries management. Graphs of common murre and Cassin auklet density over time were

shown as example indicators. The counts occur in June and July and are tracked as separate indicators. Future reports will include similar indicator graphs for these and additional species, as well as possible other information on habitat use, reproductive performance, mortality rates, and diet composition. The analysis and suite of indicators should be reviewed when they are available in the next report. Reproductive indices are likely more meaningful than count data, especially at sea. For example, the time series presented contained multiple "spikes" which might be explained by movement, but occurred and then disappeared too quickly to be explained by demographic processes of birth and death.

K. ***Example from AFSC: North Pacific Ecosystem Considerations Report***

Dr. Stephani Zador (AFSC) briefed the SSCES on the Alaska Fisheries Science Center's North Pacific Ecosystem Considerations Report, which has been prepared for and presented to the North Pacific Fishery Management Council (NPFMC) annually since 1995. This allowed both the CCIEA team and the SSCES to consider a comparable report, and better understand what could be learned from the evolution of the NPFMC process. The current NPFMC report has evolved from a simple "compendium of general information" in 1995 to one with considerable content and structure that has been organized iteratively within technical teams and with feedback from stakeholders. The timing of the report's review and presentation to the NPFMC has also been aligned to coincide with the timing for stock assessments, to increase the opportunity for ecosystem information to influence key decisions where appropriate.

The current format includes a suite of report cards (approximately 7 pages, one to two pages per ecosystem or ecoregion), to summarize the status of the top indicators for the ecosystems reported on for the NPFMC, an Executive Summary of the entire report (~ 20 pages), an Ecosystem Assessment that synthesizes climate and fishing effects on the different ecosystems based on data from the stock assessments (~40 pages), and finally a section on Ecosystem Status and Management indicators (over 160 pages, covering 50 indicators in 14 categories). Within the Ecosystem Assessment are included "hot topic" summaries of very timely or ongoing events. For example in 2014 information was summarized regarding the Northeastern Pacific "warm blob" of anomalously high ocean surface temperatures which were associated with mushy halibut flesh and reproductive failure in many seabird populations. Highlights are also presented directly to the Council each year. A separate report is also prepared for economic indicators, and both reports are revised annually in response to review by the NPFMC SSC, as well as comments from plan teams, advisory bodies and the public, to ensure that the report remains an adaptive document that can facilitate and improve the ability to utilize environmental and ecosystem information.

From the NPFMC experiences, the items of greatest interest have been the interpretation of the trends in various indicators regarding the implications for fisheries management. Although there are relatively few examples in which the NPFMC's evaluation of indicators directly affected management decisions, one example was discussed related to the applied use of ecosystem information in making a key ABC determination. In this example, the combined observations of a declining (yet above target levels) stock size, a distributional shift of the stock, a declining index of prey (zooplankton) for recruits, and increasing predation (by arrowtooth flounder) on juveniles was used to justify a reduction in the target catch of Eastern Bering Sea Pollock in

2006 for the 2007 target catch level.

In discussing the role of ecosystem information, Dr. Zador clarified that the NPFMC SSC is not currently required to formally respond to or address in a quantitative sense any ecosystem considerations results or trends that might raise alarm bells, although from experience there is generally considerable interest in discussing and better understanding any such results. The longer term goals of the effort for the NPFMC and the AFSC include improving predictive capacity, developing potential ecosystem thresholds, and moving or integrating indicators directly into stock assessments. However, it is also recognized that there will always be a role for the qualitative synthesis for those events/observations that are outside the bounds of current modeling systems for solely informative purposes. There was some discussion regarding the utility of having separate reports for environmental/ecosystem indicators relative to economic/human dimension indicators, but overall the NPFMC formats and lessons learned were found to be informative by both the SSCES and the CCIEA team members present.

L. ***Format of Annual Ecosystem Report***

There was insufficient time to discuss this agenda item directly, though it was discussed indirectly in several other agenda items.

M. ***Format of Linked Web Pages***

There was insufficient time to discuss this agenda item.

N. ***Minimum Performance Standards for End-To-End Models Isaac Kaplan***

Dr. Isaac Kaplan (NWFSC) outlined draft minimum performance standards for end-to-end models which were developed in response to a recommendation from the SSC review of the Atlantis Model. The proposed performance standards were designed specifically for end-to-end models that are to be used for providing strategic management advice rather than other types of ecosystem models such as Models of Intermediate Complexity (MICE).

The SSCES generally supported the proposed performance standards. It offers the following suggestions for further modifying the standards:

- The evaluation of persistence should be conducted for the case when there is no fishing. There is a need to define "persistence." Possible definitions could be that no stock biomass drops below 1% (or 5%) of its initial stock biomass.
- In simulations with no stochasticity, constant oceanographic forcing and no fishing, there should be no significant trends in biomass except for stocks for which cyclic behavior would be expected (such as cannibalistic species).
- Standards "Hindcasts" and "Agreement with data" should be combined, and what "80% of biomass" means should be specified. In addition, the model should mimic observed trends in any species which are the focus for analyses, especially analyses that are to be presented to the Council.
- Stocks which exhibit cyclic or periodic dynamics historically should show such dynamics

into the future.
- The evaluation of natural mortality should also consider whether the mortality rate for adults is roughly consistent with expectations from life history theory or longevity.
- Whether the model mimics the expected length / weight structure should be evaluated as well as whether it mimics the expected age structure.

The SSCES recommends that standards be developed for the harvesting component of the model. For example, standards could be developed for whether catches occur spatially as expected, whether vessel behavior is realistic, and whether bycatch rates are replicated.

O. ***Initial Review of New Habitat Indicators***

Dr. Correigh Greene (NWFSC) provided an overview of the plan for how indicators related to habitat condition will be developed, including considerations related to the spatial framework within which the indicators will be developed. This plan is focused on four conceptual models for how habitat impacts sentinel species. A list of potential indicators were provided, scored according to the selection criteria outlined in Section C above, along with a gap analysis highlighting information which is missing and indicators which are desirable but have yet to be developed.

Several questions were identified (which are the most important indicators, how to select reference points for these indicators, what spatial scale is most relevant for defining indicators, and how critical is reporting of uncertainty), the resolution of which would help to select new indicators. The SSCES noted that these questions pertained to all indicators. In relation to spatial scale, the SSCES noted that for freshwater habitat, a focus on river basin scale would be appropriate. The analysis and suite of indicators should be reviewed when they are available in the next report.

P. ***Initial Review of New Human Dimensions Indicators***

Dr. Sara Breslow (NWFSC) gave a presentation on Social Wellbeing Indicators for Marine Management (SWIMM). SWIMM is a two-year project supported by the NWFSC, Washington Sea Grant, and the University of Washington whose primary purpose is to develop human wellbeing (HWB) indicators for the CCIEA. SWIMM has identified over 3,000 indicators from 52 social-ecological indicator projects worldwide. Candidate HWB indicators from the 52 projects, a literature review, and local input are being organized into six priority domains: resource access, self-determination, social integrity, job quality, food systems, and intangible connections to nature. The next step would be to test promising HWB indicators with data and make them available to the Council and other managers of marine resources.

The SSCES notes that human dimensions expertise on the CCIEA team would be particularly useful for addressing some of the Ecosystem Initiatives identified in Appendix A of the Council's Ecosystem Fishery Management Plan, most notably "Human Recruitment to the Fisheries" and "Cross-FMP Socio-Economic Effects of Fisheries Management".

Q. ***Discussion: Process for Selecting and Evaluating Indicators for the Report***

The CCIEA Team would like further guidance regarding the types of indicators that would facilitate Council consideration of ecosystem initiatives and ecosystem dynamics in fishery management deliberations. The SSCES noted that any guidance regarding potential Council applications of such indicators would need to come from a more inclusive process involving the Council and its advisory bodies (i.e., not just the SSC). One way to obtain such guidance would be a workshop attended by members of the Council, the CCIEA Team, and appropriate Council advisory bodies (including the SSCES). The CCIEA Team also would like to establish a routine schedule whereby they receive SSC input 3-6 months prior to completing their annual SOTCC report. Given the current state of development of report, the SSCES recommends a one day meeting with CCIEA Team to review proposed improvements to the report, ideally in association with a Council meeting. This request should be considered as part of the SSC's routine discussions regarding workload planning.

General Comments and Recommendations

1. Indicator development should take advantage of new tools for analyzing survey data and time series. Distinguishing between observation error and process error is an important issue for nearly every indicator in the report. Consider applying state-space models to analyze data time-series to help distinguish process from observation error. State-space models can estimate the observation and process error variances. However, the performance of these models is optimized for short time-series if independent estimates of observation error variances are available.
2. The Council and its advisory bodies should have a stronger role in selecting indicators for the report. Indicator selection involves both technical considerations and policy issues. Technical review by the SSC would ensure that candidate indicators meet scientific standards. A workshop or series of workshops could solicit input from management teams and advisory subpanels on indicators that represent the ecosystem objectives expressed in the Council's FMPs and FEP, and are relevant to Council decision-making.
3. The present title of the annual ecosystem report is potentially confusing, and is too similar to the State of the California Current report in CalCOFI reports, a scientific journal. A different title should be used to clarify that the report is a formal product of the CCIEA process, and is focused on indicators of interest to the Council.
4. Management application of indicators (at any geographic scale) would require feedback between the status components of the CCIEA and the Management Strategy Evaluation (MSE) components of the CCIEA, a consideration of sampling/measurement error, and consideration of appropriate time lags (e.g. upwelling, productivity, and food supply may affect the returns of salmon susceptible to the fishery 2-3 years later). Qualitative analysis of indicators (as in the "traffic-light" approach) is of limited use in management decision-making, but could potentially be used for ad-hoc adjustments to harvest recommendations (e.g. the North Pacific pollock example).
5. Although the 20-page limit for the ecosystem report has served a useful purpose, there is some danger that this constraint may hamper the creativity of the CCIEA team in developing products useful to Council. The more extensive experience in NPFMC with ecosystem reports has produced in a variety of reports, ranging from very short 1-2 page ecosystem status summaries, to longer but still focused ecosystem assessments of around

40 pages. The schedule of presenting ecosystem information to the Council should also be regarded as open to revision, given the NPFMC example where the timing of the annual process provides an opportunity for ecosystem information to influence management decisions where appropriate.

6. There is an important role for narratives in the ecosystem report in addition to simply showing indicator trends. For example, a carefully crafted narrative can synthesize basin-scale and regional climate indicators to characterize current conditions. Narratives can establish probable links between indicator trends and fishery management issues important to the Council. Conceptual models are another tool for building a better understanding of the linkages between ecosystem components.
7. There would be benefit in establishing a routine schedule whereby the CCIEA receives SSC input 3-6 months prior to completing their annual State of the California Current report. Given the current state of development of report, SSCES recommends a one day meeting with CCIEA Team to review proposed improvements to the report, ideally in association with a Council meeting. This request should be considered as part of the SSC's routine discussions regarding workload planning.

Appendix 1: List of Participants

SSC Ecosystem Subcommittee members:
Martin Dorn (Chair), SSC, AFSC
John Field, SSC, SWFSC
Galen Johnson, SSC, Northwest Indian Fisheries Commission
Todd Lee, SSC, NWFSC
André Punt, SSC, University of Washington
Will Satterthwaite, SSC, SWFSC
Cindy Thomson, SSC, SWFSC
Tien-Shui Tsou, SSC, Washington Department of Fish and Wildlife

Pacific Fishery Management Council:
Kit Dahl, Council Staff
Mike Burner, Council Staff

CCIEA Team (remote participants indicated with *):
Kelly Andrews, NWFSC
Sara Breslow, NWFSC
Alison Collins, NWFSC
Jason Cope, NWFSC
*Jennifer Fisher, Oregon State University Cooperative Institute for Marine Resource Studies
*Toby Garfield, SWFSC
Tom Good, NWFSC
Correigh Greene, NWFSC
Chris Harvey, NWFSC
Dan Holland, NWFSC
Isaac Kaplan, NWFSC
*Jeff Laake, AFSC
*Andrew Leising, SWFSC
Phil Levin, NWFSC
*Aaron Mamula, SWFSC
Melissa Poe, NWFSC
Jameal Samhouri, NWFSC
Nick Tolimieri, NWFSC
Brian Wells, SWFSC
*Thomas Wainwright, NWFSC
Greg Williams, NWFSC
*Thomas Williams, SWFSC

Others in Attendance (remote participants indicated with *):
Maggie Allen, University of Washington
Yvonne deReynier, NMFS West Coast Region
Ben Enticknap, Oceana
Kirstin Holsman, AFSC
Corey Niles, Washington Department of Fish and Wildlife

Corey Ridings, Ocean Conservancy
*Theresa Labriola, Wild Oceans
Kristin Marshall, University of Washington/NWFSC
Steve Marx, Pew Charitable Trusts
Brit Sojka, University of Washington
Stephani Zador, AFSC

Appendix 2: Documents reviewed

Andrews, K. S., G. D. Williams, V. V. Gertseva. 2013. Anthropogenic drivers and pressures. CCIEA Phase III Report 2013. NOAA. 161 p.

Breslow, S., D. Holland, P. Levin, K. Norman, M. Poe, C. Thomson, R. Barnea, P. Dalton, N. Dolsak, C. Greene, K. Hoelting, S. Kasperski, R. Kosaka, D. Ladd, A. Mamula , S. Miller, B. Sojka, C. Speir, S. Steinbeck, C. Thomson, and N. Tolimieri. 2013. Human dimensions of the CCIEA: a summary of concepts, methods, indicators, and assessments. CCIEA Phase III Report 2013. NOAA. 37 p.

Cope, J., and M. Haltuch. 2013. Groundfish. CCIEA Phase III Report 2013. NOAA. 64 p.

Greene, C., K. Andrews, T. Beechie, D. Bottom, R. Brodeur, L. Crozier, A. Fullerton, L. Johnson, E. Hazen, N. Mantua, C. Menza, M. Sheer, W. Wakefield, C. Whitmire, M. Yoklavich, and J. Zwolinski. 2013. Selecting and evaluating indicators for habitats within the California Current large marine ecosystem. CCIEA Phase III Report 2013. NOAA. 113 p.

Hazen, E. L., I. D. Schroeder, J. Peterson, B. Peterson, W. J. Sydeman, S. A. Thompson, B. K. Wells, S. J. Bograd, N. Garfield. 2013. Oceanographic and climatic drivers and pressures. CCIEA Phase III Report 2013. NOAA. 76 p.

Kaplan, I. Proposed Standards for Ecosystem Model Performance. Unpublished manuscript. 2 p.

Kasperski, S and D. S. Holland. 2013. Income diversification and risk for fishermen. Proceedings of the National Academy of Sciences 110(6):2076–2081.

Kershner J., Samhouri J.F., James C.A., Levin P.S. 2011. Selecting Indicator Portfolios for Marine Species and Food Webs: A Puget Sound Case Study. PLoS ONE 6(10): e25248. doi:10.1371/journal.pone.0025248.

NOAA. 2014 State of the California Current Ecosystem Report. Report to the Pacific Fishery Management Council, March 2014, Agenda Item C.1.a, Attachment 1, 20 p.

NOAA. 2014 State of the California Current Ecosystem Report, Supplementary Material. Report to the Pacific Fishery Management Council, March 2014, Agenda Item C.1.a, Attachment 2. 81 p

Sojka, B. 2014. Integrating Human Wellbeing Assessment into Marine Resource Management. 2014. Master Thesis. School of Marine and Environmental Affairs, University of Washington. 127 p.

Wells, B. K., R. D. Brodeur, J. C. Field, E. Weber, A. R. Thompson, S. McClatchie, P. R. Crone, K. T. Hill, C. Barceló. 2013. Coastal pelagic and forage fishes. CCIEA Phase III Report 2013. NOAA. 46 p.

Wells, B., T. Wainwright, C. Thomson, T. Williams, N. Mantua, L. Crozier, S. Breslow, and K. Fresh. 2013. Pacific Salmon. CCIEA Phase III Report 2013. NOAA, 102 p.

Williams, G.D., K. S. Andrews, J. F. Samhouri, N. Tolimieri, C. Barcelo, R. D. Brodeur, J. Field, B. Peterson, A. Thompson. 2013. Ecological integrity. CCIEA Phase III Report 2013. NOAA. 77 p.

Background document:

Zador, S. (ed.), 2014. Ecosystem Considerations 2014, Stock Assessment and Fishery Evaluation Report, North Pacific Fisheries Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Appendix 3: Agenda

Scientific and Statistical Committee Ecosystem Subcommittee Joint Meeting
Review of CCIEA State of the California Current Annual Report
December 15-16, 2014
National Oceanic and Atmospheric Administration
Western Regional Center
7600 Sand Point Way NE
Seattle, WA 98115-6349
Telephone: 206-526-6150

This meeting is open to the public and public comments will be accepted at the discretion of the meeting chair. Agenda times are approximate and are subject to change.

WebEx INFO:
Call-in number: 1-650-479-3207
Meeting number: 808 656 472

MONDAY, DECEMBER 15, 2014, 9:00 AM – 5:00 P.M.

A. ***Background on the California Current IEA (9:00-9:30 a.m.)*** ***Phil Levin***

B. ***Overview: 2014 State of the California Current Report (9:30-10:00 a.m.)*** ***Chris Harvey***

C. ***Criteria for Indicator Evaluation (10:00-10:30 a.m.)*** ***Kelly Andrews***

BREAK (10:30-10:45 A.M.)

D. ***Technical Review of Climate/Ocean Indicators (10:45-11:45 a.m.)***
1. Basin-scale climate indicators — Toby Garfield
2. Northern copepod biomass/richness anomalies — Bill Peterson

LUNCH BREAK (11:45 A.M.-12:45 P.M.)

E. ***Technical Review of Coastal Pelagic Species Indicators (12:45-1:45 p.m.)***
1. Abundance — Brian Wells
2. Species diversity — Brian Wells

F. ***Technical Review of Groundfish Indicators (1:45-2:45 p.m.)***
1. Groundfish status relative to reference points — Jason Cope
2. Mean trophic level of groundfish — Nick Tolimieri

BREAK (2:45-3:00 P.M.)

G. ***Technical Review of Salmon Indicators (3:00-3:30 p.m.)***
1. Chinook salmon abundance — Brian Wells

H. ***Technical Review of Upper Trophic Level Indicators (3:30-4:00 p.m.)***

1. California sea lion pup production — Jeff Laake

I. ***Technical Review of Human Dimension Indicators (4:00-5:00 p.m.)***

1. Fleet diversity — Dan Holland
2. Personal use — Melissa Poe

TUESDAY, DECEMBER 16, 9:00 A.M. – 4:00 P.M.

J. ***Technical review of other indicators (e.g., anthropogenic pressures, seabirds, HMS, as needed) (9:00-9:30 a.m.)*** ***Tom Good***

K. ***Example from AFSC: North Pacific Ecosystem Considerations Report (9:30-10:00 a.m.)*** ***Stephani Zador***

10:00-10:15 BREAK

L. ***Format of Annual Ecosystem Report (10:15-11:15 a.m.)*** ***Chris Harvey & Toby Garfield***

M. ***Format of Linked Web Pages (11:15 a.m.-12:00 p.m.)*** ***Greg Williams & TBD***

LUNCH BREAK (NOON – 1:00 P.M.)

N. ***Minimum Performance Standards for End-To-End Models (1:00-1:30 p.m.)*** ***Isaac Kaplan***

O. ***Initial Review of New Habitat Indicators (1:30-2:00 p.m.)*** ***Correigh Greene***

P. ***Initial Review of New Human Dimensions Indicators (2:00-2:30 p.m.)*** ***Melissa Poe & Sara Breslow***

Q. ***Discussion: Process for Selecting and Evaluating Indicators for the Report (2:30-3:30 p.m.)***

~Which indicators will aid the Council in making progress on ecosystem initiatives?
~Which indicators are important to aid the Council in making fisheries management recommendations?

PUBLIC COMMENT PERIOD (3:30-4:00 P.M.)