SUMMARY MINUTES

Scientific and Statistical Committee

Pacific Fishery Management Council
Via Webinar

September 9 and 10, 2020

Members in Attendance

Dr. John Budrick, California Department of Fish and Wildlife, Belmont, CA
Mr. Alan Byrne, Idaho Department of Fish and Game, Boise, ID
Dr. John Field, SSC Chair, 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. Owen Hamel, 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, Northwest Indian Fisheries Commission, Olympia, WA
Dr. Kristin Marshall, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. André Punt, University of Washington, Seattle, WA
Dr. William Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Jason Schaffler, Muckelshoot Indian Tribe, Auburn, WA
Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Tien-Shui Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Will White, Oregon State University, Corvallis, Oregon

Members Absent

Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

SSC Recusals for the September 2020 Meeting		
SSC Member	**Issue**	**Reason**
Dr. John Budrick	D.4 Assessment Methodology Reviews – Final	Dr. Budrick was a proponent of the California nearshore ROV survey under review.

A. Call to Order

Dr. Galen Johnson called the meeting to order at 0800. Mr. John DeVore briefed the Scientific and Statistical Committee (SSC) on the meeting and the Pacific Fishery Management Council's (Council's or PFMC's) expectations for the items on the SSC agenda.

D. Groundfish Management

4. Assessment Methodology Reviews – Final

The Scientific and Statistical Committee (SSC) discussed reports and recommendations from a review of nearshore remotely operated vehicle (ROV) surveys to inform future groundfish stock assessments (held February 4-6 in Santa Cruz, CA; Agenda Item D.4, Attachment 1) and a review of data-moderate length-based assessment methods (conducted online from May 12-14, Agenda Item D.4, Attachment 2). The review of length-based assessment methods was followed by a workshop to more generally review data limited assessment methods and the potential to use the Data Limited Method Tool (DLM Tool) developed by researchers at the University of British Columbia in PFMC stock assessments. A report from that workshop will be provided at a later meeting.

Review of ROV Survey Designs and Methodologies

The purpose of the ROV methodology review meeting was to evaluate and review fishery-independent visual survey methodologies developed by state agencies in Oregon and California and recommend whether the results are sufficiently robust to inform stock assessments of nearshore groundfish, which are generally data-limited. The review panel made numerous requests of the analysts during the meeting, to better understand issues relating to the temporal and spatial coverage, potential bias in length measurements, the species and life history types best surveyed by these methods, the means for the determination of uncertainty in the indices, and other constraints related to the development of absolute or relative biomass indices and length compositions. Neither state is currently able to conduct coastwide surveys within a single year, and some habitats, particularly very nearshore (<20 meters) and soft-bottom habitats, or deeper habitats for shelf species, have very little data.

The SSC endorses the use of the ROV surveys to inform stock assessments for the species explicitly listed in the panel report. The SSC also notes that stock assessment reports for assessments that use data from ROV surveys, particularly as absolute abundance indices, should provide detailed information on how that assessment addresses the key concerns raised in the report. Additional areas for improvement in the ROV survey and analytical methods are documented in the report, and the SSC recommends that additional workshops be held to promote further development and harmonize both field and analytical methods. Finally, the SSC commends the survey and analytical teams for their work in conducting and analyzing survey data, preparing for the review, and addressing reviewer concerns. The SSC also thanks the reviewers for their contributions.

Review of Length-Based Assessment Methods

The SSC reviewed the report of the Length-based Assessment Methods Methodology Review Panel (Panel), which was held by webinar between May 12th - 14th, 2020. The review focused on two newly developed assessment methods that rely primarily on length-composition data: Stock Synthesis with Catches and Length (SS-CL) and the Length-based Integrated Mixed Effects (LIME) assessment platform. The SS-CL method uses both length and catch data, while the LIME method uses a state–space approach and does not require catch information. The proponents of LIME determined that their approach would require considerable additional work to become operational. Consequently, the proponents and the Panel agreed that the LIME method should not be adopted at this time, although it could be further developed for future consideration.

The Panel Report documents rigorous testing and evaluation conducted by the analysts on SS-CL, including evaluation of model performance using both simulated data as well as previously adopted stock assessments from which other data sources were removed. Both approaches were highly informative of the strengths and shortcomings of SS-CL. Detailed descriptions of some of the more counterintuitive outcomes were presented by the analysts and considered by the panel. The SSC concurs with the Panel recommendation that several short-term tasks, detailed in section 6 of the Panel report, should be completed prior to formal adoption of SS-CL.

The SSC notes that if SS-CL is adopted, it would also recommend formal approval of the "SS-CL-Index" approach (where "SS-CL-Index" would include indices from well-designed and commonly used fishery-independent surveys); that the Council has already adopted several data-moderate assessment methods that include relative abundance indices (see Table 1 of the Panel report). There will also be a need to provide clear guidance regarding when biological parameters (growth, natural mortality) in addition to "conventional" parameters (e.g., R_0, selectivity) should be estimated. Such issues will need to be addressed in revisions to the Terms of Reference for data-moderate assessments. This follow up review of the short-term research that needs to be conducted before SS-CL can be adopted can be conducted by the SSC Groundfish Subcommittee and the SSC will make a recommendation with respect to timing under future meeting planning at this Council meeting. The SSC commends the data-moderate methods development team for their progress in addressing these challenging analyses, and for their responsiveness to the requests of the Panel.

SSC Notes:

ROV methodology

The SSC discussed including specific guidance for how to incorporate ROV survey data into stock assessments in forthcoming updates to the groundfish stock assessment best practices document.

The SSC discussed the potential to use these indices in data-limited assessment contexts, and agreed that while some sensitivity analyses, or comparisons to scale to data-limited model results could be useful, that incorporating these indices into data limited-models would be premature given the relative novelty of both the data limited methods and the nearshore ROV surveys.

Additional validation work, such as interagency calibrations, validation of expansion methods and determination of overall uncertainty should be undertaken.

Data-Moderate Methods

The SSC notes that the data-moderate methods review did not include CIE reviewers, and this was a reasonable approach given the expertise available along the US west coast with respect to data-limited and -moderate assessment methods.

Adjustments to the 2021 stock assessment terms of reference will be made following final review of the tasks discussed in the workshop report and the subsequent SSC recommendations, noting that the minutes of the June meeting provide draft language for these revisions.

As part of the final evaluation and revisions to the Terms of Reference will be a need to explicitly decide whether or not to include the "category 3" language with respect to SS-CL models with fewer than ten years of length data.

A report on the workshop to discuss the Data-Limited Methods Toolbox (DLMTool) will come at a future date; review of this report could be concurrent with the final review of SS-CL by the SSC.

G. Coastal Pelagic Species Management

1. Pacific Sardine Rebuilding Plan – Final Preferred Alternative

The Scientific and Statistical Committee (SSC) reviewed the Pacific Sardine Rebuilding Analysis Based on the 2020 Assessment (NMFS Report 1) along with the Pacific Sardine Rebuilding Plan Preliminary Environmental Analysis (Attachment 1, noting the errata reported in Supplemental CPSMT Report 2) prepared by Coastal Pelagic Species Management Team (CPSMT), as well as CPSMT Report 1. The SSC had limited time to review Supplemental CPSMT Reports 2 and 3, but provided some comments on the economic analysis contained in Supplemental CPSMT Report 3. Dr. Kevin Hill (NMFS SWFSC, CPSMT) presented the rebuilding analysis and members of the CPSMT answered questions regarding the documents prepared by the CPSMT. Dr. André Punt (University of Washington, SSC) presented the report from the SSC's CPS subcommittee meeting held on July 15-16, 2020 via webinar (subcommittee report appended to the end of this statement).

The CPS subcommittee report also describes 2020 survey plans and recommendations for 2021 assessments. However, this will be addressed in the SSC report under Agenda Item C.7.

Rebuilding Analysis

The rebuilding analysis described in NMFS Report 1 reflects changes that adequately addressed the recommendations of the SSC at its June meeting and the July meeting of the CPS subcommittee. The rebuilding analysis is parameterized based on the 2020 stock assessment, as required by the Groundfish Terms of Reference (TOR) for rebuilding, with minor modifications (annual rather than seasonal time steps, zero fecundity for age-0 fish) necessary for compatibility with the Rebuilder software. The SSC agrees that these changes are appropriate. While acknowledging the challenges associated with projecting rebuilding for a highly dynamic species whose recruitment seems to be largely driven by environmental factors, the SSC reiterates its endorsement of using Rebuilder for this purpose. The SSC also reiterates its endorsement of calculating the B_{MSY} proxy by projecting forward under $E_{MSY} = 0.18\ yr^{-1}$. The rebuilding plan should specify a process for assessing progress toward rebuilding and the SSC's role in this.

Recruitment values from two time-periods (one a more recent subset of the other) were used to create two productivity states of nature (or productivity scenarios) for this analysis. There was no analysis presented to the SSC that would clearly justify choosing one productivity scenario over the other. The low recent recruitments estimated in the 2020 assessment could imply that recruitments over the next few years may be more similar to the lower productivity $SB_{0(2010\text{-}18)}$ scenario, and so that scenario might better characterize the near term. However, rebuilding is projected to take many years under either scenario, and projections are provided for multiple decades. It is difficult to forecast what productivity is likely to be decades into the future. Note that even the more productive $SB_{0(2005\text{-}18)}$ scenario projects quite moderate recruitment compared to the recruitment that produced the high population levels during the early 2000s. The SB_{MSY} value for the $SB_{0(2005\text{-}18)}$ scenario (median 116,374 mt) is not high compared to historical estimates of population size. Thus, the $SB_{0(2005\text{-}18)}$ scenario might be a better representation of the possible recruitment levels that could be seen over the next 10+ years. When assessing the progress toward rebuilding, thought should be given to the merits of considering recruitment estimates from further back in time, as well as more recent values. For estimates of earlier recruitment, consideration should be given to the merits of a single assessment parameterized over a longer time period versus stringing together information from multiple assessments performed over time. Future rebuilding plans should consider scenarios that project forward using regime shifts in recruitment.

The SSC agrees with the CPSMT that assuming a constant harvest rate for the Mexican fishery is likely to better reflect reality than assuming constant catch by this fishery and endorses how this rate was calculated. The SSC notes that the projections under Alternative 1 assume the full U.S. ABC will be harvested. However, in practice U.S. catches have been below the ABC, and some of the U.S. catch has been from the southern subpopulation.

The stock will be declared rebuilt once the spawning biomass is assessed to have been rebuilt to SB_{MSY}. In other words, once the biomass trajectory achieves the rebuilding target, the stock is considered to have rebuilt by that year, regardless of its future trajectory or subsequent population declines. Thus, the probabilities of achieving rebuilding status on or before a given year from the

Rebuilder monotonically increase through time in all scenarios, even in those in which the expectation is for the stock to be driven below the target, or even below the Minimum Stock Size Threshold (MSST) in some cases, after it rebuilds. Note also that biomass projections and the rebuilding target are expressed in terms of spawning biomass, but the MSST and cutoff are expressed in terms of 1+ biomass. Therefore, the horizontal dashed lines at 50,000 mt and 150,000 mt in the plots of spawning biomass trajectories (NMFS Report 1 Figures 8-10 and 14) are not informative with respect to overfished status or exceeding cutoff.

Simulations suggesting that rebuilding occurs faster under the lower productivity $SB_{0(2010\text{-}18)}$ scenario likely reflect rebuilding targets that are closer to the starting biomass combined with high variability in recruitments. Under the lower productivity $SB_{0(2010\text{-}18)}$ scenario, there is little further increase in rebuilding probability through time after the first several years. This is because assumptions about recruitment in the first year, along with random fluctuations leading to large recruitments in subsequent years, can drive the biomass above the rebuilding target from modest levels. Over time, biomass is expected to decline further such that larger positive fluctuations, or less likely sequences of large recruitments, are required to achieve rebuilt status. Still, the probability of rebuilding continues to increase slowly over time because the right sequence of fluctuations can still occasionally drive rebuilding from low biomass.

NMFS Report 1 characterizes average SB_{MSY} values for each scenario using arithmetic means. However, medians are more comparable to the presented trends in median biomass, and the median is more consistent with the 50% probability used to characterize rebuilding times.

Economic Analysis

The economic analysis contained in Supplemental CPSMT Report 3 is largely qualitative. The SSC found that the scope of the economic analysis adequately addressed the recommendations contained in the subcommittee report and the June 2020 SSC report. While a more quantitative analysis that compares the expected economic outcomes of the three alternatives in present value terms would be desirable, the SSC recognizes that there was insufficient time and data to support such an analysis. There is an error in the table on p. 23 of Supplemental CPSMT Report 3, under Alternative 3 and the scenario used in the report ($SB_{0(2010\text{-}18)}$) productivity scenario, constant Mexican catch rate) the probability of age 1+ biomass reaching cutoff exceeds 50 percent before the probability of spawning biomass reaching the rebuilding target does, so the directed fishery is not projected to remain closed after rebuilding occurs (although some biomass trajectories may subsequently fall below cutoff again).

SSC Notes:

The CPS subcommittee gave some suggestions for choosing between productivity scenarios that might be considered when assessing progress toward rebuilding: "…(the analysts should examine past rebuilding analyses when there were multiple states of nature – e.g., the earlier bocaccio rebuilding analyses), as well as the results of studies of rebuilding rates for Pacific sardine and past historical evidence for sustained low productivity and abundance levels even in the absence of fishing (e.g., Soutar and Isaacs, [1974]; Baumgartner et al., [1992]; McClatchie et al. [2017] paleo-studies regarding the average length (years/decades) of low abundance/collapse level)."

It is possible to include recruitment regimes in the Rebuilder, or other software could be used in the future that would accommodate recruitment regimes.

The question was raised of whether the estimate of SB_0 also increases, if recruitments estimated in new stock assessments increased and would this result in "chasing our tails"? It was noted that a moving target could reflect the best available science at the time.

There was some discussion of the most likely values of steepness and whether there was any need to consider steepness values outside the range (0.3-0.8) profiled. It was noted that model mis-specification is likely to be an issue, and there will be challenges associated with any assertion of a stationary stock-recruit relationship, its form, or a single/constant value for steepness.

Note that each iteration in the Rebuilder simulation has its own SB_{MSY}, based on the SB_0 for that iteration along with an average depletion corresponding to MSY (0.365).

There is pronounced bimodality in the distribution for unfished spawning biomass for the 2010-2018 recruitment scenario. This likely reflects 2010 recruitment being much higher than other recruitments in the 2010-2018 time-series, along with resampling from past recruitments directly rather than a fitted distribution. Thus, the lower mode likely reflects simulations in which 2010 was not resampled, and the higher mode likely reflects simulations in which 2010 was resampled.

Figure legends in the NMFS Report and associated presentations should highlight the distinctions between 1+ biomass and spawning biomass, and which form of biomass is used for different purposes.

The preliminary environmental analysis (attachment 1, p. 3) refers to P and the probability of overfishing, but then defines overfishing as the probability of exceeding the established OFL. However, the point of P* is to account for the possibility that the OFL was set incorrectly, which is not encompassed by this definition of overfishing.*

The preliminary environmental analysis (attachment 1, p. 17) states that "It is difficult to determine if this zero-fishing option would rebuild sardine faster than the other alternatives presented here" but basic biology and demography dictate that rebuilding will be faster with lower fishing mortality, the question is how much faster.

The subsections of Supplemental CPSMT Report 3 under Commercial CPS titled Overview and Regional-level breakout of the CPS fishery on pages 8-11 are hard to follow as they jump around between total CPS revenues and sardine revenues and absolute numbers and percentages. Separating out the sardine and overall CPS revenue discussions into separate paragraphs and stating the absolute numbers for each period and region in the regional discussion would make this easier to follow. It might be useful to add a table showing the regional breakdown of revenues by year.

Other countries have closed live-bait fisheries and still prosecuted fisheries using artificial baits. Closing the live-bait fishery would not necessarily close all the fisheries that previously used live bait.

Scientific and Statistical Committee Coastal Pelagic Species Subcommittee Report to the SSC on Review of the Draft Sardine Rebuilding Plan and 2021 Assessments

A. Background

The Scientific and Statistical Committee (SSC) Coastal Pelagic Species (CPS) Subcommittee (SSCCPSS) met by webinar with analysts from the Southwest Fisheries Science Center (SWFSC) and members of the Coastal Pelagic Species Management Team (CPSMT), the Coastal Pelagic Species Advisory Subpanel (CPSAS) and the public on July 15 and 16, 2020. The meeting's purpose was to review model specifications of the draft Pacific sardine rebuilding analysis based on the Council Rebuilder tool and to discuss the 2021 CPS assessments and Stock Assessment Review (STAR) Panels.

The SSCCPSS Chair (Dr. André Punt, University of Washington) called the meeting to order, summarized the aims of the meeting (Appendix A), after which the Agenda (Appendix B) was adopted. Appendix C lists the members of the SSC, CPSMT, CPSAS, Council Staff, and the public who participated in the webinar. The meeting was conducted over two days to allow for a limited number of requests to the analysts (see Section B.2). Dr. Punt noted that he updated the rebuilding tool in response to the SSC discussions at the June 2020 Council meeting and provided advice to the analysts.

B. Review of the draft Pacific sardine rebuilding analysis

Dr. Kevin Hill (SWFSC), on behalf of the analysts (Dr. Hill, Dr. Peter Kuriyama, and Dr. Paul Crone), presented the draft rebuilding analysis. The Subcommittee discussed the draft rebuilding analysis under the items listed in the meeting description. Dr. Hill noted that the rebuilding tool had been updated by Dr. Punt to: (a) allow projections to be conducted for a control rule that is a combination of a constant exploitation rate strategy (mimicking the current Acceptable Biological Catch, ABC, control rule for Pacific sardine) and a constant catch strategy (used for the catches off Mexico), (b) allow the control rule to pertain to 1+ biomass and not exploitable biomass, (c) allow reporting of the probability of rebuilding to given level of 1+ biomass (the cutoff value of 150,000 mt for this analysis), and (d) allow the target relative biomass (the biomass corresponding to MSY relative to unfished biomass, B_{MSY}/B_0) to differ among steepness values.

B.1 Specific review items (see Appendix B)

B.1.1 Establishing a stock-recruitment relationship and associated uncertainty

The stock-recruitment relationship was modeled as a Beverton-Holt curve with steepness profiled from 0.3 through 0.8 in steps of 0.05. Each steepness value was weighted based on the likelihood from the assessment. The steepness value of 0.8 led a likelihood with less than 0.5% weight, and was consequently ignored for the analyses. In principle, values for steepness between 0.2 and 0.3 could be considered in the rebuilding analysis, but it was not possible to consider steepness values less than 0.28 due to technical problems. The Subcommittee agreed that the range of steepness values were adequate.

Recruitment values from two time-periods (one a more recent subset of the other) were used to create "high" and "low" states of nature (or productivity states) for this analysis. Note that the "high" state of nature is really quite moderate compared to those that produced the high population levels during the early 2000s. Thus the "high" state of nature might be a better representation of the possible recruitment levels that could be seen over the next 10+ years. On the other hand, the "low" state of nature would more accurately reflect the recent low recruitments and could represent a low productivity regime that persists into the future. The "high" state of nature (based on 2005-2018) encompasses values from the "low" state of nature alternative (based on 2010-2018), and reflects lower as well as moderate levels of recruitment. Each alternative should be considered in relative terms rather than as extremes of the biological potential of the stock. The highest potential of the stock during periods of strong recruitment prior to 2005 are not reflected in either alternative.

B.1.2 Establishing T_{min}, T_{max}, and B_{MSY}

The draft rebuilding analysis was based on steepness-specific B_{MSY} values. The analysts should develop a single value for B_{MSY}/B_0 across the steepness levels as has been done for groundfish in similar cases (see B.2, Request 1) and report results for both options for specifying B_{MSY}. The current approach creates some unexpected results, such as 36% of runs for the low state of nature being already rebuilt. However, using a single value for the rebuilding target does not eliminate the modest probability of being already rebuilt or rebuilding very quickly under the low productivity scenario, because the single value of the rebuilding target is moderate, and there is a large amount of variation in projected recruitments.

B.1.3 Setting other model parameters

Changes in model structure from the assessment to the rebuilding analysis included some simplifications that are expected to have very small effects: (a) changing the model time-step from seasonal to annual, (b) basing selectivity and size-at-age in the projections on a single fishery (Mex-Cal season 2) rather than three fisheries, and (c) setting maturity and fecundity at age zero to zero (the analysts should annotate Table 2 to make this explicit).

B.1.4 Application of the rebuilder for the Council's rebuilding alternatives

The harvest strategies analyzed in the draft rebuilding included:

a. Total E=0; used to establish T_{MIN}
b. US E=0 and Mexico catch = 6,044 mt per year
c. US E=0.18 and Mexico catch = 6,044 mt per year, i.e., 'Status Quo'
d. US E=0.05 and Mexico catch = 6,044 mt per year
e. US E=0.05 and Mexico=0; this strategy was not requested by the PFMC or its Advisory Bodies but was included as a sensitivity scenario.

Note that the US E is modified by "Distribution" (0.87) and the Category 2 ABC-OFL buffer.

The SSC recommends that the analysts and the CPSMT consider additional sensitivity scenarios, including projecting the impacts of Mexican fishing assuming a constant Mexican harvest rate rather than a constant Mexican catch (see Request 2 for suggestions). In addition, the CPSMT should provide the rationale for the E=0.05 harvest strategies in relation to the rationale for the Council motion.

There were 101 parameter vectors due to rounding when assigning whole percent probabilities across the range of steepness values. However, 2,000 projections were undertaken so the intended probability of each steepness was not achieved. Given 101 vectors, the total number of simulations should be 2020 rather than 2000 for all 101 parameter vectors to be used an equal number of times in each rebuilding simulation. The analysts instead chose to develop the best distribution of weight across steepness values using 100 vectors instead of retaining 101, and incorporated that change into their responses to requests (below).

B.1.5 Reviewing model outputs for the development and analysis of alternatives

The probability of rebuilding in any projection year should reflect the proportion of runs where the rebuilding target for each scenario has been met, either in that year or in any prior year, even if the biomass is below the target in the year reported due to a subsequent decline. This differs from way the draft rebuilding analysis was conducted, which defined the probability of rebuilding in any year as the proportion of simulations in which the spawning biomass was above B_{MSY} in that year. The suggested approach is more consistent with management practice because the stock will be declared rebuilt once the spawning biomass is assessed to have rebuilt to B_{MSY}. In other words, once a simulated biomass trajectory achieves the rebuilding target, it is considered to have rebuilt by that year, regardless of its future trajectory or subsequent population declines. Thus, the probabilities of achieving rebuilding status on or before a given year monotonically increase through time in all scenarios, even in those in which the expectation is for biomass to be driven below the target, or even below the Minimum Stock Size Threshold (MSST) in some cases, after it rebuilds.

Other presentational suggestions:

- Add a table with reference points, including T_{MIN} and T_{MAX};
- Add a plot showing the uncertainty in the projections (e.g. the distribution of possible future catches and spawning biomass) because the medians for Pacific sardine are less representative of the full range of outcomes than would be the case for longer-lived species such as most groundfish.
- Add plots showing the probability of 1+ biomass being greater than or equal to 150,000 mt each year.
- Add plots of depletion over time, with corresponding probabilities of exceeding target levels adjacent for each alternative for both the rebuilding target and cutoff.
- The term E_{MSY} is being used in two contexts in the document (as a parameter of the rebuilder that determines B_{MSY} and as a parameter of the harvest control rule). These two uses should be clearly distinguished. In addition, the E values in the strategies are best considered "strategy parameters" rather than alternative E_{MSY} values.

B.1.6 Other

The SSCCPSS had the following additional observation and suggestions:

- Why is the probability of rebuilding faster when productivity is "low" rather than "high"? This likely reflects low rebuilding targets combined with high variability in recruitments. Note that under the low productivity scenarios, there is little further increase in rebuilding probability through time after the first several years. This is because stochastic fluctuations (and assumptions about the deterministic recruitment the first year) can drive the biomass above the rebuilding target from modest levels, but over time the biomass is expected to

be driven far below the target such that larger positive recruitment deviations, or less likely sequences of positive deviations, are required to achieve rebuilt status. The SSC should revisit the reasons for this effect once the final rebuilding analysis is available.

- Why can the probability of rebuilding (or: having rebuilt) be high when median biomass and catch are low and declining?
- The discussion should state that the prior for the biomass inshore of the ATM survey is based on a subset of the coast and changing this would impact the scale of biomass and recruitment.
- The discussion should state that the B_{MSY} value for the "high" productivity scenario (377,567t) is not high compared to historical estimates of population size or even the average biomass from the simulations used to determine the current harvest control rules.
- Reasons should be given as to why the "low" or "high" productivity scenarios are more or less likely (the analysts should examine past rebuilding analyses when there were multiple states of nature – e.g. the earlier bocaccio rebuilding analyses), as well as the results of studies of rebuilding rates for Pacific sardine and past historical evidence for sustained low productivity and abundance levels even in the absence of fishing (e.g., Soutar and Isaacs, [1974]; Baumgartner et al., [1992]; McClatchie et al. [2017] paleo-studies regarding the average length (years/decades) of low abundance/collapse level). The analysts should emphasize that we do not know what future recruitment will be or how it will respond to the environment. Some members of the Subcommittee suggested that the "high" recruitment scenario was more likely because it is actually moderate relative to the long run of the stock and may be more representative of the expected productivity (range) over the rebuilding period of the next 10+ years.
- What are the reasons for the bimodality in the distribution for unfished spawning biomass for the "low" recruitment scenario.
- Any presentation of this work should include a summary of what a rebuilding analysis is, including a description of how individual projections are conducted. Dr. Steven Ralston developed a presentation for groundfish on which a sardine-related presentation could be based (this presentation was subsequently located and shared with both the analysts and the SSCCPSS).
- Is the biomass maintained above the "overfished" threshold (perhaps quantified by the probability of being below the overfished threshold one, two, etc. years after being rebuilt)[1].
- The analysts should re-enforce that sardine biomass is largely driven by environmental conditions. For example, it will not be possible to rebuild to the biomass levels of the early 2000s if the stock is in a low productivity regime. In contrast, if the environment changes to a better state (i.e., the recruitments observed during the early 2000s) the stock could

[1] The probability of being below the overfished threshold as a function of time since becoming rebuilt is not computed by the current version of the rebuilder tool.

rebuild more quickly to a higher biomass than expected under the "high productivity" scenario.

- The SSCCPSS did not review the social/economic analysis. Moreover, a rigorous social/economic analysis cannot be completed until the rebuilding time projection analysis is complete.

B.2 Requests

Request 1: Develop an approach to produce single target depletion level across scenarios and determine that depletion level.

Rationale: Given difficulty in determining productivity, a single target depletion level has been used for other rebuilding analyses, such as those for groundfish, including those profiling over steepness levels.

Response: The analysts produced weighted averages of the target depletion level across steepness values for the high and low scenarios. Both produced averages of 36.5% to the nearest half-percent. This value will be used as target depletion across all runs going forward.

Request 2: The analysts should work with the CPSMT to determine other future catch scenarios to be analyzed. In particular, additional scenarios should use a constant exploitation rate for Mexico [e.g. Catch = $Biomass_{age1+}$*(ER_{US}*Buffer*US_Distribution + ER_{Mexico})] determined from the overall rate over the four years used to determine average Mexican catch. The value for ER_{Mexico} could be determined by dividing the Mexican catch (6,044t) by the 1+ biomass for the corresponding year for each value of steepness and then weighting the steepness-specific ER_{Mexico} values by the corresponding likelihoods.

Other assumptions to consider are a constant US catch at low population levels, or a total US catch based on combination of constant catch and exploitation rate for different parts of the fishery.

Rationale: Future catch scenarios should attempt to reflect the (potential) realities of the fisheries that are being modeled.

Response: The analysts calculated exploitation rate as average catch divided by average 1+ biomass over the last four years for which those values are available. This was done using either season 1 or season 2 biomass values, and across steepness values (though the latter only led to small changes across the range). Since the rebuilder uses biomass at the start of the year, season 1 biomass is the correct value to use. Weighting across steepness values leads to a Mexican (or non-US) exploitation rate of 0.0986. This value will be used going forward.

The CPSMT discussed which scenarios would be useful, but did not draw any firm conclusions as to what scenarios should be undertaken, other than the requested runs using a constant non-US exploitation rate rather than constant catch for that sector.

C. Discuss 2021 stock assessments for coastal pelagic species.

Dr. Annie Yau (SWFSC) provided an update on COVID-19 impacts on SWFSC surveys and biological sampling, and discussed plans for 2021 CPS assessments.

The 2020 CalCOFI egg and larvae survey and the spring Acoustic Trawl (AT) survey were canceled. The juvenile rockfish survey was conducted entirely on contracted industry vessels with greatly reduced scope and some methodology changes that may limit its use in assessments. The status of the summer AT survey remains uncertain, but at best it will last approximately 45 days

compared to the usual 80 days, and begin substantially later than its usual start date in June. There will likely be some unknown impacts of COVID-19 on 2021 surveys. SWFSC staff are aging backlogged anchovy and sardine otoliths so new historical age data should be available for assessments in 2021. Even if an AT survey is conducted in 2020, it is unknown whether the biological samples from that survey could be processed in time for use in 2021 assessments.

Dr. Yau noted that it would be impossible to adequately cover the range of Pacific sardine in a 45-day survey. Thus, a 2020 AT survey abundance estimate for Pacific sardine would not be comparable to abundance estimates from other years. The Subcommittee agreed and therefore concurred with a suggestion that a 2020 AT survey focus on attaining sufficient coverage of the Central Subpopulation of Northern Anchovy (CSNA), to be make it as comparable as possible to past surveys with respect to CSNA.

The SWFSC will engage in discussions on how industry survey efforts in 2020 and 2021 can be most useful for assessments. It was noted that the aerial survey has previously been used in conjunction with the AT survey to provide a prior on catchability (q), but doing this requires both surveys operate simultaneously, which may not be possible in 2020. Past juvenile rockfish surveys using contracted industry vessels attempted to maximize utility and comparability by conducting paired surveys to allow estimation of vessel effects, using depth monitoring gear to assure the correct sampling depth, duration, and net deployment, and by contracting the same vessel(s) in subsequent years when paired surveys with NOAA vessels would be possible.

An update assessment of Pacific sardine is scheduled for spring of 2021. In the absence of a usable 2020 AT survey estimate for sardine, a catch-only projection may be more appropriate. Revisions to historical catch estimates can be accommodated within catch-only projections, although a slightly elevated level of review involving refitting of the model would be needed if any of the revised catches are for years entering the likelihood calculations. Substantial additions of age data would require an update assessment, but the information content of a modest amount of new age data may not justify the workload impact of an update assessment. Alternatively, if the inclusion of the new age had negligible impact on the assessment, it could be considered as catch-only update.

A full assessment of CSNA is planned for late 2021. The Subcommittee sees considerable value in conducting this assessment even if 2020 AT survey estimates are unavailable, and supports conducting the assessment as planned. An assessment would increase the biological understanding of CSNA and could be informative with respect to reference points. Substantial new age data for CSNA will be available, as will multiple historical survey estimates (e.g. from CalCOFI). Egg and larval data have been reviewed for use with the CSNA, and the juvenile rockfish survey has been approved for use in groundfish assessments. There could be workload benefits to scheduling the CSNA assessment as late in the year as possible, which may allow incorporation of data from 2021 surveys. However, the high natural mortality of the CSNA means that it is important for survey timing to be comparable across years, or differences to be accounted for in the assessment.

The Pacific mackerel catch-only projection scheduled for delivery to the Council in June 2021 should proceed as planned regardless of 2020 and 2021 surveys.

References

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McClatchie, S., Hendy, I.L., Thompson, A.R. and Watson, W., 2017. Collapse and recovery of forage fish populations prior to commercial exploitation. *Geophysical Research Letters*, *44*(4), pp.1877-1885.

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Appendix A: Meeting Description: Scientific and Statistical Committee (SSC) Coastal Pelagic Species (CPS) Subcommittee meeting

The Pacific Fishery Management Council (Council) will hold an online meeting of its Scientific and Statistical Committee (SSC) Coastal Pelagic Species Subcommittee to review model specifications regarding the Pacific sardine rebuilding plan Rebuilder tool. The Council's Coastal Pelagic Species Management Team (CPSMT) is responsible for the overall development of the Pacific sardine rebuilding plan and will be considered full meeting participants. This meeting is open to the public and public comment will be taken at the discretion of the Chair. Draft documents being reviewed by the Subcommittee are not available for public dissemination, and will be available for public dissemination via the Council's September Briefing Book.

Key personnel

Meeting Chair: André Punt
Principal Analyst: Kevin Hill
Council Staff Officers: Kerry Griffin and John DeVore
Members of the SSC CPS Subcommittee and the CPSMT

Dates/times: Wednesday and Thursday, July 15-16, 2020; 8:30 a.m. to 1 p.m. Pacific Daylight Time each day, or until business for the day has been completed.

Background

The estimated biomass of Pacific sardine fell below the minimum stock size threshold of 50,000 metric tons, based on the 2019 stock assessment. The Council and NMFS are required to develop a rebuilding plan, which is scheduled for Council adoption at its September 2020 meeting. The primary purpose of the July 15-16 SSC Subcommittee meeting is to provide review and advice on developing proposed rebuilding alternatives relative to the Pacific sardine rebuilding plan.

Meeting objectives

SSC CPS Subcommittee to review and provide advice on:

1. Establishing a stock-recruitment relationship and associated uncertainty
2. Establishing T_{MIN}, T_{MAX}, and B_{MSY}
3. Setting other model parameters

4. Application of the rebuilder for the Council's rebuilding alternatives
5. Reviewing model outputs for the development and analysis of alternatives.
6. Discuss 2021 stock assessments for coastal pelagic species.
7. Other technical aspects of the sardine rebuilding plan may also be considered, as appropriate

Roles and Responsibilities

- The Chair is responsible for overall prosecution of the meeting, ensuring objectives are met, making rapporteur assignments, coordinating a report to the full SSC, and managing public comment.
- The SSC CPS Subcommittee is responsible for providing expert review and advice relative to the meeting objectives.
- The CPSMT is responsible for developing a reasonable suite of alternatives for consideration at the September Council meeting. The CPSMT is expected to fully participate in the meeting, especially as related to development of alternatives for Council consideration.
- Council Staff Officers are responsible for running the online meeting platform and supporting the meeting Chair as needed.

Appendix B: Agenda

Wednesday, July 15, 2020 – 8:30 a.m.		
8:30 a.m.	Introductions, rapporteurs, recusals, review agenda and meeting objectives	André Punt, Kerry Griffin
8:45 a.m.	Proposed Rebuilder specifications (S-R relationship, T_{MIN}, T_{MAX}, B_{MSY}) and discussion	Kevin Hill
9:15 a.m.	Discussion and requests	All
10 a.m.	Rebuilder results for application to alternatives – discussion with CPSMT	André Punt
11 a.m.	Public comment	André Punt
11:30 a.m.	Discussion and parking lot issues	André Punt

Thursday, July 16, 2020 – 8:30 a.m.		
8:30 a.m.	Rebuilder specifications - response to requests & discussion	Kevin Hill
9:15 a.m.	SSC Subcommittee discussion of 2021 CPS assessments and STAR panels	André Punt, Galen Johnson
10:15 a.m.	Rebuilder specifications, as needed	Kevin Hill
11 a.m.	Rebuilder results for alternatives and discussion with CPSMT	All
12 p.m.	SSC summary, wrap up, next steps, discuss plan for September Council meeting	André Punt

Adjourn

Appendix C: Participants

SSC CPS Subcommittee	
André Punt	UW, SSC, Chair
Alan Byrne	IDFG, SSC
John Budrick	CDFW, SSC
John Field	SWFSC, SSC
Marisol García Reyes	Farallon Inst., SSC
Owen Hamel	NWFSC, SSC
Theresa Tsou	WDFW, SSC
Will Satterthwaite	SWFSC, SSC
STAT members:	
Kevin Hill	SWFSC, CPSMT
Peter Kuriyama	SWFSC
Other attendees:	
Al Carter	Ocean Gold Seafoods, CPSAS
Alan Sarich	Quinault Indian Nation, CPSMT
Annie Yau	SWFSC
Ben Enticknap	Oceana
Briana Brady	CDFW, PFMC
Corey Niles	WDFW, PFMC
Dale Sweetnam	SWFSC
Diane Pleschner-Steele	Cal. Wetfish Producers, CPSAS
Dianna Porzio	CDFW
Emmanis Dorval	SWFSC
Frank Lockhart	NMFS WCR
Galen Johnson	NWIFC, SSC
Geoff Shester	Oceana
Greg Krutzikowsky	ODFW, CPSMT
James Hilger	SWFSC, CPSMT
John DeVore	PFMC
Josh Lindsay	NMFS WCR, CPSMT
Kerry Griffin	PFMC
Kirk Lynn	CDFW, CPSMT
Kris Kleinschmidt	PFMC
Kym Jacobsen	NWFSC, CPSMT
Lorna Wargo	WDFW, CPSMT
Lynn Massey	WCR
Meg Johnson	
Mike Burner	PFMC
Mike Okoniewski	Pacific Seafoods, CPSAS
Richard Parrish	
Sandra Krause	PFMC
Steve Crooke	CPSAS
Theresa Labriola	Wild Oceans
Trung Nguyen	CDFW, CPSMT
Whitney Roberts	WDFW, GMT

F. Ecosystem Management

2. Fishery Ecosystem Plan Five-Year Review – Chapters 3-5

The Scientific and Statistical Committee (SSC) reviewed the draft of chapter 3 and the outlines for chapters 4 and 5 of the Fishery Ecosystem Plan (FEP) five-year review and offers the following comments. The SSC commends the Ecosystem Workgroup's (EWG's) work on the development of the FEP and appreciates that the EWG has added additional staff and expertise since March. The SSC also supports the EWG's efforts to add a social scientist to the workgroup.

The revised fishery groupings described in section 3.4.2 (Current Fisheries), where fisheries are organized into benthic and pelagic categories, may not be the best way to organize this section. There are multiple possible ways to do this. A more human-centric way of organizing this section that relates more closely to how fishermen or fishing communities group or utilize fisheries may be preferable. For example, groups could be defined using seasonal patterns (see Figure 3-7), operational or cultural linkages, or by geographic area.

Section 3.4.6 (Fishing communities), as currently written and proposed contains too much information and analysis that will quickly become out of date. Much of this information can be found in more frequently updated documents, including the California Current Integrated Ecosystem Assessment (CCIEA) team's annual report, stock assessment and fishery evaluation (SAFE) documents, and groundfish environmental impact statements (EISs). It may be more effective for the FEP to keep the discussion more qualitative and reference or link to these documents so readers can access current information on the state of fisheries and fishing communities.

The rationale for partitioning of the seven regions described in section 3.4.6 should be better explained. It is not clear whether or how these regions correspond to biogeographic regions, fishery management areas, or geographically distinct groups of related fishing ports/communities. The reasons why these regions were established should be described, or if they are based on existing regional definitions, references should be given.

Some examples cited as ecosystem-based management (EBM) measures within fishery management plans (FMPs), section 3.5.2 (Ecosystem-Based Management Measures within FMPs) are not necessarily EBM. While the list of FMP-specific EBM examples can be a useful reference, describing how these measures address EBM goals and objectives would improve this section. Also, there could be more exploration of cross FMP measures that address technical and biological interactions between species and fisheries.

The SSC supports the further development of Chapters 4 and 5 and looks forward to reviewing them as drafts are completed.

SSC Notes:

In the Social Science Roundtable, the EWG indicated that they were considering including a broad set of indicators (social vulnerability, fishing dependence, and other items). SSC social scientists gave the same feedback – that this information will quickly become out of date and having it in the FEP is redundant with other documents.

Some examples cited as EBM measures within FMPs, section 3.5.2 (Ecosystem-Based Management Measures within FMPs) are not necessarily EBM. For example:

- *The buffers involved in setting harvest limits for CPS Monitored Stocks are not necessarily "precautionary" (CPS item 5, page 47) since they do not involve an explicit statement of risk tolerance applied to a quantified level of uncertainty. In general, it is not clear that buffers against uncertainty in single-species stock assessments are necessarily EBM (also applies to groundfish item 7, page 48).*
- *It is not clear how the prohibition on shark finning (HMS item 8, p. 49 item) relates to EBM.*
- *It is not clear how participation in international regional fishery management organizations (salmon item 6, p. 50) relates to EBM.*

The Council's prohibition on new fisheries for forage fish, which is only briefly mentioned in the current draft, may also qualify as an additional EBM measure worth mentioning in the CPS FMP. It could also be mentioned at the start of section 3.5.2 as something that applies to multiple FMPs.

The groundfish stock assessment terms of reference encourages stock assessments to allow the SSC and Council to consider the impacts of relevant ecological, biological, social, and economic factors. (section 3.5.2, groundfish item 9, page 48). The stock assessments implement this to varying degrees. Recent examples that have included more extensive analyses, such as the 2019 sablefish assessment, could be highlighted here.

Additional references to consider regarding salmon in section 3.3.3:

- *p. 20 Kilduff et al. papers (doi:10.1093/icesjms/fsu031 and doi:10.1073/pnas.1503190112) are some more current citations for synchrony in survivals;*
- *pp. 20-21 on critical period could also address match/mismatch, e.g., Satterthwaite et al 2014 (doi:10.3354/meps10934).*

There are several statements regarding salmon in the draft of chapter 3 that should be checked for clarity and accuracy.

- *On page 20, the draft states: "Several salmon stocks are listed under the ESA or considered overfished by PFMC; consequently, many West Coast salmon fisheries are supported by hatcheries." Salmon hatcheries on the west coast were generally not established to rebuild overfished or recover ESA-listed stocks. Most hatcheries were established as mitigation for destroyed habitat (e.g., inaccessible spawning grounds due to dams) and/or to supplement harvest but predate ESA listings or formal overfished designations.*
- *The statement on page 35 that "many stocks are listed under the ESA" is non-specific and potentially misleading. Further, the statement that "many" targeted salmon stocks "are the result of hatchery operations in freshwater spawning areas" is also non-specific and*

potentially misleading (i.e., how many is "many"). Target stocks are sometimes supplemented by hatchery production, but it is difficult to conclude that they are "the result of" hatchery production.

- *The second paragraph on page 51 (which begins, "Since 1991…") is potentially misleading. Though different runs of salmon have significant spatial and temporal separation in their spawning, there is not an absolute inability to interbreed. The statement that they "cannot interbreed" is too strong. Also, it should be noted that fall and spring runs have been included in the same ESU in some specific cases, for example, the Klamath/Trinity ESU contains both fall and spring runs.*

The revised FEP should address the effects of non-fishery management action on fish stocks somewhere in Chapter 4. For example, the effect of marine mammal protection on fisheries and the effects of freshwater and terrestrial habitat management on anadromous fish stocks are important ecosystem consideration. It is not clear from the existing outline how or whether these issues will be addressed in Chapter 4.

C. Administrative Matters

7. Future Council Meeting Agenda and Workload Planning

The Scientific and Statistical Committee (SSC) continues to note the negative impact on the group's engagement and efficiency due to the inability of National Marine Fisheries Service (NMFS) employees to participate in the video/screen-sharing portion of the Ring Central meetings with government owned computers. The SSC is developing a list of best practices for presenters to make it easier for NMFS employees who must present while Council staff displays their slides and for participants who must view the slides without seeing pointers/cursors of speakers. This may help matters but will not have the same effect as everyone simply being able to use the same platform.

The SSC offers the following guidance on the future Council meeting agenda and workload planning.

The SSC did not receive any proposals for methodology review under Agenda Item D.3 at this meeting. Therefore, the SSC recommends removal of Agenda Item I.2 - Impact Analyses Methodology Review, Final Topics proposed for the November Council meeting in Agenda Item C.7, Attachment 2.

The SSC Groundfish Subcommittee met with analysts on September 2, 2020, to discuss the information available for a possible methodology review of the Elasmobranch Harvest Control Rule in the late fall or early winter. The Subcommittee plans to have another check-in with the analysts prior to the November Council meeting; if a methodology review is scheduled the SSC recommends inviting Dr. Martin Dorn (Alaska Fisheries Science Center) because of his experience in harvest control rule development, including for elasmobranchs. The SSC Groundfish Committee also needs to review the short-term tasks requested of the Stock Synthesis with Catches and Length (SS-CL) proponents prior to formal adoption of the methodology. This review could be conducted at the same meeting as the Elasmobranch analyst check-in, in October or early

November prior to the November 2020 Council meeting. The SSC also recommends additional remotely-operated vehicle methodology workshops to promote further development and to harmonize both field and analytical methods; these could be scheduled to occur after September 2021 when biennial stock assessment duties are complete. The SSC continues to give high priority to the review of the ongoing Sablefish Management Strategy Evaluation (MSE) and hopes to hear an update from the analysts in November 2020.

The SSC discussed the STT report from the April 2020 Council meeting (Agenda Item E.4.a, Supplemental STT Report 2) which raised concerns about possible lack of sampling or under-sampling of total catch, effort, and/or sampling of catch for code-wire tags due to concerns over COVID-19. In particular, this may impact the calculation of cohort size and of exploitation rates used to determine overfishing status for Klamath River Fall Chinook and Sacramento River Fall Chinook, and that serve as annual inputs to their forecast models. The SSC advises that agencies coordinate with the Salmon Technical Team as soon as possible about data gaps and how they will be addressed, changes in forecast methodology, and changes in sampling. If the Council tasks the SSC or the SSC Salmon Subcommittee with reviewing or advising on any changes, the SSC recommends having that review take place before the March meeting.

The California Current Integrated Ecosystem Assessment team alerted the SSC Ecosystem Subcommittee chair that there may be major changes to the annual integrated ecosystem assessment (IEA) report in 2021 due to COVID-19 impacts on data collection and processing. The SSC Ecosystem Subcommittee can meet in January 2021 if the Council requests review of these changes prior to the March 2021 Council meeting.

The SSC reviewed the SSC Coastal Pelagic Species (CPS) Subcommittee report from July 2020 (appended to Agenda Item G.1.a, Supplemental SSC Report 1, September 2020) and updated information regarding surveys. The California Cooperative Oceanic Fisheries Investigations (CalCOFI) egg and larval survey, and the spring and summer Acoustic Trawl (AT) surveys were cancelled this year. Southwest Fisheries Science Center staff are ageing backlogged anchovy and sardine otoliths so new historical age data should be available for assessments in 2021. The SSC agrees with the CPS subcommittee report conclusions that a full assessment of the Central Subpopulation of Northern Anchovy (CSNA) should be conducted in 2021 even without recent AT survey data. An assessment would increase the biological understanding of the CSNA and could be informative with respect to reference points. Substantial new age data for the CSNA will be available, as will multiple historical survey estimates (e.g., from CalCOFI). Egg and larval data have been reviewed for use with the CSNA.

The Pacific mackerel catch-only projection scheduled for delivery to the Council in June 2021 should proceed as planned regardless of 2020 and 2021 surveys.

The SSC also agrees with the CPS subcommittee recommendation of a catch-only projection for Pacific sardine during 2021. Revisions to historical catch estimates can be accommodated within catch-only projections, although a slightly elevated level of review involving refitting of the model would be needed if any of the revised catches are for years entering the likelihood calculations. Substantial additions of age data would require an update assessment, but the information content of a modest amount of new age data may not justify the workload impact of an update assessment. The review of a catch-only update can occur at an SSC meeting and does not require a separate SSC CPS Subcommittee meeting. The SSC recommends that the next full assessment for Pacific

sardine consider a longer time series than the previous full assessment. Such a "research assessment" could be very informative in evaluating progress toward rebuilding.

SSC Notes:

Economics: 5 year review of catch-share, 2022.

Salmon: NMFS Directive on BSIA, similar to what we do for GF and CPS but not salmon and HMS. A review of past SSC statements showed clear endorsement of some things we do for salmon, murky or absent (or at least not found) endorsement of other things. (Mention in April: The SSC's Willapa Bay coho provisional endorsement of forecast methodology from last year was just for 2020, but there was no salmon methodology topic selection this year .)

CPS: there may be industry inshore work, but we don't know when this is likely to occur or when data will be analyzed. Anchovy is the highest priority (last assessment 30 years ago, overdue), but sardine are overfished so it is important but there are no new survey data. In the not too distant future, a research assessment for sardine that incorporates a longer data set may be useful before next progress assessment…probably doesn't have to be 2021.

Proposed Workshops and SSC Subcommittee Meetings for 2020 and 2021							
Workshop/Meeting		**Potential Dates**	**Sponsor/ Tentative Location**	**SSC Reps.**	**Additional Reviewers**	**AB Reps.**	**Council Staff**
1	Elasmobranch Harvest Control Rule Methodology Planning and Length-Based Assessment Review Follow-up	October TBD	Council/Webinar	Groundfish Subcommittee Members	Dorn	NA	DeVore
2	Elasmobranch Harvest Control Rule Methodology Review, if recommended	Fall 2020/Winter 2021	Council/TBD	Groundfish Subcommittee Members	Dorn	GMT GAP	DeVore
3	SSC Ecosystem Subcommittee	January 2021	Council/Webinar	Ecosystem Subcommittee Members	CCIEA Team Members	NA	DeVore Dahl
4	CSNA STAR Panel	Spring 2021?	Council/TBD	CPS Subcommittee Members	2 CIE	CPSMT CPSAS	Griffin
5	Pacific Sardine Update Assessment Review (unless a catch-only projection is provided as recommended by the SSC, in which case the full SSC would review).	Spring/Summer 2021?	Council/TBD	CPS Subcommittee Members	NA	CPSMT CPSAS	Griffin
6	Groundfish STAR Panel 1	May 3-7, 2021	Council/TBD	TBD	2 CIE	GMT GAP	DeVore
7	SSC Groundfish Subcommittee	June 21, 2021	Council/Vancouver, WA	Groundfish Subcommittee Members	NA	GMT GAP	DeVore

8	Groundfish STAR Panel 2	July 12-16, 2021	Council/TBD	TBD	2 CIE	GMT GAP	DeVore
9	Groundfish STAR Panel 3	July 26-30, 2021	Council/TBD	TBD	2 CIE	GMT GAP	DeVore
10	7th National Meeting of the Scientific Coordination Subcommittee of the Council Coordination Committee	2021?	NPFMC/ Sitka, AK	4 TBD	NA	NA	DeVore
11	Groundfish mop-up STAR Panel, if needed	September 27-October 1	Council/TBD	TBD	2 CIE	GMT GAP	DeVore
12	Proposed Workshop for Conducting Nearshore ROV Surveys	Fall 2020l/Winter 2021?	Council/TBD	TBD	TBD	GMT GAP	DeVore

SSC Administrative Matters

Planning the Research and Data Needs Database

Mr. John DeVore briefed the SSC on progress made in developing the Research and Data Needs Database. Rick Busch and Josh Clemons, contractors for the Pacific States Marine Fisheries Commission, are programming the database, which is modeled after an analogous database used by the North Pacific Fishery Management Council. Dr. John Budrick, Mr. Alan Byrne, Dr. Marisol Garcia-Reyes, Dr. Owen Hamel, Dr. André Punt, Dr. Cameron Speir, and Mr. John DeVore are members of the development team advising on the database structure. Ms. Meisha Key is on contract to populate the database using the details in the 2018 Research and Data Needs document and has been added to the development team. The Council will need to determine how research priorities are ultimately decided with an option to solicit priorities recommended by Council advisors directly through the database. The Council may begin their deliberations on how future research and data needs are prioritized and how the database is structured to aid that effort as early as the upcoming November Council meeting.

SCIENTIFIC AND STATISTICAL COMMITTEE'S ECOSYSTEM SUBCOMMITTEE REPORT ON TOPICS TO CONSIDER IN FUTURE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT REPORTS

Pacific Fishery Management Council Via Webinar
September 4 and 8, 2020

The Scientific and Statistical Committee's Ecosystem Subcommittee (SSCES) met via webinar September 4 and 8 to review topics relevant to the California Current Integrated Ecosystem Assessment (CCIEA) team's annual Ecosystem Status Report (hereafter CCIEA report). The four topics selected by the Council in March were:

A. California Sea Lion Pup Growth as an Indicator of Forage Conditions

B. Natural Origin Central Valley Fall Chinook Stock Indicator

C. Habitat Compression Index

D. Theil Index of Fishery Revenue Concentration

Dr. Kristin Marshall chaired the meeting. She thanked the presenters for their thorough presentations and willingness to engage with the review, and the SSCES and participants for their attentive discussion. Meeting participants are listed in Appendix A.

A. California Sea Lion Pup Growth as an Indicator of Forage Conditions

Dr. Sharon Melin (NOAA, Alaska Fisheries Science Center) provided an overview of the indicators based on California sea lions included in the CCIEA report. The SSCES was provided three papers as background (Thompson et al. 2019, Laake et al, 2018, Melin et al., 2012).

California sea lions were identified as indicators of regional forage conditions because: (1) they are permanent residents of the California Current Ecosystem; (2) long time series of monitoring data are available that overlap with existing forage, climate and oceanographic indices, permitting some validation of the indicators; (3) sea lions consume predominantly species of commercial importance; (4) the selected indices are relatively straightforward to monitor. The indices are based on monitoring San Miguel Island as ~45% of the total population is found there.

The indices computed are (a) the number of live pup births in June, (b) a measure of pup condition based on pup weights at 3 months of age, (c) pup growth rates between 3 and 7 months, reflecting the ability of females to nurse given forging conditions (these indices have been related to pup stranding and survival rates), and (d) diet data for breeding females from scats. Although monitoring at San Miguel Island started in 1975, the CCIEA time-series is restricted to 1997 onwards to facilitate comparison with other time-series in the CCIEA report.

The number of pup births is intended to reflect the accumulation of energy for the 9 months prior to the counts, and hence provides an indirect measure of relative forage conditions. However, some pups die between birth and counting. Data on such pups are available and should be used to compute a best estimate of the number of live births. The data on deaths following birth provides information on foraging conditions soon after birth.

California sea lions are opportunistic feeders, with over 100 identified prey taxa. Their core diet items are sardine, anchovy, hake, mackerels, rockfish and market squid, and the frequency of occurrence of various diet items (data on prey quantity are not reported) has been correlated to prey abundance ($R^2 = \sim 0.35$). The SSCES noted that the correlation should be interpreted carefully given the forage surveys are subject to measurement error. In general, the frequency of occurrence of hake, squid and rockfish tends to be high when the frequency of occurrence of sardine, anchovy and mackerels are low.

The measures of pup condition are related to the diet composition (e.g. higher when the diet is dominated by sardine/anchovy and lower when market squid and rockfish dominate the diet). Average pup weights after 3 months are also correlated to SST (computed as temperature on the foraging grounds).

The SSCES had the following suggestions for additional work:

- Consider developing / reporting (initially in the detailed appendix to the CCEIA report) an index of pup survival rate, which would integrate the multiple effects, although it was noted that pup survival depends not only on the availability of forage but also the effects of other stressors such as domoic acid (DA) in their prey.
- Attempt to integrate or evaluate data from other apex predators, such as sea birds.
- Examine whether it is possible to distinguish forage effects from other stressors (e.g. DA) on the indices, particularly pup survival.
- Further analyze the relationship between the indices and measures of forage abundance, recognizing the uncertainty in those measures.

An initial rationale for the review of the sea lion indices was a concern that the indices may be influenced to a substantial extent by the population reaching carrying capacity. This is because resource limitations may be inconsequential when the population is small but be dominant at high population sizes. However, analyses conducted to date suggest that sea lion abundance is not a very important factor affecting pup counts and growth rates compared to ocean and forage conditions, but its impact could not be ruled out completely. The SSCES recognized that carrying capacity depends on ocean and forage conditions and is not constant.

The SSCES highlighted the need to document what the indices are intended to indicate. For example, the analyses presented to the SSCES showed that the indices were significantly related to ocean conditions and forage abundance, but not how well forage abundance is predicted by sea lion indices. This is relevant because one of the stated objectives of these indices is to provide information about the forage base available to apex predators. Dr. Chris Harvey noted that there is

limited information on what many apex predators (some of which are threatened / recovering) are feeding on, and the information from sea lions helps to fill that gap. Moreover, greater evaluation of these indices and forage data could potentially help with our interpretation of how oceanographic processes such as habitat compression alter foraging habits or preferences for high trophic level predators. Refining and improving the rationale for including these indices is recommended in the next report.

B. Natural Origin Central Valley Fall Chinook Stock Indicator

Drs. Nate Mantua and Brian Wells (NOAA, Southwest Fishery Science Center) presented the Natural Origin Central Valley Fall Chinook Stock Indicator (hereafter CVFC Indicator) from the CCIEA report. The SSCES was provided two papers as background (Friedman et al. 2019; Munsch et al. in press).

The CVFC Indicator is based on measures of parent spawner escapement, water temperature during egg incubation, wintertime river flow, and an index of predation by seabirds shortly after juvenile salmon enter the marine environment. The primary support for each of these component indicators comes from a formal covariate screening process associated with a lifecycle model (Friedman et al. 2019). In addition, each component indicator reflects a mechanistic hypothesis for effects on particular life stages, and each is supported by at least one other peer-reviewed study. These covariates were chosen to reflect effects on natural-origin fish; however, the Friedman et al. (2019) model includes effects of flow and predation on hatchery-origin fish as well. Modeling effects of wintertime flow on hatchery-origin fish may be problematic because some hatchery-origin fish in this system are trucked downstream without experiencing the river environment, and hatchery fish released into the river are usually released in late spring. However, flows in late spring were reasonably well correlated ($r=0.62$) with winter flows.

The lifecycle model developed by Friedman et al. (2019) predicted total escapement (of both origins, and returning to either natural areas or hatcheries), but it compared these predictions to escapement to natural areas alone (and regardless of origin). The two escapements are highly correlated, so this is not likely to have major consequences, but model fit and confidence in covariate selection might be increased by future work fitting to total escapement, and/or modeling hatchery fish released in-river versus trucked downstream separately. Vital rates in the ocean are assumed to be identical for hatchery- and natural-origin fish due to a lack of natural-origin data. As sufficient data specific to natural-origin fish become available, it would be beneficial to model origin-specific vital rates, and to compare predictions of natural-origin escapement to natural-origin data.

The CVFC Indicator is currently intended as a purely qualitative metric to inform tactical and strategic decision making. For tactical preseason planning, the CVFC Indicator provides information on likely ocean abundance that is complementary to the Sacramento River Fall Chinook forecast. The CVFC Indicator helps to focus attention particularly on the natural-origin component of the Central Valley Fall Chinook stock complex, which may otherwise escape direct attention in fisheries planning. Strategically, the CVFC Indicator might provide insight into likely adult abundances two years out (through its prediction of age-2 cohort strength) and can help draw

the Council's attention to potential benefits of spawning escapement above the current management target. The CVFC Indicator also highlights important non-fishery factors (e.g. water management) that will affect future abundances and fishing opportunities, even though these factors are beyond the Council's direct purview. The SSCES agreed that a qualitative rather than quantitative indicator was sufficient for these purposes, while encouraging attempts to validate the indicator's broad-sense predictive power (e.g., by comparing values of the indicators to harvest-adjusted escapement, ideally for natural-origin fish, in past years).

The SSCES supports continued inclusion of the CVFC Indicator in annual CCIEA reports. Brief explanatory text highlighting the distinctions between natural-origin and composite (natural- plus hatchery-origin) escapement, and the implications of each for Council tactical and strategic thinking, would be valuable for future reports. The SSCES also recommends adding a brief methodological description (in particular, specifying how category boundaries are chosen) to the CCIEA report appendix, along with validation if possible.

The SSCES encourages communication of the CVFC Indicator to the Salmon Technical Team (STT) in time to help inform the salmon preseason report preparation and planning process. For example, the "STT Concerns" section sometimes included at the start of Preseason Report 1 could discuss any apparent inconsistencies between the CVFC Indicator and the Sacramento River Fall Chinook abundance forecast for the coming year. Communication between the CCIEA team and STT may reveal other potential uses of the CVFC Indicator. The SSCES also supports reporting data on hatchery- versus natural-origin escapement when available, either in the CCIEA report and/or in annual reports on salmon escapement produced by the STT.

If there are future efforts to make the CVFC Indicator more quantitative, this should involve the STT and be reviewed through the salmon methodology review process rather than through the SSCES.

C. Habitat Compression Index

Dr. Jarrod Santora and Dr. Isaac Schroeder (SWFSC) presented an overview of the Habitat Compression Index (HCI) that was included in the March 2020 CCIEA report, including a justification for spatially explicit process-based indicators (such as the HCI), and the management challenges that the HCI is able to inform. The SSCES was provided one paper as background material (Santora et al. 2020).

Spatially explicit indicators can describe the non-uniform effects of ocean warming events and oceanographic conditions in the California Current. The HCI is a regional indicator of the areal extent of cool water habitat, related to coastal upwelling. It is derived from seasonally and regionally resolved temperature differences between nearshore and offshore regions, synthesized through the University of California Santa Cruz data-assimilative oceanographic model (C. Edwards et. al.). Development of the HCI index took place in response to increasing numbers of whale entanglements during the 2014-2016 marine heatwave and tracks habitat compression in central California, where late winter conditions are leading indicators for summer conditions. Habitat compression (less available cool water habitat) was correlated with shifts in forage distribution and community structure, which were correlated with shifts in whale distribution and

aggregation intensity (Santora et al., 2020). The West Coast Regional Office (WCRO) is supporting the expansion of the HCI work from a single index for central California (included in 2020 CCIEA report) to four regional HCI indices that span the US West Coast.

The SSCES commends Drs. Jarrod Santora and Isaac Schroeder on the development and application of the HCI to fisheries management challenges. The SSCES supports the continued development and validation of the regional HCI indices as well as the development of synthetic CCIEA indices that combine ecosystem and oceanographic indices. The SSCES supports inclusion of the four regional HCI indices in future CCIEA reports as they approximately align to bioregions already in use by the CCIEA team.

The SSCES discussed potential vulnerabilities in maintaining the HCI in the CCIEA Report because it depends upon an ocean model product provided via UCSC partners. However, in the unlikely event that this model is not available, NOAA operated satellites can be used to calculate a similar index. Moreover, a strength of the HCI is its simplicity as it can also be calculated from other currently available ROMS models.

The SSCES discussed the potential for using the HCI as the basis for a relative measure of sardine and anchovy availability to the fishery as the mechanism behind the HCI is that upwelling drives the distribution and density of species that respond to upwelling, such as forage species. Exploring an HCI based index of forage fish availability could be useful for the sardine and anchovy stock assessments. Research would need to focus on how the HCI could inform sardine and anchovy distribution and density. Additional data such as the SWFSC acoustics survey data and spatially explicit catch data would be needed to investigate connections between HCI and availability to the fishery.

D. Theil Index of Fishery Revenue Concentration

Dr. Karma Norman (NOAA, Northwest Fisheries Science Center) and Amanda Phillips (Pacific States Marine Fisheries Commission) presented the Theil Index of Fisheries Revenue Concentration, a proposed index for the 2021 CCIEA report. The SSCES was provided two papers as background material (Speir et al., *in press*, Bellanger et al., 2016).

The Thiel Index is an index of geographic concentration that characterizes the amount of disproportionality, compared to a reference, in the distribution of fishing activity (e.g. revenue) across mutually exclusive regions (e.g. ports or port groups). The Thiel index is being proposed to measure changes in port consolidation and fisheries concentration.

The SSCES noted the strengths of the Thiel Index, especially its use of existing data, its replicability and its flexibility to be adjusted according to Council interests (e.g. scale and species). As noted by the presenters, more research is needed before causal links to fishery revenue concentration shifts can be inferred. Additional work is also needed to define the spatial units that are most appropriate for any given analysis using the Theil index of concentration, as well as other community-level indicators, such as the Community Social Vulnerability Indices, reported to the PFMC. The SSCES asked that careful attention be paid to the way in which the Theil index number is explained to a general audience so a reader can interpret the changes in the index

between years and differences across species. Specifically, the Theil index values give a relative ranking of concentration values, but changes in the index value are not proportional (e.g., a doubling of the Theil index does not necessarily imply a spatial concentration value that is twice as high). This issue of interpretation is common to many indices used in the CCIEA report and not just the Thiel Index.

The Theil index, like any spatial concentration index, will depend on how ports are defined. Most of the results presented to the SSCES were calculated using ports as defined by IO-PAC regions. The results will change if spatial concentration is calculated using different port definitions, as the presenters demonstrated by comparing with an index calculated from PacFIN port groups. The CCIEA report often uses alternative port or community definitions (especially Census Designated Places). The SSCES encourages the CCIEA team to consider the implications of how ports or fishing communities are defined where possible, and clearly communicate the consequences of those definitions in the report.

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Appendix A. Meeting Participants

Friday September 4, 2020

Members in Attendance

Dr. Kristin Marshall, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA (Chair)
Mr. Alan Byrne, Idaho Department of Fish and Game, Boise, ID
Dr. John Field, SSC Chair, 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. Owen Hamel, 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, Northwest Indian Fisheries Commission, Olympia, WA
Dr. André Punt, University of Washington, Seattle, WA
Dr. William Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Jason Schaffler, Muckelshoot Indian Tribe, Auburn, WA
Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Members Absent

Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Others in Attendance

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
Mr. John DeVore, Pacific Fishery Management Council, Portland, OR
Dr. Michael Drexler, Ocean Conservancy, Saint Petersburg, FL

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
Mr. Galeeb Kachra, National Marine Fisheries Service West Coast Region, Seattle, WA
Ms. Gway Kirchner, The Nature Conservancy, Newport, OR
Mr. Kris Kleinschmidt, Pacific Fishery Management Council, Portland, OR
Ms. Sandra Krause, Pacific Fishery Management Council, Portland, OR
Dr. Nate Mantua, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Sharon Melin, National Marine Fisheries Service Alaska 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, Santa Cruz, CA
Dr. Isaac Schroeder, University of California Santa Cruz, Santa Cruz, CA
Dr. Theresa Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Brian Wells, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA

Tuesday September 8, 2020

Members in Attendance

Dr. Kristin Marshall, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA (Chair)
Mr. Alan Byrne, Idaho Department of Fish and Game, Boise, ID
Dr. John Field, SSC Chair, 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. Owen Hamel, 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, Northwest Indian Fisheries Commission, Olympia, WA
Dr. André Punt, University of Washington, Seattle, WA
Dr. William Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Jason Schaffler, Muckelshoot Indian Tribe, Auburn, WA
Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Members Absent

Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Others in Attendance

Mr. Kelly Andrews, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Mr. Travis Buck, California Department of Fish and Wildlife, San Diego, CA
Dr. Brian Burke, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Tim Copeland, Idaho Department of Fish and Game, Boise, ID
Dr. Alex Curtis, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Ms. Yvonne de Reynier, National Marine Fisheries Service West Coast Region, Seattle, WA
Mr. John DeVore, Pacific Fishery Management Council, Portland, OR
Mr. Bob Dooley, Pacific Fishery Management Council, Half Moon Bay, CA
Dr. Michael Drexler, Ocean Conservancy, Saint Petersburg, FL
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. Elliott Hazen, National Marine Fisheries Service Southwest Fisheries Science Center, Monterey, CA
Dr. Mary Hunsicker, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Mr. Galeeb Kachra, National Marine Fisheries Service West Coast Region, Seattle, WA
Ms. Gway Kirchner, The Nature Conservancy, Newport, OR
Mr. Kris Kleinschmidt, Pacific Fishery Management Council, Portland, OR
Mr. Corey Niles, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Karma Norman, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Ms. Amanda Phillips, Pacific States Marine Fisheries Commission, Portland, OR
Dr. Tanya Rogers, National Marine Fisheries Service Southwest Fisheries Science Center, Santa

Cruz, CA
Mr. Gary Rule, National Marine Fisheries Service West Coast Region, Portland, OR
Dr. Jameal Samhouri, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Jarrod Santora, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Isaac Schroeder, University of California Santa Cruz, Santa Cruz, CA
Dr. Andi Stephens, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Andrew Thompson, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA
Dr. Theresa Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Brian Wells, National Marine Fisheries Service Southwest Fisheries Science Center, La Jolla, CA

PMFC
10/19/20

SSC Subcommittee Assignments, September 2020

Salmon	Groundfish	Coastal Pelagic Species	Highly Migratory Species	Economics	Ecosystem-Based Management
Alan Byrne	**John Budrick**	**André Punt**	**Michael Harte**	**Cameron Speir**	**Kristin Marshall**
John Budrick	John Field	John Budrick	John Field	Michael Harte	John Field
Owen Hamel	Melissa Haltuch	Alan Byrne	Marisol Garcia-Reyes	Dan Holland	Marisol Garcia-Reyes
Michael Harte	Owen Hamel	John Field	Dan Holland	André Punt	Melissa Haltuch
Galen Johnson	Kristin Marshall	Marisol Garcia-Reyes	Kristin Marshall		Michael Harte
Will Satterthwaite	André Punt	Owen Hamel	André Punt		Dan Holland
Jason Schaffler	Jason Schaffler	Will Satterthwaite			Galen Johnson
Ole Shelton	Tien-Shui Tsou	Tien-Shui Tsou			André Punt
Cameron Speir	Will White				Will Satterthwaite
Tien-Shui Tsou					Ole Shelton
					Cameron Speir

Bold denotes Subcommittee Chairperson