Scientific and Statistical Committee

Pacific Fishery Management Council
Via Webinar

November 15-16, 2021

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. Fabio Caltabellotta, Oregon State University, Corvallis, OR
Dr. John Field, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Marisol Garcia-Reyes, Farallon Institute, Petaluma, CA
Dr. Melissa Haltuch, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. 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, SSC Chair, 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, Muckleshoot Indian Tribe, Auburn, WA
Dr. Ole Shelton, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Cameron Speir, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Tien-Shui Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Will White, Oregon State University, Corvallis, Oregon

Members Absent

None.

SSC Recusals for the November 2021 Meeting		
SSC Member	**Issue**	**Reason**
Dr. John Budrick	E.2 – Adopt Stock Assessments	Dr. Budrick was on the STAT for the copper and quillback assessments.
Dr. Melissa Haltuch	C.4 Preliminary West Coast Regional Framework for Determining the Best Scientific Information Available	Dr. Haltuch contributed to the development of the draft BSIA framework.
Dr. Owen Hamel	E.2 – Adopt Stock Assessments	Dr. Hamel supervised STAT members for the copper, quillback, and spiny dogfish assessments.
Dr. Will Satterthwaite	C.4 Preliminary West Coast Regional Framework for Determining the Best Scientific Information Available	Dr. Satterthwaite contributed to the development of the draft BSIA framework.

A. Call to Order

Dr. Galen Johnson called the meeting to order at 0800. Mr. Chuck Tracy 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.

E. Groundfish Management

2. Adopt Stock Assessments

The Scientific and Statistical Committee (SSC) received a report from Dr. André Punt (University of Washington) on the results of the Groundfish Subcommittee (GFSC) meeting held via webinar on September 29-30, 2021. The GFSC and Dr. Matt Cieri (Center for Independent Experts) reviewed the additional sensitivity analyses to the spiny dogfish assessment, sensitivity and rebuilding analyses for California copper and quillback rockfish, and stock and management delineations for copper and quillback rockfish. The subcommittee report is appended to this statement. The stock and management delineation recommendations from the SSC are reported under Agenda Item E.3.a. The SSC thanks the assessment authors for their continued extensive and thorough work in response to questions and concerns raised by the Pacific Fishery Management Council (Council) community.

Pacific Spiny Dogfish Stock Assessment

The SSC reviewed and discussed outcomes from the GFSC review of additional requests for analyses of the 2021 spiny dogfish assessment made by the Council at the June 2021 meeting. These included deeper explorations into the plausibility of the survey catchability coefficient (q) estimated in the base model, given the seasonal migrations of spiny dogfish. The analyses reviewed at the September GFSC meeting were challenging to both develop and interpret due to highly skewed data distributions, the presence of extreme catch events, confounding model factors, and generally poor model fits. However, the results indicated that bottom trawl fishery bycatch rates reflect fairly strong seasonal shifts in availability, such that catch rates were considerably greater in the winter months relative to the summer months during which the West Coast Groundfish Bottom Trawl Survey (WCGBTS) is conducted. The SSC concurred with the GFSC finding that in light of these results, the base model assessment estimate of survey q is likely too high as a central value. The SSC also concurred with the finding that the analyses did not provide a basis for informing either a prior or a prior estimate that would better inform the survey q in the model.

In light of this finding, the SSC also concurred with the GFSC recommendation to neither accept the previous base model, nor reject the current benchmark assessment. Instead, the SSC recommends modifying the decision table in the assessment to incorporate support for a lower value of survey q. Specifically, the SSC recommends dropping the lowest state of nature from the existing assessment (in which q was estimated to be 0.9) as implausible and shifting the decision table such that the high state of nature is unchanged and the current base model becomes the "low" state of nature. The SSC recommends adopting a new base model with a fixed value of q between the new low (0.586) and the previous high (0.3) states of nature, which would lead to a base model in which q is fixed at 0.43. This approach is analogous to the approach taken with the 2017 Pacific ocean perch assessment to arrive at a plausible value of steepness during the "mop-up" panel review for that assessment (see *November 2017 SSC statement*). As this results in an effective narrowing of the uncertainty presented in the decision table, which is contrary to the recognition of greater uncertainty in the model provided by the additional analyses, the SSC also recommends that the low, base and high states of nature not be assigned specific probabilities (as is typically done with decision tables).

The SSC endorses the 2021 full assessment of spiny dogfish, with these modifications, as providing the best scientific information available and suitable for informing management decisions. However, the SSC recommends that this approach be viewed as a short-term solution for providing management advice for spiny dogfish. The SSC recommends the stock be assigned to category 2, and that the next spiny dogfish assessment be a full assessment. The SSC recommends that this full assessment be conducted as soon as practicable, while recognizing the need to conduct the research to better inform the next assessment with respect to seasonal migration, survey representativeness, and the potential for developing a transboundary assessment with Canada, which would be more appropriate in light of the observed migration patterns.

Elasmobranch Reference Point Concerns

The SSC also discussed the appropriateness of the current target Spawning Potential Ratio (SPR) in light of the extremely low productivity and fecundity of dogfish, previously described in a November 2020 statement. Specifically, due to their life history, fishing at the target SPR of 50% may not be sustainable. However, a meta-analysis comparable to those conducted for other

groundfish life history types (e.g., flatfish) to inform a potential new target is not likely to be informative due to the limited number of species with this type of life history. The SSC recommends that the spiny dogfish STAT conduct simulations and research that could identify a harvest policy that would allow the stock to be maintained at a range of target levels, based on the revised base model. The SSC recommends that this issue be revisited at a workshop or meeting prior to the next management cycle and will consider additional options as part of future meeting planning.

California Copper Rockfish Stock Assessments

The SSC discussed the GFSC findings regarding the influence of additional age estimates for copper rockfish developed since the June meeting, which provided the opportunity to evaluate whether there was sufficient change in growth estimates and associated model results to consider changing the previously accepted assessment. For the southern California assessment, the SSC agreed that the addition of new age data led to growth parameter estimates that were very similar to the base model estimates. Consequently, the SSC recommends that no changes be made to the accepted base model for southern California copper rockfish.

For the northern California model, the results indicated some sensitivity to changes in the asymptotic growth parameter ($L\infty$) estimate, specifically that $L\infty$ could be lower in this region relative to other areas, which would infer a slightly less depleted stock. Careful evaluation based on likelihood profiling suggested that the estimated differences fell outside of the range expected by the model, although this could have been due to the very limited number of estimates from larger individuals (recognizing there was also a paucity of data from smaller individuals). This suggests that there may be growth differences between Oregon/Washington and California, although it is also possible that faster growing individuals are being removed at a faster rate by fishing, or that larger, older fish are in closed areas where they are not encountered. However, the changes in age and growth estimated in the assessment with the limited additional data available at present were insufficient to consider either revising or rejecting the previous base model for northern California copper rockfish.

Consequently, the SSC continues to endorse the 2021 data-moderate assessments of copper rockfish in southern and northern California as providing the best scientific information available and suitable for informing management decisions. The SSC recommends these stocks be assigned as category 2 assessments. The SSC notes that both additional age data and additional sources of relative or absolute abundance could be available to future assessments, to better resolve stock status and address issues that were raised during the review of the 2021 data-moderate assessments. These include indices based on the California Cooperative Fisheries Research Program, which monitors the state Marine Protected Area (MPA) network, recreational fishery catch-per-unit-effort indices, and state remotely operated vehicle survey indices. Consequently, the SSC recommends that future assessments be full assessments, although the SSC recognizes that update data moderate assessments could be feasible. The SSC reiterated that obtaining life history data needed for these stocks remains a very high priority, particularly for smaller and younger copper rockfish in all waters. The SSC also continues to emphasize the importance of collecting data within the California MPA network, given the concerns raised in these (and other) assessments, as well as between inshore and offshore habitats, to better support evaluations of localized and regional differences in exploitation rates and demographic structure.

The SSC reviewed the rebuilding analysis for southern California copper rockfish and confirmed that the analysis appears to be technically correct. The rebuilding analysis indicates a minimum rebuilding time of 10 years and a mean generation time of 17 years, but also indicated that most rebuilding strategies identified in the Terms of Reference for Rebuilding Analyses did not achieve rebuilding by a T_{max} of 2033, with at least 50% probability. Essentially, only rebuilding strategies with SPR rates greater than 0.935 had at least a 50% probability of rebuilding by T_{max}. These strategies were associated with removals of approximately 2 metric tons in 2023. As the current SSC recommendation regarding status determination is to pool the results of the southern and northern California assessments (see Agenda Item E.3.a, Supplemental SSC Report 1, November 2021), the SSC did not request that additional scenarios be developed for this rebuilding analysis.

California Quillback Rockfish Stock Assessment

The SSC discussed the sensitivity analyses of the California quillback rockfish stock assessment to new age data reported by the GFSC. The additional California data were very sparse, particularly with respect to data from younger, smaller individuals, so a new California-specific growth curve could not be estimated from the available data. Consequently, the SSC continues to endorse the 2021 data moderate assessment for California quillback rockfish as a category 2 stock assessment for use in stock status determination. With respect to future stock assessments, the SSC continues to emphasize that the paucity of data for this species will be a key constraint to improving future assessments, although there are several potential data sources that should be more rigorously evaluated to determine whether they could potentially inform either a full or a data moderate assessment model in the future. The SSC recommends deferring decisions regarding the type of future assessments pending a more robust evaluation of these potential sources of information and what data are needed to inform the composition of the stock in closed areas not reflected in the assessment, in addition to growth considerations.

California Quillback Rockfish Rebuilding Analyses

The SSC reviewed the rebuilding analysis for California quillback rockfish and confirmed that the analysis appears to be technically correct. The analysis assumed catch estimates as provided by the GMT for 2021 and 2022, and uncertainty was based on differences in natural mortality consistent with the states of nature reported in the assessment, and variability in future recruitment (assuming recruitment deviations with a sigma R of 0.6). The analysis estimated a minimum time for rebuilding of 17 years (T_{MIN}= 2040), and a mean generation time of 26 years, which leads to an estimated T_{MAX} of 2066. The rebuilding analysis reported a sensitivity in which the model assumed asymptotic selectivity early in the time period and dome-shaped selectivity in the later period, to capture changes in selectivity due to depth restrictions. The results were comparable to those in the base model; thus, this change was not recommended in the base rebuilding analysis.

Additional Stock Assessment Considerations

The SSC also discussed stock and management delineations for copper, quillback, and vermilion/sunset rockfishes, and the SSC recommendations for each of these are reported in the SSC statement on Agenda Item E.3. The SSC notes that the process of recommending stock and management delineations would have been more objective, had *a priori* criteria for deciding whether or not to combine assessment areas for purposes of status determination been established prior to adopting the assessments. The SSC will update the stock assessment Terms of Reference to ensure that stock assessments specifically address the rationale for spatial structuring of

assessment models and provide a summary of information that could inform decisions regarding status determinations. The SSC notes that while assessments can be pooled for status determination with sufficient justification, it would not be feasible or appropriate to disaggregate an assessment for separate status determinations (e.g., for areas north and south of 40º 10' N lat.).

Defining Substantive Change in Stock Assessments

In light of the multiple sensitivity analyses evaluated as part of the 2021 stock assessment cycle, the SSC also discussed the merits of developing *a priori* criteria for evaluating the consequences of sensitivity analyses of previously endorsed assessments. The SSC recognizes the need to ensure that decisions made with respect to such analyses are objective, repeatable, and risk-neutral. The SSC will discuss this issue further at the upcoming "post-mortem" meeting and could recommend a more focused workshop or process to address the concern. Such an effort could benefit from participation by Coastal Pelagic Species (CPS) analysts and the SSC CPS Subcommittee.

SSC Notes:

For spiny dogfish, among the research that should be pursued before attempting the next full assessment would be conducting further research on a potential survey q prior, conducting additional exploration of bycatch rates in the WCGOP and Pikitch data using spatio-temporal hurdle models such as VAST or sdmTMB, exploring the possibility that the WCGBTS may not be representative for spiny dogfish, and exploring the potential for a transboundary assessment with Canada.

For copper rockfish in the south, the GFSC expressed some concerns regarding how the prioritization of hook and line survey age structures was done in preparation for the southern California assessment. Specifically, emphasis was made on aging larger fish over smaller fish, which could potentially lead to some bias in the length-at-age data for the southern California model.

The Groundfish Subcommittee of the Scientific and Statistical Committee (GFSC) and Dr. Matt Cieri, Center for Independent Experts met via webinar on September 29 and 30, 2021 to review 1) rebuilding analyses and other analyses potentially informing management of California copper and quillback rockfish, 2) the spiny dogfish assessment, and 3) stock and management delineations for copper rockfish, quillback rockfish, and vermilion and sunset rockfishes. The GFSC provides the following observations and recommendations.

Spiny Dogfish

The GFSC reviewed one remaining request from the August 2021 GFSC meeting that stemmed from the Council's request from June 2021 that the spiny dogfish Stock Assessment Team (STAT) conduct additional analyses investigating the West Coast Groundfish Bottom Trawl Survey (WCGBTS) catchability coefficient (q) estimated in the assessment. The response to this outstanding request was presented by Dr. Ian Taylor and Mr. John Wallace (NWFSC).

Request: The GFSC suggests that an analysis of the seasonality of bycatch rates of spiny dogfish from the West Coast Groundfish Observer Program (WCGOP) and other available data sources (e.g., At-Sea Hake Observer Program (ASHOP) and the Pikitch et al. bycatch study) should be conducted to evaluate whether the data indicate a strong seasonal availability of spiny dogfish as bycatch to fisheries. A reasonable way to do this would be to examine haul-specific catch rates in a General Linear Model (GLM) or delta-GLM (depending on the frequency of occurrence of dogfish in a given dataset), with the primary factor of interest being month (or some other seasonal variable, such as Julian day bins, two month periods, etc. as appropriate given the data) as a factor, along with appropriate covariates that were determined by the analyst. These might include year, depth, latitude/state or region, vessel size or power, gear type, stated fishing strategy, or comparable information. Alternatively, it may be feasible to explore the use of modeling frameworks such as the Vector Autoregressive Spatio-Temporal (VAST) or the Species Distribution Model in Template Model Builder (sdmTMB; see https://pbs-assess.github.io/sdmTMB/index.html) to develop this analysis. It may also be appropriate to do separate analyses by region (e.g., Washington coast, Oregon coast, northern California coast), depending on data availability, in order to facilitate interpretation of model results. As with any such model an exploration of available information and relevant covariates will require some exploratory work, but GLMs and delta-GLMs are standard tools for any assessment analyst and the precise approach should be at the analyst's discretion.

Rationale: The results should provide an indication, albeit imperfect as there will be challenges associated with developing a conclusive result from these data sources, of the relative differences in catch rates of dogfish by fisheries participants. This alone should provide some insights to the SSC and to the Pacific Fishery Management Council (Pacific Council or Council), who made the formal request, with respect to how encounter and catch rates in the fisheries themselves appear to change seasonally, and thus the extent to which the model-estimated q was consistent with seasonal fluxes in catch rates. For example, if catch rates were on average 10x greater between November and March than those between April and October, then a model-estimated q greater than 0.5 for a survey that exclusively takes place between April and October may be a questionable model result. In such a scenario, there may be the potential to develop a weakly informative "upper bound" prior for catchability based on the ratio of bycatch rates during the months during which the survey takes

place relative to the months in which spiny dogfish are likely to be more abundant. This request does not include an explicit request to develop such a prior, but rather will provide the SSC with a basis for considering whether such an approach might be feasible and worthwhile in light of the limited time remaining in this stock assessment cycle.

Response: The STAT explored the hypothesis that spiny dogfish may be less available during the survey period than through the year due to seasonal migrations using GLMs fit to trawl bycatch rates of spiny dogfish from the WCGOP. These models fit log-catch per unit effort (CPUE) to a combination of predictors including depth, year, month, week, area (defined as north and south of 45°46' N lat.), and a month by area interaction. Predictions from a model with a month by area interaction revealed higher monthly average catches in November through February in the northern area. However, when weeks were pooled into a survey season and a non-survey season, even though survey season was a statistically significant predictor, the STAT found little contrast between predicted CPUE in survey and non-survey seasons. In their written response to the request, the STAT concluded that while the WCGOP was the most promising source of year-round observations for spiny dogfish and seasonal differences in distribution were apparent, there was not definitive evidence that the survey q estimated in the assessment was too high. However, additional diagnostics presented during the meeting by Mr. John Wallace, but not included in the briefing material circulated before the meeting, did suggest strong seasonal availability of spiny dogfish from this dataset. However, substantial uncertainty remains about seasonal migration and distribution of dogfish, as well as other factors that may influence survey catchability such as the shallower depth distribution of dogfish compared to the minimum survey depths, and these should be examined further before the next assessment for this stock.

GFSC Discussion:

The GFSC appreciates the efforts of the STAT to conduct additional exploratory analyses that could inform the plausibility of survey q estimated in the model and agrees with the STAT that multiple additional factors may influence survey q and the WCGOP data contain many complexities that warrant further exploration. The materials presented during the meeting indicated that availability (at least with respect to bycatch rates in the bottom trawl fishery) was strongly seasonal and was considerably greater in winter months relative to late spring, summer, and the early fall months when the WCGBTS takes place. However, the residuals from the GLM-fitted models were bi-modal, indicating poor fit, and additional fit diagnostics were not available. The poor fits may be related to the treatment of the zero/non-zero observations (which could be addressed more robustly in the future using a delta-GLM, or hurdle model). The scale of the predictions from the fitted model was considerably smaller than the means of the raw data by month, suggesting a skewed distribution and/or the presence of extreme catch events. The GFSC also identified potential issues with using multiple factors associated with time of year in the same model as they are often confounded.

A supplementary analysis of the WCGOP data was submitted by Mr. Corey Niles (WDFW), presented as public comment, and discussed by the GFSC. A full examination was not possible because this analysis was only available just prior to the meeting. This analysis fit random forest and Generalized Additive Models (GAMs) to spiny dogfish CPUE using similar predictors as the STAT but used hurdle models that account for the presence-absence and positive CPUE components of the data. Mr. Niles' analyses showed higher catch rates in non-survey months and also demonstrated skewness and complex spatial patterns in the WCGOP data.

The GFSC concluded that the seasonal pattern in relative CPUE observed in the GLM, random forest, and GAM approaches to fit the WCGOP data suggests that seasonal migration of dogfish is a component of survey catchability that was not accounted for in the assessment and suggests that the estimate of q from the assessment is likely to be too high. However, the GFSC also concluded it was not possible to use these analyses quantitatively to inform a prior on q at this time and further analysis of these data should occur prior to the next assessment. The GFSC discussed several potential ways forward, from recommending no change to the assessment to rejecting it. There was little support for either of the extremes. While accepting the assessment with no further changes would not acknowledge the sources of uncertainty in survey catchability that the analyses presented at the meeting revealed, rejecting the current assessment would not recognize the additional data and improved modeling in the current assessment, including the updated fecundity relationship, separate from the considerations of seasonal migration and distribution discussed. The updated model and data still have limited ability to estimate the value of catchability for the survey.

In discussing potential alternatives, members of the GFSC suggested that a reasonable alternative to either rejecting or to unconditionally accepting the assessment would be to recommend a modified decision table that incorporates support for a lower value of q. Precedent for this approach exists in the treatment of the 2017 Pacific ocean perch (POP) assessment, in which two alternative treatments of the Triennial shelf survey data (1980-2004) resulted in contrasting estimates of stock-recruitment steepness. In both cases, there was little contrast in likelihood across the full range of steepness values. A new base model was found by choosing the steepness value that most closely matched the average 2017 spawning biomass and depletion values across the models from a profile for steepness from 0.25 to 0.95. In the spiny dogfish assessment, due to the new analysis indicating that the low state of nature (high q) in the draft assessment is substantially less likely than the draft base and high states, a range of values for survey q from the draft base to the draft high state of nature was used in a similar manner to the analysis for POP. Spiny dogfish model runs from the likelihood profile for q across the range (q=0.3 to 0.586) and a subsequent new run presented during the meeting by Dr. Ian Taylor suggested that applying this approach to the spiny dogfish decision table would result in a new middle state of nature with q=0.43. This modification truncates the states of nature presented in the assessment, dropping the lowest, using the assessment base model (q=0.586) as the new low state of nature, while retaining the high state of nature in the base model (q=0.3).

The GFSC also discussed potential options for assigning weights to the states of nature in a revised decision table. Typically, these are assigned with higher weight to the middle state of nature (0.5) and lower weights to the low and high states of nature (0.25). Options discussed included equal weights, declining weights from the low to the high states of nature, and greater weight for the revised middle state of nature. Due to the uncertainty associated with the distribution of the revised states of nature, the GFSC recommends not assigning weights.

While the GFSC recommends the modified decision table as a way to move forward with the current spiny dogfish assessment, this should be viewed as a short-term solution for providing management advice for spiny dogfish during this management cycle. The GFSC recommends that a full assessment for spiny dogfish should be conducted as soon as practicable, taking into account the need to allow time to conduct the research to better inform that next assessment. At a minimum, that research should include further exploration of spiny dogfish catch rates in the WCGOP and Pikitch data, using spatio-temporal hurdle models such as VAST or sdmTMB. Because the data in this assessment were not informative with respect to survey catchability, and multiple lines of

evidence qualitatively suggest the presence of seasonal migrations, the next assessment should also explore the possibility that the WCGBT survey may not be as representative for spiny dogfish as the base model suggests. A longer term, but still important, recommendation is to explore the potential for a transboundary assessment for spiny dogfish with Canadian collaborators, to account for the seasonal patterns in CPUE that suggest movement between US and Canadian waters.

Definition of Substantial Change

The GFSC received a presentation by Dr. Will Satterthwaite (SWFSC) regarding a potential approach for developing *a priori* criteria for evaluating alternative assessments or sensitivity analyses of previously endorsed assessments. Noting that the SSC has a responsibility to provide unbiased, risk-neutral and policy-neutral advice, and that stock assessments involve numerous interacting decisions and assumptions, it is recognized that similarly supported (by the data) models can yield very different results. This can involve externally derived functional forms not explicitly estimated within an assessment model, such as growth, maturity, and the shape of the spawner-recruit relationship. Thus, there can be a risk of not providing risk-neutral advice by working backwards from what might be considered "desired" outcomes or cherry-picking requests deemed likely to yield a more "desirable" outcome. This risk could be reduced through the development and application of objective, repeatable, policy-neutral criteria. Dr. Satterthwaite's suggestion was to calculate logged ratios of the two ending spawning biomass estimates to put differences on the same scale as sigma (the currently established metric of assessment uncertainty), and to compare the proportional divergence to the "typical" level of uncertainty in biomass inferred from past uncertainty analyses. Criteria from which to consider appropriate actions would be determined based on threshold levels of change identified prior to conducting the analyses, which would distinguish the magnitude of the observed change from changes that might be more modest from a "magnitude of change" perspective, but larger from the perspective of the impact regarding management responses. The GFSC recognized considerable merit in the concerns and potential approaches outlined by Dr. Satterthwaite and agreed that an *a priori* basis for making decisions would be beneficial. It was noted by others that the comparison of outcomes was results-based and that consideration of differences in parameter values themselves might inform a more optimal model, which might be preferable. The GFSC recommended that this issue be discussed in greater detail during the post-mortem meeting.

Copper Rockfish in California

Age Data and Sensitivity Test

Dr. Chantel Wetzel (NWFSC) provided the GFSC with an overview of new age data for copper rockfish developed since the June meeting. These data include 613 additional age estimates, most of which were collected north of Point Conception. Among all data sources and regions, a key challenge is a lack of data for fish younger than age 4, although data for fish in older age classes in California are also rather sparse. The data show a much greater fraction of older fish in Oregon and Washington. In noting that the SWFSC research samples from areas south of Point Conception are generally smaller than the NWFSC hook and line survey samples, Dr. Wetzel informed the GFSC that initial aging efforts from the NWFSC hook and line survey focused on older, larger fish (those larger than 35 cm), at the request of the STAT. There were some concerns expressed regarding this length-stratified sampling, given that it could be biasing length-at-age upwards, as smaller fish were undersampled. It was also noted that the data were not developed with the intent of developing an external growth curve and would be better treated as conditional age-at-length

for growth estimation internal to the assessment. The intent had been to provide a more robust basis for estimating L_∞ and for evaluating whether that value in the southern California model diverged from L_∞ estimates elsewhere in the range of the species (recognizing that k and t_0 were based on growth curves estimated using Washington and Oregon data).

The new analysis of growth in the south included growth estimated using the historical CDFW (Bob Lea) samples (which do not include sex information), the new data from the SWFSC (Don Pearson) research efforts, and the additional NWFSC (WCGBTS and Hook and Line Survey) samples. The new estimates of the parameters of the growth curve are nearly identical to the original estimates in the adopted base model (male and female L_∞ estimates of 46.7 cm and 47.2 cm, relative to original base model estimates of 47.1 cm and 47.7 cm, respectively). These changes had very modest impacts on base model results. It was noted that there are reasonable numbers of samples, including smaller fish, which could be aged to inform future assessments and address potential bias from sample selection and use of parameters from Oregon and Washington for southern California. The GFSC concluded that there were no significant changes in age and growth estimated in the assessment with the limited additional data available at present and thanked the analysts for the additional information and analysis.

With respect to additional age data north of Point Conception, the majority of the available data are now coming from the SWFSC (Pearson) research surveys. New external estimates of growth were made both with and without the Lea estimates (for smaller fish). The results indicated similar k values relative to the base model, but smaller L_∞ values for both sexes. The STAT conducted a joint profile across L_∞ for males and females (within the assessment model), which indicated that the differences fell outside of the range expected by the model (which was initially driven primarily by the length data). The STAT reported that the new external estimate of the growth curves does not appear consistent with the estimated growth from other areas, nor with the available length data for the northern California model. This may in part be the result of the limited sample size for larger individuals in the recent samples to better inform L_∞, though smaller individuals that were well represented in collections from California also showed shorter lengths at age, indicative of differences in growth from Oregon and Washington or the faster growing individuals being removed from the sample frame due to fishing and/or moving into closed areas, warranting further examination in future assessments. The STAT's conclusion was that although their results indicated more sensitivity to changes in L_∞ in the northern California model, the observed changes cast more doubt on the externally estimated growth curve rather than the base model. The GFSC identified a need for sampling of more small and large individuals to inform the externally estimated growth curve for comparison to growth currently used in the base model.

It was noted that the model structure might have been different had these data been available and used in place of the coastwide growth estimates. During model development, the STAT noted that while there was initially interest in estimating biological parameters, there was a general reluctance to do so given the sparseness of the data, limited collection/ageing resources due to COVID 19 and ageing priorities for other assessments. Consequently, the STAT opted for the simplest model structure, given that the estimates were close to the fixed values at the time. The GFSC concluded that although it is possible that L_∞ could be lower for this region, which could imply a less depleted stock (based on the sensitivity analysis included in assessment), the evidence reviewed during the meeting was not sufficient to reject the base model.

In discussing the new data, the GFSC expressed concerns regarding possible bias in the carcass sampling data, due to the potential for shrinkage in carcasses with time and the qualitative observation that age and length estimates from carcass-sampled fish appeared to have lower length at age and more outlying length-at-age observations than the other data sources. As most carcass samples did not include sex information, the STAT noted that most of those data were not used in the growth estimation, and that those samples were unlikely to disproportionately impact the estimates. The desire to base growth estimates on data from samples collected from whole fish was noted, as measurements of carcasses were likely to be more variable than those of whole fish. The GFSC broadly agreed and reiterated that life history data needs for these stocks remain a very high priority.

Rebuilding Analysis

Dr. Chantel Wetzel (NWFSC) presented the rebuilding analysis for copper rockfish south of Point Conception. The rebuilding analysis is required based on the 2021 data-moderate stock assessment that estimated depletion to be at 18.1%, which is below the Minimum Stock Size Threshold (MSST) of 25%. The rebuilding analysis was based on the 2021 assessment and assumed the GMT-recommended removals for 2021 and 2022 of 90.8 and 88.9 metric tons, respectively. The analysis was conducted based upon the Terms of Reference for the Groundfish Rebuilding Analysis and used the Rebuilder software version 3.12h (August 2021).

A range of alternative rebuilding strategies were evaluated: 1) setting all harvest to zero (F=0) and determining the rebuilding timeline without fishing (T_{MIN}); 2) applying a range of SPR values between 0.55 and 0.75; 3) applying annual catch limits (ACLs) based on the 40:10 control rule; 4) applying the acceptable biological catch (ABC) control rule with time-varying sigma; and 5) looking at SPR harvest rates that are estimated to lead to rebuilding at T_{MID}, T_{MAX} and the years between them.

In terms of uncertainty, the only area providing estimates of recruitment deviations was northern California, where the assumed recruitment variation was 0.6. The base model for southern California did not estimate recruitment deviations, but the rebuilding analysis assumed that recruitment was stochastic into the future with σ_R=0.6. The GFSC endorsed the approach for accounting for uncertainty in forward projections.

The rebuilding reference points were calculated using the base model. The rebuilding plan was assumed to start in 2023, with the estimated minimum time for rebuilding of 10 years (T_{MIN} = 2033), and the mean generation time being 17 years. During the presentation, an error was identified in how T_{MAX} was calculated using the Rebuilder program for stocks with a T_{MIN} of 10 years. Considering that the stock can rebuild in 10 years or fewer, T_{MAX} was corrected and set to 2033 based on the requirements of the MSA. Since this was the first rebuilding plan for copper rockfish, a T_{TARGET} and SPR_{TARGET} had not been defined by a previous rebuilding plan. According to the results presented in Table 2 of the updated report document, most of the strategies examined are not viable because they do not rebuild the population by T_{MAX} with at least 50% probability. However, the T_{MID} which applies an SPR harvest rate of 0.935 has a 50% probability of rebuilding by T_{MAX} .

The STAT provided an additional run with higher SPR values (Table 3, in the updated report document), which gives an additional option since the only one available was for T_{MID}. The only viable SPR values were those greater than or equal to 0.935, thus values of SPR equal to 0.94,

0.95, and 0.96 were explored, which provided results that were similar to those for T_{MID} (Table 2). This represents quite high SPR harvest rates in order for the stock to rebuild by 2033.

According to Table 4, using the typical range of SPR values, the probability of rebuilding at T_{MID} = 2033 was 50% as expected. The STAT clarified that the reason the original document wasn't getting an exact fit each time (i.e., 0.50) is that the number of total years between the start year and T_{MAX} was odd, and thus T_{MID} was calculated as occurring mid-year rather than at the start of the year. In terms of median catches, the results from Table 9 indicated removals starting around just over two metric tons in 2023. Therefore, rebuilding between 2023 and 2033 indicated that removals would move from two metric tons to 4.64 metric tons, respectively.

The GFSC agrees that the rebuilding analysis, which includes the technical update, was conducted correctly, and recognizes that additional runs may be requested by the GMT and other PFMC Advisory Bodies should the population south of Point Conception be considered a stock and rebuilding be implemented. See discussion below regarding whether the assessments for northern and southern California should be combined for determining status.

Notes:

Dr. John Budrick pointed out the catastrophic effect of rebuilding the southern California population given that the stock was previously providing somewhere around 90 metric tons when it was healthy (as inferred by the 2013 index-based assessment) versus two metric tons that resulted from rebuilding analysis. Some GFSC members also pointed out that 10 years for rebuilding is arbitrary, although still statutorily required.

Quillback Rockfish in California

Age Data and Sensitivity Test

Dr. Brian Langseth (NWFSC) provided an overview of an updated growth analysis for quillback rockfish in California. While the assessment is "statewide," nearly all of the available data are from waters north of Point Conception, as quillback rockfish are exceedingly uncommon south of Point Conception, declining markedly in abundance south of Pigeon Point, California near Santa Cruz near the southern extent of their range. A total of 245 new quillback rockfish age and length samples are available, 122 of which have been aged (the "Abrams" research otoliths could not be aged in time for this analysis). These ages were combined with 21 existing samples from the WCGBTS for California waters. The STAT noted that of the 143 total aged samples, only two were smaller than 20 cm, and only three were younger than five years of age.

When the California data were overlaid on the growth curve from the base assessment (in which growth was shared among all regions), a slightly larger fraction of the length-at-age observations falls below the estimated growth curve from the coastwide model. A growth curve fit using only the California data results in an L_∞ estimate consistent with the base model, although the L_0 estimates are larger than that for the base curve due to the paucity of smaller individuals. The growth model was very sensitive to the inclusion or exclusion of the two youngest fish. When the values at the lower end of the growth curve were fixed (at the original coastwide model estimates), the California data estimated similar values for *k*, although the estimated L_∞ appear "unreasonably" low based on both the coastwide model estimate and the existing (albeit sparse) observations for older fish from California waters. Overall, length-at-age in California appeared

lower than the length-at-age for samples from Oregon and Washington, resulting in a fitted curve that was lower than the base model. This result was consistent with the growth curve estimated internally to the model, for which the stock was in the precautionary zone in sensitivity analyses. The STAT noted that it would generally not put credence in internal estimates without age data in the model and evidence of strong age classes evident in the length data to overcome that deficit, thus growth was not estimated internally and the comparison serves only to illustrate that the fitted growth curve parameters are consistent with a more optimistic result than the base model. While this was the case, the STAT concluded that there is an insufficient number of samples of younger fish to robustly estimate a separate California growth curve at this time, noting as well that the curve resulting from estimating growth within the Oregon model was quite similar to that resulting from the same exercise for California, but in the former case it was clear that the estimated model did not match the robust age and length data for Oregon. The need to consider the appropriate parameterization for a growth curve was also recognized by the GFSC, given the sparseness of data at the low and high ends of the age range. The GFSC supports collection and ageing of additional samples for smaller and larger fish to better inform growth in future assessments.

With respect to the internally estimated growth curve, the STAT expressed concern with using an internally estimated growth curve from a model without ages. The GFSC did not see sufficient evidence in the results of these analyses to reject the previously recommended base model, despite the more optimistic results of sensitivity runs being in the precautionary zone. It was recognized that future assessments could better address some of the questions and challenges associated with estimating growth. The GFSC recognized that it would be helpful to better understand existing thresholds associated with data availability to inform growth and other life history processes on a regional basis and ensure that the key data are available before moving forward with additional length-based assessments in the future. As with copper rockfish, the GFSC broadly recognized the critical need for improved collection of life history data to better inform future models.

Rebuilding Analysis

Dr. Brian Langseth (NWFSC) presented the rebuilding analysis for quillback rockfish in waters off California. The rebuilding analysis is required based on the 2021 data-moderate stock assessment that estimated depletion to be at 14%, which is below the MSST of 25%. The rebuilding analysis was based on the 2021 assessment and assumed the GMT-recommended removals for 2021 and 2022 of 13.5 metric tons. The analysis was conducted based upon the Terms of Reference for the Groundfish Rebuilding Analysis and used the Rebuilder software version 3.12h (August 2021).

A range of applicable alternative rebuilding strategies was evaluated according to the following categorizations: 1) strategies that are specified in the TOR (e.g., setting all harvest to zero, F=0); 2) strategies that are specified in the TOR, but require an SPR or catches that would result in an SPR < 0.5 (not done); and 3) additional strategies that include a range of SPR values between 0.5 and 0.9. The strategies in categorization 2 include two options, one generating ACL contributions for the current year of around 5.86 metric tons, and another one applying SPR harvest rates that are estimated to lead to rebuilding by T_{MAX} from the current cycle. There are also three additional strategies specified in the TOR. However, these are not applicable to the current analysis as they only apply to species with existing rebuilding plans.

All runs assumed full attainment and included uncertainty and starting values based on states of nature around natural mortality. In terms of uncertainty, the model included uncertainty in

recruitment deviations with a $\int_R$ of 0.6. The rebuilding reference points were calculated using the base model. The rebuilding plan was set to start in 2023, with an estimated minimum time for rebuilding of 17 years (T_{MIN}= 2040), and a mean generation time of 26 years, which resulted in a T_{MAX} of 2066. Alternative target years were not explicitly presented in the current analysis, though the various SPR runs provide a range of expected rebuilding years.

One of the requests received by the STAT was to conduct an additional rebuilding analysis as a sensitivity, with the recreational and commercial selectivities blocked at 2001 in the assessment model, with asymptotic selectivity in the early time period and dome-shaped selectivity in the latter period. The intent of the sensitivity analysis was to capture the changes in availability of fish of differing size classes before and after depth restrictions (20-30 fm) were implemented north of Pigeon Point, California where most of the biomass of quillback rockfish resides. For this model, the alternative states of nature were not applied. Therefore, the only uncertainty was recruitment variability. The results of the Stock Synthesis sensitivity model were similar to those of the base model, which did not warrant a change to the base model. The comparison of the results between Tables 1 (i.e., base) and 7 (i.e., rebuilding sensitivity), indicated that the sensitivity model has slightly higher spawning output in the initial year, as well as in the recent year. Therefore, T_{MIN} was one year sooner, leading to a slightly shorter time for rebuilding. The mean generation time was one year longer, and thus T_{MAX} was the same for these two runs. This is due to applying the alternative states of nature for natural mortality in the base rebuilding analysis. The current SPR for the sensitivity model also indicates slightly less intense fishing due to the higher spawning output level.

In terms of comparing the ACLs between Tables 2 (i.e., base) and 8 (i.e., sensitivity), those for the sensitivity runs were around 10 to 20% higher. The probabilities were also higher for achieving recovery by T_{MAX}. While the sensitivity model attempts to account for differences in the availability of fish before and after depth restrictions, examination of length composition and indices of abundance from inside and outside of closed areas from CCFRP and ROV data are preferable for capturing differences in abundance. That said, the base model, by assuming asymptotic selectivity, which is more parsimonious, ignores the potential differences in availability by size including 20% of the estimated habitat area for this stock that is permanently closed to take of groundfish including quillback rockfish in the Marine Protected Area network (Agenda Item G.5, Supplemental CDFW Report 1, June 2021). The GFSC requested the STAT include in the document the reference point and summary tables that report the base rebuilding alternatives without the states of nature for direct comparison to the sensitivity analysis.

The GFSC agrees that the rebuilding analysis was conducted correctly and recognizes that additional runs may be requested by the GMT and other PFMC Advisory Bodies.

Notes:

The logarithm of the ratio of the sensitivity model's 2021 spawning output to the base model's 2021 spawning output would result in the value of 0.12.

Dr. John Budrick appreciated the STAT analysis in running the sensitivity addressing one of the outstanding concerns with this assessment regarding not integrating the CCFRP and ROV data, as well as the ability to account for the closures that took place in 2001, in terms of depth restrictions and potential effects on availability, which potentially will be borne out in a later assessment.

Stock and Management Delineations for Copper, Quillback, and Vermilion and Sunset Rockfishes

As requested by the Council, the GFSC discussed the appropriate spatial delineations for management of copper, quillback, and vermilion and sunset rockfishes. For each stock, the discussion centered on evidence for spatial stock structure and whether spatially segregated assessments (e.g., for southern and northern California copper rockfish assessments) should be aggregated for the purpose of setting catch limits and status determination. Some discussion of the spatial structure of the assessments occurred during the pre-assessment workshops.

Copper rockfish

Dr. Chantel Wetzel presented a summary of evidence for the stock structure of copper rockfish, specifically focusing on whether there should be separate management units north and south of Point Conception. Several population genetics studies have found weak or mixed evidence for genetic differentiation for copper rockfish in northern and southern California. However, genetic divergence requires much greater isolation over longer time scales than would necessarily be relevant for spatial management considerations. Spatial differences in demographics or depletion may be present even in genetically well-connected populations. Evidence related to adult movement was variable, but in any case, the scale of adult movement is dwarfed by the potential scale of larval dispersal in this species. Small differences in growth and size at maturity between north and south are present, but such spatial gradients are common and likely reflect environmental differences.

The arguments for spatial structure in management largely arose from the assessments themselves, which estimated different recruitment patterns, as well as different overall trajectories (though it was noted that there was coastwide coherence in recruitment of this species during the 2014-2016 period based on survey results reported by Field et al. [2021]). The difference in trajectories is particularly concerning because simulation studies have shown that assessment and management that does not properly account for spatial structure can lead to localized overfishing. While it may not be necessary to have management operate at the same spatial scale as assessment, any aggregation of assessments should be done such that local depletion of components is not masked.

The GFSC discussed whether it was preferable to assess status at the scale of individual assessments or to pool the assessments for southern and northern California for status determination. Related precedents are the 2009 and 2019 Cabezon stock assessments, in which separate assessments of northern and southern California were maintained because of differences in recruitment patterns; the two assessments were then pooled for status determination. After discussion, the GFSC recommendation is that the two California assessments should be pooled for status determination. This results in an overall depletion of 31.7% of unfished spawning stock biomass of copper rockfish in California. However, given spatial differences in recruitment and estimated trajectory, differences in management north and south of Point Conception should be considered to keep harvest proportional to biomass across the species range in California. Further, the GFSC recommends further research on stock structure in this species (noting that the SSC may reconsider this delineation recommendation in light of new evidence) and a workshop to investigate the implications of managing a groundfish stock separately south of Point Conception. The GFSC requests that estimates of stock status at the areas on which assessments are based

(which may not match state boundaries), state and coastwide level be available at the November Council meeting.

Dr. Wetzel provided an apportionment calculation based on average historical total catch from 2005-2020 because no habitat or biomass estimates were available for this purpose. This results in an apportionment of 3.9% to the north and 96.1% to the south of 40º 10' N. lat. within California.

Quillback Rockfish

Dr. Brian Langseth presented information on the spatial apportionment of quillback rockfish, based on a proposed management delineation at 40º 10' N. lat. The apportionment was based on average historical total catch from 2005-2020 because neither habitat nor biomass data were available for that calculation. The resulting split was 49.6% in the north and 50.4% in the south within California. At the GFSC's request, Dr. Langseth showed how that split would vary over different periods of available total catch data. There was no consistent trend in the division of catches, and the GFSC agreed that future calculations should apply a consistent approach in determining the averaging window.

The GFSC discussed the rationale for a management delineation at 40º10' N. lat., rather than at 42º N. lat. (the California-Oregon border), which is how the stock assessment areas were split. Dr. Langseth pointed out that the different history of management and catches in the two states led to that choice for the assessment areas, but that other divisions were possible. The GFSC proposed that the Terms of Reference for stock assessment be updated so that assessment reports specifically address the rationale for such decisions in the future. The GFSC also noted that while the California and Oregon assessments could be pooled for status determination, it would not be suitable to attempt to disaggregate an assessment for separate status determinations north and south of 40º10' N. lat.

The GFSC tabled further discussion of management delineation of quillback rockfish pending a request that the STAT provide a summary of evidence related to stock structure, similar to that provided for copper rockfish, at the November Council meeting. The GFSC also requested estimates of stock status at the assessment areas, California+Oregon and coastwide level be available at the November Council meeting.

Vermilion & Sunset Rockfishes

Dr. Melissa Monk (SWFSC) presented information on the spatial management allocation of vermilion and sunset rockfishes in California. Her calculations used a method developed in collaboration with Dr. E.J. Dick and used previously for blue and deacon rockfishes. The method uses the product of a fishery-dependent CPUE estimate and habitat availability to estimate a proxy for the proportion of biomass in each region. The CPUE used was from the CDFW California recreational fisheries survey (CRFS) private/rental boat mode index, averaged over 2016-2019 (2020 was excluded due to COVID-related sampling issues). The habitat proxy was based on a product developed at the SWFSC using the 2-meter bathymetry from the California Seafloor Mapping Program. The habitat proxy was only available north of Point Conception so the apportionment analysis is also restricted to that region. This method estimated that the relative biomass in the Central, Bay, Wine, and Redwood CRFS districts is 59.32%, 27.45%, 8.82%, and 4.41%, respectively. The GFSC endorses this method and the calculations, and notes that this approach is much preferred over catch-only apportionments.

The GFSC recognized that the Council seeks advice on the management of vermilion and sunset rockfishes as a complex. However, this topic was tabled until the Groundfish Management Team produces their own recommendation on the topic at their October meeting. The GFSC also tabled discussion of management delineation for vermilion and sunset rockfish pending a request that the STAT provide a summary of evidence related to stock structure, similar to that provided for copper rockfish, as well as estimates of stock status at the assessment area, state, and coastwide level at the November Council meeting.

Notes:

Stratification of assessment areas to capture differences in data availability or considerations regarding historical exploitation to make use of informative regional data sources such as the Hook and Line Survey to appropriately capture differences in dynamics, does not necessitate determination of status or management at the assessment scale. Examination of depletion at multiple scales from coastwide to assessment area may help inform considerations at a species level as well as more regional depletion concerns.

Reference

Field, J.C., Miller, R.R., Santora, J.A., Tolimieri, N., Haltuch, M.A., Brodeur, R.D., Auth, T.D. et al. 2021. Spatiotemporal Patterns of Variability in the Abundance and Distribution of Winter-Spawned Pelagic Juvenile Rockfish in the California Current. *PLOS ONE* 16 (5): e0251638. https://doi.org/10.1371/journal.pone.0251638.

Review Panel Members Present

Dr. John Budrick, California Department of Fish and Wildlife, San Carlos, CA
Dr. Fabio Caltabellotta, Oregon State University, Corvallis, OR
Dr. Matt Cieri, Center for Independent Experts
Dr. John Field, National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, 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. Kristin Marshall, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. André Punt, University of Washington, Seattle, WA (Chair for this meeting)
Dr. Jason Schaffler, Muckleshoot Tribe, Auburn, WA
Dr. Tien-Shui Tsou, Washington Department of Fish and Wildlife, Olympia, WA
Dr. Will White, Oregon State University, Corvallis, OR

Stock Assessment Teams Present

Dr. E.J. Dick; Vermilion and Sunset Rockfishes; National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA

Dr. Brian Langseth; Copper Rockfish and Quillback Rockfish; National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Melissa Monk; Vermilion and Sunset Rockfishes; National Marine Fisheries Service Southwest Fisheries Science Center, Santa Cruz, CA
Dr. Ian Taylor; Spiny Dogfish; National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Mr. John Wallace; Spiny Dogfish; National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Dr. Chantel Wetzel; Copper Rockfish and Quillback Rockfish; National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA

Other Attendees

Mr. Russell Barabe, California Department of Fish and Wildlife, San Diego, CA
Mr. George Bradshaw, F/V Susan, Crescent City, CA
Ms. Susan Chambers, West Coast Seafood Processors Association, GAP, Charleston, OR
Dr. Jason Cope, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Mr. John DeVore, Pacific Fishery Management Council, Portland, OR
Ms. Jaime Diamond, Stardust Sportfishing, Santa Barbara, CA
Mr. Ben Enticknap, Oceana, Portland, OR
Mr. Ken Franke, Sportfishing Association of California, San Diego, CA
Mr. Tom Hafer, Morro Bay Commercial Fishermen's Organization, Morro Bay, CA
Mr. Don Hansen, Dana Wharf Sportfishing, Dana Point, CA
Ms. Heather Hall, Washington Department of Fish and Wildlife, Pacific Fishery Management Council, Olympia, WA
Ms. Gretchen Hanshew, National Marine Fisheries Service West Coast Region, Seattle, WA
Dr. Jim Hastie, National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA
Mr. Christian Heath, Oregon Department of Fish and Wildlife, Newport, OR
Mr. Brian Hooper, National Marine Fisheries Service West Coast Region, Seattle, WA
Mr. Harrison Ibach, GAP, McKinleyville, CA
Mr. Bob Ingles, Golden Gate Fisherman's Association, GAP, Half Moon Bay, CA
Mr. Bill James, Salem, OR
Mr. Will Jasper, Makah Tribe, Neah Bay, WA
Mr. Steve Joner, Makah Fisheries Management, GAP, Neah Bay, WA
Mr. Galeeb Kachra, National Marine Fisheries Service West Coast Region, Seattle, WA
Ms. Keeley Kent, National Marine Fisheries Service West Coast Region, Seattle, WA
Mr. Kris Kleinschmidt, Pacific Fishery Management Council, Portland, OR
Ms. Traci Larinto, California Department of Fish and Wildlife, GMT, West Sacramento, CA
Mr. Dan Lee
Ms. Mel Mandrup, California Department of Fish and Wildlife, GMT, West Sacramento, CA
Ms. Heather Mann, Midwater Trawlers Cooperative, Newport, OR
Mr. Tom Marking, GAP, McKinleyville, CA
Dr. Steve Martell, Sea State Inc., Seattle, WA
Ms. Lynn Mattes, Oregon Department of Fish and Wildlife, GMT, Newport, OR
Mr. Merit McCrea, Sportfishing Association of California, GAP, Santa Barbara, CA
Mr. Pete McHugh, California Department of Fish and Wildlife, GMT, Santa Rosa, CA

Mr. Corey Niles, Washington Department of Fish and Wildlife, Pacific Fishery Management Council, Olympia, WA
Mr. Mike Okoniewski, Pacific Seafoods, CPSAS, Woodland, WA
Mr. James Phillips, California Department of Fish and Wildlife, Santa Rosa, CA
Mr. Todd Phillips, Pacific Fishery Management Council, Portland, OR
Ms. Katie Pierson, Oregon Department of Fish and Wildlife, GMT, Newport, OR
Mr. Dan Platt, Salmon Trollers Marketing Association, GAP, Fort Bragg, CA
Mr. Rick Powers, Golden Gate Fisherman's Association, GAP, Bodega Bay, CA
Mr. Gerry Richter, B & G Seafoods, Inc., GAP, Santa Barbara, CA
Ms. Whitney Roberts, Washington Department of Fish and Wildlife, GMT, Olympia, WA
Dr. Will Satterthwaite, National Marine Fisheries Service Southwest Fisheries Science Center, SSC, Santa Cruz, CA
Ms. Maggie Sommer, Oregon Department of Fish and Wildlife, Pacific Fishery Management Council, Newport, OR
Dr. Andi Stephens, National Marine Fisheries Service Northwest Fisheries Science Center, Newport, OR
Mr. Daniel Studt, National Marine Fisheries Service West Coast Region, GMT, Long Beach, CA
Mr. Nick Tharp, El Tiburon Sportfishing, Santa Barbara, CA
Mr. Dan Waldeck, Pacific Whiting Conservation Cooperative, GAP, Portland, OR
Ms. Marci Yaremko, California Department of Fish and Wildlife, San Diego, CA
Mr. Louis Zimm, Sportfishing Association of California, San Diego, CA

SSC Recusals for this Meeting

SSC Member	**Issue**	**Reason**
Dr. John Budrick	Copper Rockfish and Quillback Rockfish	Dr. Budrick was on the STAT for these assessments.
Dr. Owen Hamel	All assessments	Dr. Hamel supervises STAT members on these assessments.
Dr. Tien-Shui Tsou	Copper Rockfish and Quillback Rockfish	Dr. Tsou was on the STAT for these assessments.

F. Salmon Management

1. Final Methodology Review

The Scientific and Statistical Committee (SSC) received a report summarizing reviews of salmon methodology topics conducted by the SSC Salmon Subcommittee (SSCSS) via webinar on October 20-21, 2021 (SSCSS report appended). The SSCSS received presentations and documents on four topics:

1. Complete the documentation of the Chinook Fishery Regulation Assessment Model (FRAM) program and the development of the new Chinook base period, including algorithms and User Manual.
2. Evaluate post-season metrics of FRAM performance.
3. Provide documentation of the abundance forecast approach used for Willapa Bay natural coho.
4. Review Oregon Production Index Hatchery forecast.

Complete the documentation of the Chinook Fishery Regulation Assessment Model (FRAM) program and the development of the new Chinook base period, including algorithms and User Manual.

The SSC appreciates the new FRAM documentation provided by the FRAM analysts. The new, online, "living document" format of the FRAM user manual and associated documents is a significant step forward and will enable managers, scientists, and the public to better understand and critically evaluate the model. The SSC supports ongoing efforts to make the source code publicly available and provide a venue for future improvements to code and documentation. Overall, the SSC considers the FRAM documentation sufficient, though there remain components of the documentation that need additional detail, including further description of the estimation algorithms and the distinction between data and parameters within the model. Additionally, documentation for the Chinook and coho base periods should be completed and undergo methodology review. Over the long term, the SSC encourages moving from FRAM's current deterministic framework to a likelihood-based framework that can inform the uncertainty around model outputs.

Evaluate post-season metrics of FRAM performance

The SSC reviewed a report comparing exploitation rates calculated using the Exploitation Rate Analysis (ERA) conducted by the Pacific Salmon Commission's Chinook Technical Committee with exploitation rates derived by FRAM. The ERA and FRAM analyses share many similarities, relying on the same basic cohort-reconstruction structure and base data type (coded-wire tags [CWTs]), but make many different assumptions about the biological and statistical attributes of the Chinook salmon data. Overall, exploitation rate estimates between the two methods were moderately related for the 2009-2018 period but unrelated for 1999-2008, demonstrating the importance of the model assumptions in determining estimates of exploitation rates.

The SSC commends and thanks the analysts for their exploratory comparative analyses and looks forward to future analyses that may help direct improvements in each method. The SSC identified

four areas in particular that would be productive for improving exploitation rate analyses: 1) Genetic analysis to get CWT-independent estimates of catch by stock, including non-tagged stocks (often the case for wild stocks); 2) analysis of the benefit of updating the base period more often and determining the ideal update time interval; 3) updated analyses that include uncertainty estimates; and 4) pre- and post-season comparison of FRAM fishery impact estimates. The SSC also looks forward to future work aimed at validating model estimates of coho exploitation rates, exploitation rates on unmarked Chinook, and quantifying impacts of mark-selective fisheries.

Provide documentation of the abundance forecast approach used for Willapa Bay natural coho

During the SSCSS meeting, Dr. Dan Auerbach (Washington Department of Fish and Wildlife; WDFW) and Mr. Thomas Buehrens (WDFW) presented the proposed forecast methodology for natural-origin Willapa Bay coho. The Willapa Bay natural coho forecast is needed to set the annual Acceptable Biological Catch (ABC). The proposed approach is based upon a recent publication (DeFillippo et al. 2021) that developed a spatiotemporal integrated population model for coho management units in Washington state excluding Columbia River coho. The analysts extended and tailored the DeFillippo et al. model to make predictions for Willapa Bay natural coho. The model showed considerable forecast skill and provided uncertainty bounds on predictions. The SSC appreciates the comprehensive analyses presented by the analysts and endorses the forecast method for determining the ABC for Willapa Bay natural coho. The SSC also appreciates the open and reproducible approach to the data and statistical code adopted by the analysts including the publication of publicly accessible data and code repositories on GitHub.

The analysts discussed several possible extensions to their existing model that may be added in the coming years including 1) adding environmental covariates to improve prediction of marine survival and smolt production; 2) adding information from additional proximate coho stocks to the model; and 3) accounting for the contribution of natural-spawning hatchery fish to coho production. The SSC suggests that the addition of such model components generally should not require a full methodology review for use in future forecasts, but the use of any such alternate models should be contingent on the availability of documentation for the proposed model including metrics of forecast skill justifying the use of a new model. The analysts should notify the SSC by the September Council meeting prior to the year in which the forecast is to be used if changes to the Willapa Bay forecast are anticipated, and the appropriate level of further review, if any, can be assessed at that time.

Review Oregon Production Index Hatchery forecast

During the SSCSS meeting, Mr. Erik Suring (Oregon Department of Fish and Wildlife; ODFW) presented an overview of the Oregon Production Index Hatchery (OPIH) coho forecast methodology. The current model structure and data streams have been in use since 2008 and are now publicly available on a GitHub repository.

The SSC recommends continuing to use the current model structure for forecasting this stock as it is currently the only available forecast model for OPIH. However, there should be a high priority placed on investigating alternative models to compete against the current model. The OPIH forecast is particularly influential for properly modeling fishery impacts to less abundant natural stocks and therefore improved forecast performance for OPIH will likely improve management of many coho stocks.

In comparison to eight natural coho stocks (those included in Figures III-1a and III-1b of Preseason Report 1), the OPIH forecast performed relatively well – though OPIH is a hatchery stock, not a natural stock. Furthermore, across all stocks considered, a majority of forecasts were biased high, and some forecasts performed more poorly than simply using the previous year's abundance as a forecast. The SSC suggests that there is considerable value in compiling and reporting metrics of forecast performance as a component of Preseason Report 1, to identify forecasts in need of review and improvement.

Additional topics

Across the topics discussed, the SSC noted the increased use of non-permanent public repositories as a method for sharing code and data. This is an encouraging and commendable step toward transparency and reproducibility. At present, many code and data repositories are maintained on personal accounts that do not have long-term archiving capabilities, making it difficult to ensure data and methods are preserved. The SSC suggests that identifying a centralized platform or method that can be used to archive information used in Pacific Fishery Management Council (PFMC, Council) applications be a priority for development in the near future.

SSC Notes:

There was considerable discussion about the potential for changing the schedule of release of the Pre-I report to allow for more time for SSC review before the current early March deadline. The possibility of the STT providing a draft of Pre-I for SSC review to allow for preliminary review may provide a solution for allowing sufficient review time, at least for estimates and forecasts associated with "major stocks" -- though "major stocks" still need to be identified, as described in the SSCSS report.

SCIENTIFIC AND STATISTICAL COMMITTEE'S
SALMON SUBCOMMITTEE REPORT ON
SALMON MEHODOLOGY REVIEW

Pacific Fishery Management Council
Via Webinar

October 20 – 21, 2021

The Scientific and Statistical Committee's Salmon Subcommittee (SSCSS) held an online meeting on October 20 and 21, 2021 with the Model Evaluation Workgroup (MEW), and the Salmon Technical Team (STT) to review salmon methodologies and to discuss planning for potential future salmon review topics. We discussed the four topics that were chosen at the September 2021 Council meeting for the methodology review: (1) Documentation of the Chinook Fishery Regulation Assessment Model (FRAM) program, including algorithms and the User Manual; (2) Evaluate post-season metrics of FRAM model performance; (3) Documentation of the abundance forecast approach used for Willapa Bay natural coho; and (4) Review the Oregon Production Index Hatchery coho forecast methodology. In addition, Ms. Angelika Hagen-Breaux (MEW) gave a FRAM tutorial at the end of the first day.

1. Documentation of the Chinook Fishery Regulation Assessment Model (FRAM) program, including algorithms and the User Manual

Mr. Jeremiah Shrovnal (Washington Department of Fish and Wildlife; WDFW) presented the updated overview portion of the FRAM model documentation. A FRAM User Manual was published previously, but since the documentation was last revised, FRAM has incorporated a number of changes including new algorithms, re-parameterization of the Chinook model base period, and re-coding the model using VisualStudio.Net to work with MS Access databases. The new documentation exists on a website (https://framverse.github.io/fram_doc/) with plans for continued updating and the capability to integrate comments from interested model users.

The SSCSS finds the online FRAM user's manual and overview portion of the documentation to be well organized and user friendly and do not require further review. The SSCSS would like opportunities to review technical details such as the specific equations and data processes used in the model in the future. The documentation should clarify the relationship between "data" inputs and fixed "parameters", including additional details on how fixed parameter values are generated. The documentation should also note any exceptions to the documented algorithms that are hard coded into the program. Documentation of the Chinook and Coho base period construction should also be completed and undergo methodology review in the future.

The SSCSS commends the workgroup responsible for creating the documentation. The FRAM user manual and other documentation is a significant step forward and will enable managers, scientists, and the public to better understand and critically evaluate the model. The SSCSS also appreciates the steps that the workgroup has taken to make the source code publicly available and consider comments from interested parties to improve the code and documentation. Over the long term, the SSCSS encourages moving from the current FRAM deterministic projection framework to one that incorporates uncertainty around point estimates and documenting this well.

2. Evaluate post-season metrics of FRAM model performance

Mr. Jon Carey (National Marine Fisheries Service, West Coast Regional Office) presented work on the evaluation of post-season FRAM performance. The evaluation was based upon comparison of FRAM exploitation rate estimates and static maturity rate estimates to those estimated by the Exploitation Rate Analysis (ERA) undertaken by the Chinook Technical Committee, for the years 1999-2018.

While both analyses are based upon data from coded wire tags (CWTs), they are derived independently from each other using markedly different analyses. FRAM is a deterministic single pool, multi-stock model designed to assess the effects of multiple mixed-stock fisheries on individual stocks, uses a base period, currently from 2005-2008, to estimate relative fishing rates of each fishery across stocks, and is used primarily for pre-season predictive analysis, although it can be used post-season as well. ERA is used only for post-season analysis for a calendar year and produces independent estimates for each year and stock.

FRAM and ERA use the same adult natural mortality assumptions and have stock definitions that can be matched up (or nearly so) for 25 of the 39 FRAM Chinook stocks. The time scales they use are not the same, however, with FRAM being run from October to September, in three time steps (although standard FRAM ERs are calculated May to April), and the ERA covering a full calendar year in a single time step. Only marked fish were used in this comparison, as ERA does not currently account for impacts of mark-selective fisheries on unmarked fish. For comparability, age 2 fish were included in the escapement for all ER computations, which is a deviation from standard practice when computing FRAM based ERs.

One would expect FRAM exploitation rate estimates to be less variable across years for each stock than those from ERA due to the constant relative exploitation rate assumption for each fishery within FRAM, along with the expected larger effect of sampling error in single-year datasets. While there was some evidence of this, it was also true that the mean exploitation rate estimate for each stock differed between the two methods. For both methods, the mean exploitation rate was between 0.2 and 0.5 for all stocks except for one outlier, which was close to 0.1 for both methods. For the period 1999-2008, there was no apparent relationship between the average rates for the two methods across stocks when not including that low outlier. For 2009-2018, there was a correlation between the means of the two methods, though, even then, the relationship was not especially tight.

The ERA analyses demonstrated a pattern of decreasing age at maturity (maturity rate for ages 2-4 increasing across time). In contrast, the maturity rates in FRAM are fixed according to the years used for the base period. This maturity pattern could lead to biases (high or low) outside the base period years. The ERA maturation rate estimates depend on assumed values for adult natural mortality (an assumption shared with FRAM), and variation in maturation rates (and/or exploitation rates) could be confounded with changes in natural mortality.

The SSCSS would like to emphasize the importance of adequate CWT tagging and recovery efforts to support both methods.

The SSCSS commends and thanks the authors for their comprehensive analyses and looks forward to seeing future analyses to help direct improvements in each method. These might include:
(1) Genetic analysis to get CWT-independent estimates of catch by stock, including non-tagged stocks (often the case for wild stocks); (2) analysis of the benefit of updating the base period more

often and determining the ideal update time interval; (3) updated analyses that include uncertainty estimates; and (4) pre- and post-season comparison of FRAM fishery impact estimates.

3. Documentation of the abundance forecast approach used for Willapa Bay natural coho

Dr. Dan Auerbach (WDFW) and Mr. Thomas Buehrens (WDFW) presented the proposed forecast methodology for natural-origin Willapa Bay. The Willapa Bay natural coho forecast is needed to set the annual Acceptable Biological Catch (ABC). The data, statistical approach, and model evaluation framework in the proposed methodology to forecast Willapa Bay natural coho are all substantial departures from previous analyses. Since full documentation for the previous approach(s) is not available, it is not possible to detail all the differences from the previous methods that were used to make forecasts.

The proposed approach is based upon a recent publication (DeFillippo et al. 2021) that developed a spatiotemporal integrated population model (ST-IPM) for all coho management units in Washington state except Columbia River coho. This state-space model integrates smolt, escapement, harvest, and coded wire tag (CWT) data from 36 coho salmon management units in Washington, including Willapa Bay, to estimate Beverton-Holt stock-recruitment relationships for each coho stock. The hierarchical structure of the model allows for information about stock productivity and marine survival to be shared spatially.

The proposed method builds off DeFillippo et al. (2021) in three ways. First, they updated the data to include information from 34 management units beginning in 1998, including use of marine survival data through 2018, smolt trapping through 2020, and harvest rate estimates from the Coho Technical Committee FRAM model runs through 2019. Second, they developed two parallel models in a Bayesian framework, a ST-IPM and a lag-one autoregressive (AR1) model for the time series. Third, they constructed a structure for evaluating forecast performance using one-step ahead evaluation methods and a range of forecast performance metrics. Due to the lag in data becoming available for use in forecasting, they investigated forecast skill using only data collected three years before the forecast year (lag-3, a conservative scenario), and data lags of two years (lag-2, an intermediate scenario) and one year (lag-1, an aspirational scenario).

The proposed methods (ST-IPM and AR1) improved the performance of forecasts of pre-fishery ocean abundance relative to the forecasts previously used and a forecast based upon a simple trailing mean. Forecasts that included more recent data (i.e., lag-one) outperformed forecasts without recent data (lag-three). The analysts noted that all forecast methods considered were relatively imprecise. The new methods provide estimates of forecast uncertainty, which were not available using the previous methods.

The SSCSS and analysts agree that there are several future avenues of research worth investigating to improve forecast skill. Three specific areas were discussed by the SSCSS: 1) adding environmental covariates to improve prediction of marine survival and smolt production; 2) adding information from lower Columbia River coho stocks to gain information from proximate populations; and 3) explicitly accounting for the contribution of natural-spawning hatchery fish to coho production. The SSCSS suggests that the addition of such model components generally should not require a full methodology review for use in future forecasts, but the use of any such alternate models is contingent on the availability of documentation for the proposed model including metrics of forecast skill justifying the use of a new model. The analysts should notify

the SSC by the September Council meeting prior to the year in which the forecast is to be used if changes to the Willapa Bay forecast are anticipated, and the need for, and appropriate level of further review can be assessed at that time.

The SSCSS appreciates the comprehensive analyses presented by the analysts and endorses the forecast method for determining the ABC for Willapa Bay natural coho. The SSCSS endorses using the single model with the highest forecast skill as measured by median symmetric accuracy (MSA) or mean absolute scale error (MASE) or using an ensemble of the ST-IPM and AR1 models with model weights determined by forecast skill. The SSCSS also appreciates the open and reproducible approach to the data and statistical code adopted by the analysts including the publication of publicly accessible data and code repositories on GitHub.

4. Review the Oregon Production Index Hatchery coho forecast methodology

Mr. Erik Suring (Oregon Department of Fish and Wildlife; ODFW) presented an overview of the Oregon Production Index Hatchery (OPIH) coho forecast methodology. The current model structure and data streams have been in use since 2008 and are now publicly available at https://github.com/ErikSuring/OPIH_Evaluation.

The forecast model is a multiple linear regression that uses total jack (age-2 adult coho) returns to all OPIH facilities and a delayed smolt release ratio to predict total adult abundance from all OPIH facilities. To explore model performance through time, this model was fit to data from 1970-2020 in 30-year blocks (i.e., 1970-1999, 1971-2000, etc.) and showed a trend of better fits for early blocks than for latter blocks. Relative long-term model performance for the OPIH forecast was comparable to or better than a select group of natural coho forecasts. OPIH coho is a large stock and consequently, OPIH forecast error may be more meaningful for Council management.

The SSCSC appreciates the work that went into documenting the methodology and providing public access to the data used to parameterize the OPIH coho forecast. The SSCSC recommends continuing to use the current model structure for forecasting this stock. However, there should be a high priority to investigate other models that may perform better and to examine various performance metrics and model selection criteria that would inform the choice of a model that best fits the data and shows the least bias. A forecast for OPIH that performs well is important because its forecasted abundance is influential for properly modeling fishery impacts to less abundant natural stocks.

5. Future Workload and Meeting Planning

The SSCSS and the STT had a discussion about future meeting and workload planning, with specific attention to the three major recommendations outlined in the SSCSS's June 2021 report (https://www.pcouncil.org/documents/2021/06/c-10-a-supplemental-ssc-report-1.pdf/). A summary of the recommendations of the SSC and the major discussion points are below, under the appropriate items. The SSCSS looks forward to working more with the STT on these issues in the future.

1. Clarify the definition of "major stocks." COP 15 provides details on the process for conducting salmon methodology reviews and states that "forecasting methods for major PFMC stocks" is an issue that could merit a full review but does not define "major". The SSC proposes that the Council explicitly define which stocks are 'major".

The SSCSS and STT agreed that Council guidance is necessary for any of the advisory bodies to move forward on establishing a definition for "major stocks" and how those major stocks relate to the "target stocks" in Tables 1-1, 1-2, and 1-3 of the Salmon Fishery Management Plan (FMP). The SSCSS previously suggested that "major stocks" be defined as those salmon stocks for which the PFMC specifies ABCs (Sacramento River Fall Chinook, Klamath River Fall Chinook, and Willapa Bay natural coho), all Chinook and coho stocks considered a fishery target stock in Tables 1-1 and 1-2 of the FMP, and all stocks with harvest control rules. The SSCSS is willing to help staff a working group to develop a definition of major stocks, which could include criteria like abundance, importance to Council fisheries, closely related stocks, and conservation concerns.

2. Establish a database that describes the forecast methodology used for each "major" stock, when that method was adopted, and when it was last reviewed. Ideally the history of all forecast methods and reviews for each stock would be included. The performance of the forecast should be evaluated and reported on each year in Pre-1 and in the database.

The SSCSS and the STT agree that this database would be helpful in the long term, but that in the short term populating the database with historical information on forecast methodology and performance may be time-consuming. The SSCSS recommends as a first step that a repository be established with the documentation of all currently used forecast methodologies, along with a way to track when changes are made to these methodologies going forward and document the reviews of these changes when reviews are performed. As time permits, information on past methodologies and performance metrics could be added. The SSCSS also recommends that the STT add one or more summary metrics of forecast performance and bias to the records of annual forecast performance already present in Preseason I Report (i.e., Tables II-4, II-8, II-9, III-1, III-3, and III-4; and/or the values presented in Figures II-4 and III-1). A number of metrics were discussed during other items at this Methodology Review which would be a helpful starting point for consideration.

3. Establish a process that outlines how and when reference points and conservation objectives are reviewed and updated as appropriate.

The SSCSS notes that in some of the FMP language and COP 15, it appears that there was an intention for reference points and conservation objectives to be periodically reviewed and updated as appropriate, but no firm process or timeline was established for doing so. To make it easier for the Council and other interested parties to see the rationale for the current values and when they were last reviewed the SSCSS recommends compiling all current documentation in a publicly accessible place and noting the year that the current analysis was developed. The current values are available in Table A-1 of Preseason Report 1 and citations are available in Table 3-1 of the FMP, but in many cases the cited documents are not publicly available. In some cases, the documentation cites previous work, so the date of the documentation is not always reflective of the age of the analysis. The SSCSS notes that for reference points and conservation objectives that are identified as possibly needing review or updating, the ideal first step would be for analysts from the relevant management agencies and/or other parties as necessary to develop reference points/conservation objectives using modern methodologies and updated data. This would allow for a review of alternatives that could lead to an adoption of a new objective(s)/reference point(s) or provide evidence that the current value(s) are still valid. These analyses could then be reviewed by the SSCSS and other advisory bodies and used by the Council for consideration to retain or change the reference points/conservation objectives.

SSCSS Notes:

Documentation of the Chinook Fishery Regulation Assessment Model (FRAM) program, including algorithms and the User Manual

• Co-authors of the documentation are jointly responsible for the FRAM documentation web site. It is unclear who will be responsible in the future, possibly the MEW.

• The documentation could provide some information on where specific pre-season abundance forecasts come from. Perhaps explain when and why forecast methods change, and/or why forecasts are typically developed as terminal run sizes despite needing a pre-fishing abundance estimate from which to model the effects of fishing. These forecasts are developed external to FRAM, however, so FRAM documentation may not be the best place to capture this.

Additional documentation review discussion:

Model algorithm:

• Additional documentation should be provided for "exceptions" that are hard coded versus flexible inputs

• How do analysts fill in missing CWT/auxiliary CWT files info and are/will these be publicly available?

• The documentation should l ay out all algorithms in equation form with documentation. For example, in Appendix Table 10, h ow do algorithms interface with data versus fixed parameters?

• In Section 4.2, equation (1),(2),(3). it is unclear whether StockScaler estimated or is it data? The authors responded that in fact, it could be either; sometimes it is input by a biologist, sometimes estimated from data. These situations need to be clearly documented.

• Procedures are needed for documenting and archiving (at PFMC or elsewhere) model runs and inputs.

Base period documentation:

• Clarify how model stock proportion is calculated? Is it only calculated during the base period development? Are there cases where externally calculated MSPs are used in FRAM runs?

• Details should be provided on what are the data and what manipulations are conducted on the data before they get used.

More details should be provided on how CWT data are used.

Evaluate post-season metrics of FRAM performance:

• Not all escapement is comparable between ERA and FRAM.

• A similar analysis should be conducted for Coho based on contemporary patterns of CWT recoveries where possible.

• It is important to understand how much difference including age 2 escapements makes in model outputs because FRAM usually does not but the PSC ERA calculations do. For example, could this change an exploitation rate estimate by enough to make a difference for overfished determinations, for example? Of particular concern, could there be cases of mismatches between the approach was used to determine MFMTs and what FRAM and ERA actually use to estimate contemporary exploitation rates for comparison against the MFMTs ?

• 8 of 10 Puget Sound stocks had higher values from ERA than from FRAM.

• The SSCSS asked for clarification on how much catch and escapement and how much variability there is in Oct-Dec (the months that are different across methods). There is one fishery

in Alaska, and some sport fisheries in Puget Sound, but the analysts could not provide a detailed answer .

• The SRKW analysis for Amendment 21 to the salmon FMP was based on constant maturation rate – this may be off, but also natural mortality of adult Chinook (assumed constant in these all of these analyses) may change view of maturation, so relative impact of SRKW over time can affect it.

• Individual stock case studies were undertaken to uncover differences that might explain the differing results from FRAM and ERA for selected stocks with the largest differences in estimated ERs. For West Coast Vancouver Island and Nooksack Samish Fall stocks, there were differences in treatment of near-terminal or in-river fisheries across the two methods, and when made consistent there was some degree of narrowing of differences in average exploitation estimates.

• We don't know the uncertainty of the estimates from either model.

• Future considerations: Both of these models are based on CWT data alone and neither model is likely to be entirely correct. Genetic analyses could allow for independent estimates of catch by stock. The CTC has made some preliminary explorations of genetic information on catches, and some genetic information was used to inform stock proportions in the FRAM base period. Allowing for time-varying maturation in FRAM might bring its outputs closer to the CTC models (although preliminary explorations indicated little effect). It may be useful to update the base period more often, as it is not clear how quickly the information becomes "stale".

Documentation of the abundance forecast approach used for Willapa Bay natural coho

• There was considerable discussion about how to provide flexibility to the analysts without providing a blanket endorsement for all potential changes to models.

• There was concern expressed about operational questions for Willapa Bay because the forecast is in terms of natural origin returns but there are hatchery contributions to the natural area returns that are currently unaccounted for.

• The analysts introduced methods around stack-weighting as a method to construct ensembles. This topic deserves further consideration in the future

Review the Oregon Production Index Hatchery coho forecast methodology

• The SSCSC appreciated posting this model and the data used to a GitHub account but noted that hosting this and other material on personal GitHub accounts may need to be reevaluated.

• Comparisons of hatchery forecasts and natural forecasts as well as large aggregates versus small populations have different consequences to management.

• Identification of jacks and adults based on a size criteria could change over time or in response to environmental perturbations. Table 1 states jack returns were corrected for small adults however methods to do so were not given.

• A number of alternative models could be explored that may increase performance and reduce bias such as truncated data series/moving window or a Kalman filter.

• Forecast performance, including measures of bias, should be examined further for the OPIH forecast, perhaps with respect to other hatchery forecasts and more local natural forecasts.

Future Workload and Meeting Planning

Item 1

Advisory bodies that may want to be involved in a workgroup or other processes for development of the definition of "major stocks" include the STT, SAS, SSCSS.

STT and SSCSS agreed that it is worth clarifying the definition of major stock, and target stock, and maybe those could be the same things? Why are similarly distributed stocks (similar spatial distributions) not always classified as the same? How can a mixed stock fishery that targets one not also be targeting the other? Who gets to decide what are the major stocks—science choice, Council choice, NMFS Region choice, hybrid?

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It was proposed that "major" stocks might only be ABC stocks and currently overfished stocks. However, we don't really want to only pay attention to stocks at low abundance—this creates a worry about some stocks only getting attention when in trouble, not a warning sign when they are headed that way, could lead to being caught flat-footed and forced into reactive management.

Item 2

Going back in time it will be hard to document when forecast methods changed, but documentation and record keeping should be easy going forward. It is important to know the history of forecasts if we are using the performance metrics. Also, documentation of changes in methods will make it easier to review Pre-I.

Having this information summarized would be helpful for onboarding/orienting new STT members.

There may need to be a workshop about what summary statistic(s) to use, or this could be left to STT discretion, with possible further discussion when a Pre-1 report containing these metrics is first reviewed.

Can this process begin before we have a major stock definitions? We already know ABC stocks are major, so could start there.

Item 3

Some reference points/conservation objectives are based on recent work, but some are based on very old (decades old) work. We don't want to be revisiting them all the time but it seems like FMP authors had the idea some review should take place periodically. What happens if we review something, and don't think the science supports it, and there is nothing else to do but use it? Will a review process maybe prevent getting into that situation? Is being proactive better than the status quo of not examining very dated information?

A strawman idea was proposed but rejected in favor of "easing" into this issue: We should at least look at reference points/conservation objectives for "major" stocks, and maybe starting with the oldest.

We need to have a better idea of what conservation objective is supposed to achieve—is that stock-specific? The FMP states that "conservation objectives for natural stocks may (1) be based on estimates for achieving MSY or an MSY proxy, or (2) represent special data gathering or rebuilding strategies to approach MSY and to eventually develop MSY objectives", but the basis for some current conservation objectives does not seem linked to MSY nor to a clear "rebuilding" or data gathering plan that would facilitate a clear link to MSY.

Table 3-1 of the FMP provides a table of all these reference points and conservation objectives and citations for the reports the reference points and objectives are based on and could be sorted from oldest to youngest supporting documentation. It is sometimes hard to tell how old the underlying analyses are from publication date alone, because some of the references just refer to previous works or use old (even at the time) data.

Is it possible to come up with a scorecard (age, importance to fisheries, economic importance, etc.) to prioritize? There could be analogies to the groundfish stock assessment prioritization process.

Catch 22: do we review and find something unacceptable but have no alternative, or do we need to always make an alternative available prior to reviewing old science, in case the old science is unacceptable? By analogy with Groundfish, if something rises to top of the prioritization list, we typically do a new assessment, even though there is no guarantee that the new assessment will be endorsed, nor that it will yield a substantially different result than simply projecting from the old assessment (which is the default fallback if the new assessment is rejected). This catch 22 applies to review of conservation objectives and reference points as well as review of forecasts.

E. Groundfish Management, Continued

3. Harvest Specifications for 2023-2024 Including Final Overfishing Limits and Acceptable Biological Catches

The Scientific and Statistical Committee (SSC) reviewed the 2023 and 2024 groundfish harvest specifications under default harvest control rules (Agenda Item E.3, Attachment 1) and made some corrections. The harvest specifications for Oregon quillback rockfish have changed from those previously reviewed due to an assumed lower catch in 2022, as the Oregon Department of Fish and Wildlife will be implementing non-retention regulations. Catch-only projections for black rockfish (Agenda Item E.3, Attachment 3) were presented for two scenarios that differed according to the timeframe for which acceptable biological catches/annual catch limits (ACLs) of 512 metric tons (mt) were assumed (2021-2022 vs 2021-2024). For both scenarios previously assumed catch projections for 2019 and 2020 were replaced with the lower observed catches for those years. Additional harvest specifications for lingcod, sablefish, spiny dogfish, and vermilion/sunset rockfishes were reviewed (Agenda Item E.3, Attachment 4). The SSC noted that a category 2 designation for vermilion and sunset rockfishes for the Northern California model was incorrectly used in this projection as well as in Agenda Item E.3.a, GMT Report 1. These projections will be updated to reflect the category 1 designation assigned and corrected in the PacFIN database. The California quillback rockfish projections were updated to reflect the 40-10 harvest control rule.

The SSC endorses the catch specifications now that the suggested corrections have been made (a supplemental revised Attachment 1 is anticipated). In addition, the SSC endorses the alternative projections in Attachments 3 and 4 except for those in Table 6 Attachment 4 (projections for Northern California vermilion/sunset rockfish).

Dr. Brian Langseth (Northwest Fisheries Science Center) provided the SSC with an update to a presentation from a Groundfish Subcommittee (GFSC) meeting held via webinar on September 29-30, 2021 that focused on available information to determine stock management delineation for copper and quillback rockfish off the U.S. West Coast. The new information was primarily related

to quillback rockfish, which was found to differ very little from that for copper rockfish. In general, adult quillback rockfish exhibit limited observed movements with high site fidelity. There is little understanding of larval dispersal patterns for these species, which is likely the mechanism by which mixing would occur given evidence for limited adult movement. However, minimal genetic variation between Washington and Alaska has been observed, which suggests the potential for broad scale larval dispersal. The only notable genetic differences observed occur between Puget Sound and coastal regions. Estimated recruitment deviations for quillback rockfish showed some unquantified degree of spatial coherence. However, this alone does not necessarily imply connectivity during the larval stage as broad scale environmental forcing could be responsible.

The SSC had extensive discussions about when to aggregate assessments across stock delineation boundaries for status determination. During these discussions, at least three tiers of information to consider were evaluated. The highest tier is a genetic difference among meaningful markers which has not been demonstrated for quillback or copper rockfish. The next highest tier of information is exchange or movement of adults, followed by larval dispersal between areas. For both copper and quillback rockfish, adults exhibit high site fidelity and the magnitude of larval dispersal is uncertain. The lowest tier of information the SSC discussed was demographic differences such as size at age. The available data for these species do not suggest strong coast-wide differences in size at age. There appears to be differences in selectivity patterns between commercial and recreational fleets that is stronger than selectivity patterns between states.

The SSC recommends for quillback rockfish that three separate stock areas be maintained for status determination: California, Oregon, and Washington. For copper rockfish, the SSC recommends a reduction to two stock areas: pooling the biomass estimates from Southern and Northern California assessments to determine status in California and pooling the biomass estimates from the Oregon and Washington assessments for a northern area status determination. For sunset/vermilion rockfish, separate stock areas should be assumed for status determination for the Southern and Northern California assessments because of the presence of sunset rockfish primarily south of Point Conception. The Oregon and Washington assessments should be combined into a single stock area because of the lack of population structure within vermilion rockfish at the northern extent of its range. The SSC notes there is considerable uncertainty regarding stock structure for the three species and that additional data may clarify the situation. The SSC reviewed and endorsed methods for catch allocation between regions. The SSC re-iterates that harvest should be spatially allocated proportional to relative biomass to reduce risk owing to stock structure uncertainty, particularly for the copper rockfish off California.

Mr. John DeVore (Council staff) provided a presentation on background and context for structuring groundfish stock complexes. GMT members were available to discuss their report on the topic (Agenda Item E.3.a, GMT Report 2). The SSC thanks the GMT for their carefully constructed report on this topic, especially given the limited timeframe, and Mr. DeVore for his concise presentation.

While recognizing that data limitations and the nature of co-occurring stocks are the primary reason to continue to use stock complexes for management, current concerns include:

1. "Inflator stocks" which have large overfishing limit (OFL) and ACL contributions to complexes, yet catches that are lower than their ACL contributions.
2. Stocks where catches consistently exceed OFL contributions within complexes, including:
    a. Those that need management action

b. Those that are caught primarily in areas outside the complex, and where coastwide management might be a better approach.

3. Stocks without OFL contributions and where targeting and retention of the species are not expected. These could be considered for designation as Ecosystem Component (EC) species.
4. Stocks with, or anticipated to have, an overfished designation

Responses to the above issues could include removing stocks from complexes and managing as individual stocks or by designating EC species, adding accountability measures, and/or prioritizing stocks for assessment, as appropriate. Impacts of such changes to quota shares should be considered in weighing alternative actions, and in general, proposed changes to complexes should consider broader management implications.

The SSC recommends management action to address the stocks with catches exceeding OFL contributions highlighted in Agenda Item E.3.a, GMT Report 2 as well as copper rockfish south of Point Conception due to new assessment results. In addition, given the anticipated overfished declaration for quillback rockfish off California, the SSC recommends that stock be removed from complexes and managed separately to facilitate rebuilding.

C. Administrative Matters

4. Preliminary West Coast Regional Framework for Determining the Best Scientific Information Available

The Magnuson-Stevens Act (MSA) and the National Standard 2 guidelines interpreting the MSA require Regional Fishery Management Councils (RFMCs) and the National Marine Fisheries Service (NMFS) to base decisions on the best scientific information available (BSIA), and a recent procedural directive called for each region to document their process for determining BSIA. The focus of this process is on the current BSIA process for catch specifications and status determinations.

The Scientific and Statistical Committee (SSC) provided feedback on a proposed Regional BSIA Framework in March and June 2021. The SSC received an update presentation on Developing a Regional BSIA Framework from Ms. Sarah Shoffler (Southwest Fisheries Science Center) and Dr. Jim Hastie (Northwest Fisheries Science Center). This included how NMFS has addressed issues previously raised by the SSC. Overall, the presentation and documents provided describe the existing BSIA process for annual catch specifications and status determinations well.

The SSC had requested more detail on the proposed approach to an arbitration process in the case of disagreements between the SSC and Science Centers. Documentation of this process now describes what the Science Centers will do in such cases, and at the SSC's request, NMFS has added the National Standard 2 criteria for BSIA to the framework.

Questions were previously raised by the SSC regarding the review and updating of the reference points used in salmon status determinations and about the process for initiating reviews of the processes and models providing inputs to annual salmon management, such as the forecasts used to inform catch specifications. National Oceanic and Atmospheric Administration Fisheries has yet to fully resolve these matters and will continue collaborative efforts to better document processes as the framework is refined leading up to the March/April Pacific Fishery Management Council (PFMC) meetings.

The process for designating a NMFS BSIA Point of Contact with the SSC for each Fisheries Management Plan has now been documented in the framework.

The SSC had identified differences between Coastal Pelagic Species (CPS) and Groundfish in the review and harvest specifications processes. These are now presented separately for CPS and Groundfish in the framework.

The SSC thanks NMFS for addressing its comments on the framework from the March and June 2021 meetings. The SSC notes that the development of the BSIA Framework is continuing with a final version to be considered by the PFMC in March or April 2022. The SSC asks that NMFS:

- Provide fuller documentation of the stock status determination process for CPS.
- Be consistent and clear in documenting the role of the SSC in the stock status determination process for each of the FMPs. The SSC notes that no role is described for the SSC or Council

in status determinations for CPS or groundfish and suggests that the final draft framework should add roles or describe why no roles are assigned.

- In the arbitration process documentation, clarify the definition of science providers and be specific about the role of the SSC versus other "science providers."

SSC Notes:

The focus of this framework is on the current BSIA process for catch specifications (stock assessments and rebuilding analyses) and status determinations. Improvements to the BSIA process as applied to catch specifications and status determinations will be addressed in the future.

There are processes that feed into catch specifications and status determinations that occur outside SSC and other PFMC subcommittee reviews and this could be made transparent in the BSIA frameworks. This is still being discussed by NMFS with a view to improving documentation as the Framework evolves. The goal for now is to focus on current processes.

International data, such as CPS information produced by Mexico that are produced outside of formal international process (e.g., HMS and Hake) are best brought into an assessment process via TOR changes rather than via the BSIA framework.

C. Administrative Matters, Continued

10. Future Council Meeting Agenda and Workload Planning

The Scientific and Statistical Committee (SSC) discussed workload planning and has the following updates to our September 2021 statement under this agenda item.

The SSC recommends continuing to convene the annual SSC Ecosystem Subcommittee meeting with the California Current Integrated Ecosystem Assessment (CCIEA) team to review additions to the IEA report in September and holding the annual Salmon Methodology Review in mid-October.

The SSC notes that the proposed salmon management schedule for 2022 (Agenda Item F.2, Attachment 1) leaves very little time for the SSC to review the Salmon Technical Team's Pre-I report. It was suggested that a draft version of Pre-I might be provided to the SSC earlier than the final publication date to allow the SSC sufficient time to review forecasts and estimates informing status determinations for major stocks.

The SSC Groundfish Subcommittee (GFSC) will hold the "Post-mortem Review" of the groundfish assessment process in January of 2022 to discuss lessons learned from this assessment cycle and potential improvements for the future.

The SSC GFSC has three workshops and two methodology review topics planned for 2022 that they propose to address in two separate meetings, each with methodology review and workshop components. The SSC recommends a meeting in late 2022 to discuss the integration of remotely operated vehicle (ROV) survey data in assessments and to review Oregon Department of Fish and Wildlife's proposed acoustic/ROV survey methodology for semi-pelagic rockfish, with the participation of a Center of Independent Experts scientist on acoustic abundance estimation

methods. The other meeting to be held in Fall of 2022 would encompass review of the species distribution model in Template Model Builder along with the workshop on the treatment of indices for hook-and-line survey data and accounting for spatial closures in assessments. Pairing the methodology review with the related workshops will reduce the number of meetings and reports through consolidation and provides time for proponents to work on requests while other topics are discussed. The outcomes of the methodology review and workshop meetings will inform the groundfish stock assessment accepted practices but are unlikely to be held in time to inform revisions of the Terms of Reference for stock assessments for review by the Council in June 2022. In addition, a workshop is proposed for consideration of alternative harvest control rules for spiny dogfish to reflect its lower productivity and the finding from the most recent assessment that the spawning potential ratio 50 percent harvest rate may not be sustainable. Planning will be discussed further at a GFSC workshop planning meeting in January 2022 and the post-mortem review of the stock assessment process.

The SSC supports the idea of the Council engaging with the Climate Change Adaptation Tools for California Current Fisheries project presented by Dr. Piers Chapman under open comment (Agenda Item B.1.b, Supplemental Public Presentation 1). Members of the SSC Ecosystem Subcommittee could attend meetings or workshops with the research team in order to support the development of their decision support tools at the request of the Council.

SSC Notes:

In March, we may want to discuss an IEA Workshop to talk about whether we still need all the indicators that are in the report. Report authors have been doing a lot of adding, without thinking about subtracting/overlap.

GFSC wants to have a ~1 hour workload planning call to talk about 2022 plans between the November 2021 and March 2022 meetings.

Proposed Workshops and SSC Subcommittee Meetings for 2021/22							
Workshop/Meeting		**Potential Dates**	**Sponsor/ Tentative Location**	**SSC Reps.**	**Additional Reviewers**	**AB Reps.**	**Council Staff**
1	CSNA STAR Panel	Dec. 7-10	Council/Webinar	Punt (Chair), Satterthwaite, Garcia-Reyes, & Budrick	2 CIE	CPSMT CPSAS	Griffin DeVore
2	Post-mortem Review of the Groundfish Assessment Process	Jan. 2022, TBD	Council/Webinar	Groundfish Subcommittee Members	Cieri	GMT Richter	DeVore
3	Proposed Workshop for Conducting Nearshore ROV Surveys and Using ROV Data in Stock Assessments	TBD	Council/TBD	TBD	TBD	GMT GAP	DeVore
4	Proposed Workshop to Develop Methods for Constructing Abundance Indices Based on Hook-and-line Surveys	TBD	Council/TBD	TBD	TBD	GMT GAP	DeVore
5	Proposed Groundfish Subcommittee Meeting to Explore Approaches to Deal with Large Closed Areas and Other Spatial Issues in Stock Assessments	TBD	Council/TBD	Groundfish Subcommittee Members	TBD	GMT GAP	DeVore
6	Proposed Workshop to Develop Alternative Harvest Control Rules for Spiny Dogfish	TBD	Council/TBD	Groundfish Subcommittee Members	TBD	GMT GAP	DeVore

7	7th National Meeting of the Scientific Coordination Subcommittee of the Council Coordination Committee	Aug. 15-17, 2022	NPFMC/ Sitka, AK	4 TBD	NA	NA	DeVore
8	Ecosystem Subcommittee/CCIEA Team Meeting	Sept. 2022 TBD	Council/TBD	Ecosystem Subcommittee Members	TBD	EWG EAS	DeVore Dahl
9	Salmon Methodology Review	Oct. 2022 TBD	Council/TBD	Salmon Subcommittee Members	TBD	STT MEW	Ehlke

SSC Subcommittee Assignments, November 2021

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	Fabio Caltabellotta	John Budrick	Fabio Caltabellotta	Michael Harte	John Field
Owen Hamel	John Field	Alan Byrne	John Field	Dan Holland	Marisol Garcia-Reyes
Michael Harte	Melissa Haltuch	John Field	Marisol Garcia-Reyes	André Punt	Melissa Haltuch
Galen Johnson	Owen Hamel	Marisol Garcia-Reyes	Dan Holland		Michael Harte
Will Satterthwaite	Kristin Marshall	Owen Hamel	Kristin Marshall		Dan Holland
Jason Schaffler	André Punt	Will Satterthwaite	André Punt		Galen Johnson
Ole Shelton	Jason Schaffler	Tien-Shui Tsou			André Punt
Cameron Speir	Tien-Shui Tsou	Will White			Will Satterthwaite
Tien-Shui Tsou	Will White				Ole Shelton
					Cameron Speir

Bold denotes Subcommittee Chairperson

ADJOURN

PFMC
02/10/22