SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON
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 (Pacific Council or 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 Pacificocean 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_∞) estimate, specifically that L_∞ 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 CPS analysts and the SSC CPS Subcommittee.

SCIENTIFIC AND STATISTICAL COMMITTEE'S GROUNDFISH SUBCOMMITTEE
REPORT ON THE STOCK ASSESSMENT MOP-UP REVIEW

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 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.

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 σ_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.

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.

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.

PFMC
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