**Center for Independent Experts Independent Peer Review Report**

**Stock Assessment Review (STAR) Panel 1 (CLIN 0001) - Copper Rockfish in California, Shortspine Thornyhead, and Rex Sole**

**Seattle, Washington**

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## Executive Summary

The SS stock assessment models were competently applied by STATs. The base model for the southern copper rockfish substock was unchanged during the STAR Panel. The model for the northern substock was revised slightly. More substantial revisions to assessment models for rex sole and shortspine thornyhead were recommended by the STAR Panel (including the STATs). These STAR panel and STAT recommended assessment models are suitable for review by the SSC to determine their merits for supporting management advice.

The major axes of uncertainty for copper rockfish were based on low and high spawning output. Values of steepness (h) were chosen so that model estimates of final year spawning output matched the 12.5% and 87.5% quantiles of the base model estimate in 2023. For the northern model, $h_{lo}$=0.637 and $h_{hi}$ = 0.892. For the southern model $h_{lo}$=0.637 and $h_{hi}$ = 0.93. For the rex sole major axis of uncertainty, natural mortality (M) values of 0.175 and 0.210 were chosen to represent the 12.5% and 87.5% percentiles of the estimated 2023 OFL. For shortspine thornyhead, M values of 0.03 and 0.05 were chosen to represent the 12.5% and 87.5% percentiles of the estimated 2023 OFL.

The main deficiency of these assessments is limited age data (including ageing error) and growth estimates. Limited information on maturity and fecundity and spatiotemporal variation of these productivity attributes is also a deficiency. Lack of external peer-review of model-based survey index standardization, and occasional large differences with design-based estimates, is also a deficiency that was difficult to address at a 5-day STAR panel for 4 stocks. There is uncertainty in catch estimates, and more so for historic periods and when interpolations are used to fill in catches for some years. This uncertainty was not quantified and provided to the Panel. The main research recommendations by the STAR Panel dealt with addressing these deficiencies.

## Background

The *Stock Assessment Review (STAR) Panel 1 (CLIN 0001) for Copper Rockfish in California, Shortspine Thornyhead, and Rex Sole* was held in Seattle, Washington during June 5-9, 2023. The STAR panel review is a key element in an overall Pacific Fishery Management Council's (PFMC's) groundfish and review (STAR) process. The STAR panel is designed to investigate the technical merits of stock assessments and other relevant scientific information. The specific responsibilities of the STAR panel (described in PMFC, June 2022) are to:

1) be familiar with the Terms of Reference, the *Accepted Practices Guidelines* (for groundfish assessments), and most recent Methodology Review reports;

2) review draft stock assessment documents, data inputs, and analytical models, along with other pertinent information (e.g., previous assessments and STAR panel reports, when available) before the STAR panel;

3) discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting, work with the STATs to correct deficiencies, and, when possible, suggest new tools or analyses to improve future assessments; and

4) develop STAR panel reports for all reviewed species-area assessments to document meeting discussion and recommendations.

5) The STAR panel and STAT in consultation with Council staff should propose an appropriate method for measuring the scientific uncertainty in the stock assessment, known as "sigma".

6) The STAR panel also makes a recommendation on whether the next assessment of the species should be a full assessment or could be an update assessment and explain reasons for its recommendation.

A benchmark stock assessment was conducted and reviewed for Copper Rockfish in California. Length-based data-moderate assessments were conducted and reviewed for Shortspine Thornyhead, and Rex Sole. STATs provided the Panel with base models for these assessments that included length data, survey indices and externally-estimated growth, but not age data. These stocks were identified within the top twenty-five rankings for assessment consideration during the Pacific coast groundfish regional stock assessment prioritization process.

Copper rockfish off the coast of California was assessed in 2021 in data-moderate assessments as two separate sub-stocks split at Point Conception. Shortspine Thornyhead was last assessed in 2013, as a single, coast wide stock using length-based models due to the absence of age data. Rex Sole was last assessed in 2013 in a data-moderate, index-based assessment.

Groundfish STAR panels include a chair appointed by the SSC and three other experienced stock assessment analysts knowledgeable of the specific modeling approaches being reviewed. STAR panel meetings also include representatives of the GMT and GAP, with responsibilities as laid out in the PFMC TOR, and a Council staff member to advise the STAR panel and assist in recording meeting discussions and results. This STAR Panel membership is described in Appendix 3. The support of all these scientists and staff to the STAR Panel process is gratefully acknowledged.

The CIE reviewers were required to have excellent communication skills in addition to working knowledge and recent experience in fish population dynamics; with experience in the integrated-analysis modeling approach, using age- and size- (and possibly spatially-) structured models, and methods for quantifying uncertainty. CIE reviewers were tasked with conducting impartial and independent peer reviews in accordance with their SoW and ToRs. The reviewers were required to be active and engaged participants throughout panel discussions and able to voice concerns, suggestions, and improvements, while respectfully interacting with other review panel members, advisors, and stock assessment technical teams.

**Role of reviewer**

All assessment documents and most supporting materials were made available to the Panel via a web page (https://pam.pcouncil.org/star-panel-1/) two weeks before the meeting, on May 22, 2023. These documents are listed in Appendix 1. I reviewed the background documents I was provided and compiled a list of issues to get clarification at the STAR Panel meeting. I attended the entire STAR Panel review meeting in person. I reviewed presentations and reports and participated in the discussion of these documents, in accordance with the SoW and ToRs (see Appendix 2). I drafted text for the Panel report for Shortspine Thornyhead. After the meeting I participated in email discussions to finalize the review panel summary report. This CIE report is structured according to my interpretation of the required format and content described in Annex 1 of Appendix 2. This includes providing a "Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs". I based this on the PFMC ToRs for the GROUNDFISH STOCK ASSESSMENT REVIEW PROCESS FOR 2023-2024, which are summarized above, and not the ToRs provided by the CIE in Annex 2.

**Summary of findings**

I first provide summaries that apply to both assessments, and then present stock-specific summaries where necessary.

***ToR 1. Be familiar with the Terms of Reference, the Accepted Practices Guidelines (for groundfish assessments), and most recent Methodology Review reports.***

I read *TERMS OF REFERENCE FOR THE GROUNDFISH STOCK ASSESSMENT REVIEW PROCESS FOR 2023-2024, JUNE 2022, Published by the Pacific Fishery Management Council.* I read this at the start of the review process.

Prior to the review I focused on reviewing the four main stock assessment documents. However, I was not aware of the *Accepted Practices Guidelines* or the recent *Methodology Review* reports that we were required to be familiar with. These documents were not directly indicated in the CIE ToRs, whereas they are in the PMFC ToRs. In retrospect I should have reviewed these documents and relevant sections of pre-assessment reports because they provided me with a better understanding of the approaches taken in these stocks assessments. It would be useful if a full list of documents were provided to reviewers, although for this 5-day STAR Panel another issue is the time required to complete the review process and CIE report, including reviewing four assessment reports and background documents.

***ToR 2. Review draft stock assessment documents, data inputs, and analytical models, along with other pertinent information (e.g., previous assessments and STAR panel reports, when available) before the STAR panel.***

I reviewed in detail the draft stock assessment documents for copper rockfish, shortspine thornyhead, and rex sole that were provided (see Appendix 1). The assessment documents were structured in a consistent way among these stocks, which made them easier to review.

***ToR 3. Discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting, work with the STATs to correct deficiencies, and, when possible, suggest new tools or analyses to improve future assessments.***

The technical merits identified by the Panel, which I fully agree with, involved the amount of data considered and used in the assessment, and the investigation of sensitivity analyses and alternative model formulations to improve the assessment model formulations. The Panel appreciates the addition of new life history (i.e. maturity and growth) information for rex sole and shortspine thornyhead.

The Panel identified the lack of aging data and growth estimates are a technical deficiency for all four assessments. I am not sure this should be called a deficiency; a technical limitation may be a better description. The Panel felt that it is important to understand the factors that influence catches in the CCFRP survey, which I agree with. The Panel only superficially reviewed the model-based survey index standardization, by comparing design-based versus model-based estimates. I think it is very important that the application of survey index standardization models be reviewed periodically. It is insufficient to say that the modelling framework has been reviewed before. That is like saying SS has been reviewed, so applications of this model do not need further review. This is silly. The species-specific application of survey index standardization models should be reviewed for each stock assessment. This is best done in an input data peer review process with the involvement of external experts. This must be done before a STAR Panel in case deficiencies are identified and need to be corrected.

*Landings Input data*

The STATs have created long time-series of catches (since 1916 for copper rockfish and rex sole, and 1901 for shortspine thornyhead) which is a merit. The accuracy of estimates of landings and discards has improved over time, as expected. This is also a merit. A deficiency is that there is uncertainty in catch estimates, and more so for historic periods and when interpolations are used to fill in catches for some years. This uncertainty was not quantified and provided to the RP. There is an important need for STATs to provide information on the quality of the annual catch estimates, and more specifically to quantify the uncertainty in these estimates. The Panel identified this as an 'Unresolved Problems and Major Uncertainties' for shortspine thornyhead, but I feel this applies to all stocks.

Discarding was not estimated within the model for the north and south copper rockfish assessments, but discards were modelled directly in the rex sole and shortspine thornyhead assessments. It was not clear to me why the different approaches were taken.

*Length Compositions*

A technical merit of the assessments is the detailed information provided on sampling for length compositions, combined with the SS3 assessment model that can use length compositions, age compositions, and length-stratified age compositions. Length compositions potentially provide an important source of information about variation in year class strength and growth rates (for gears that catch small sizes) and total mortality rates (the latter based on fleets with asymptotic selectivity).

The precision of length samples from commercial fleets was primarily summarized using an effective (i.e. input) sample size calculation. I did not understand the basis for the calculations, but this involved both the number of fish sampled and the number of trips. The same formula was applied for the four assessments the Panel reviewed. Input sample sizes for copper rockfish recreational fleets and surveys were determined by various methods (trips, transects, positive drops, number of fish). For rex sole, initial sample sizes for the survey length compositions were based on Stewart and Hamel (2014). I could not find descriptions of how input sample sizes were set for shortspine thornyhead. This was not considered in detail by the Panel, nor did the Panel have time to do this.

Fishery length sampling designs are probably complex, highly stratified cluster sampling, with many strata and possibly incomplete sampling for some strata, and the statistical properties of the composition estimates are likely difficult or impossible to derive analytically. Nonetheless, I think the uncertainty of the composition estimates, including expansions, needs to be quantified better.

I recommend that STATs provide multi-panel "SPAY" plots (e.g. https://rpubs.com/rajeevkumar/SPAY) of length- and age-composition time-series from the various sources, to provide a pre-assessment-model summary of consistency of recruitment information among the data sources. These are just plots of standardized deviations in compositions over time and they can be useful to detect strong and weak year classes. By comparing multiple data sources, we can get a high-level understanding of the consistency of the information across the data sources. With length composition plots (i.e. SPLY plots), it is also useful to overlay Von Bertalanffy growth curves for weak and strong cohorts to get a sense of how well the assessment model estimates of recruitment and growth match with the input data. I illustrate this for Rex Sole below.

**Rex Sole**

I plotted the length composition information I extracted from the SS input file (Rex_data.ss) from the rex_sole_STAR_model run the STAT provided to the Panel. The fishery length compositions (Figure 1) cover a restricted range of sizes and I do not expect these length compositions provide much information on cohort strength. Fisheries are designed to maximize profits and their composition information may not reflect the composition of the stock as a whole. The WCGBTS survey indices (Figure 2) cover somewhat smaller sizes than the fishery, although not small enough to track cohorts well. A smaller survey L95 (length at 95% retention) around 20cm may provide indices with better cohort signals for species like rex sole that do not grow to large sizes. For example, I selected two relatively weak Rex sole cohorts (1986, 2005) and four relatively strong cohorts (1995, 2009-10, 2013) based on the SS model output, and plotted their expected sizes in Figure 3. For this I used the estimates for the Schnute parameterization of the von Bertalanffy growth function provided in the Estimated Parameters table of the SS output. One needs to stare at these plots for a while to accept that 2005 was a weak cohort, and 2009-10 were strong ones. Figure 3 does not provide evidence that 2013 was a strong cohort, nor does this figure provide any information about the sizes of the 1986 and 1995 cohorts which are too old to track in lengths comps after 2003. These latter 2 cohorts are somewhat more apparent in Figure 4.

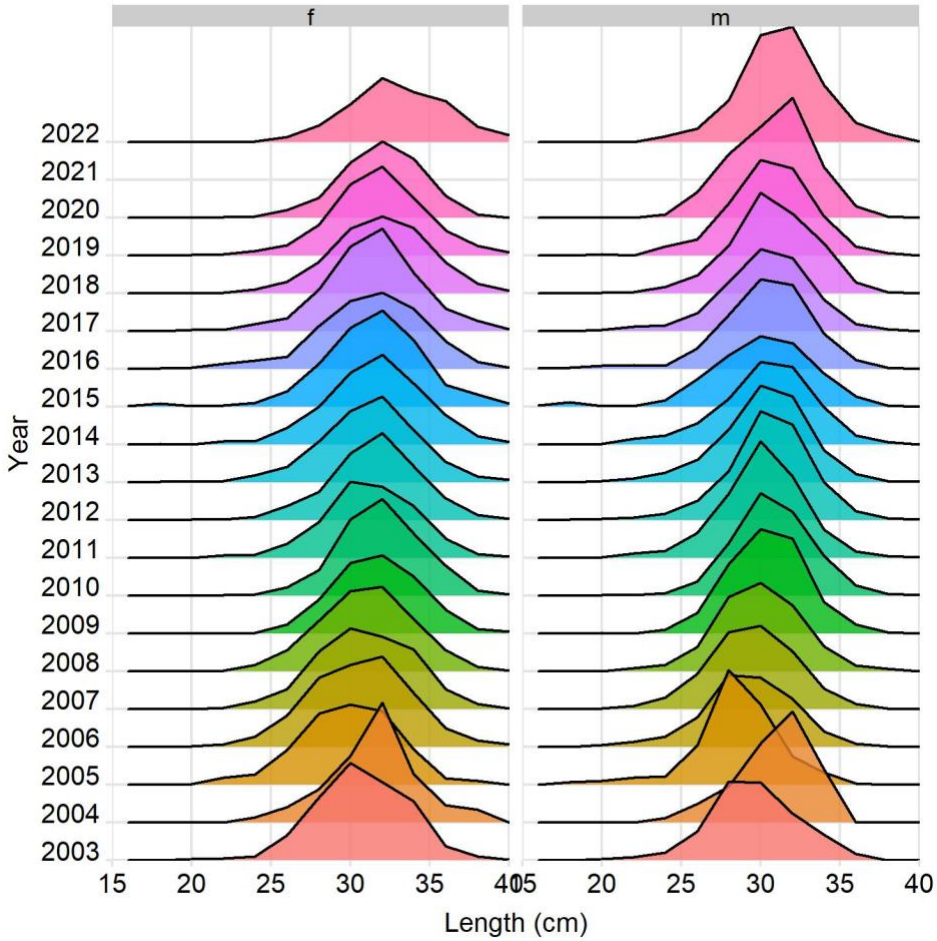


Figure 1. Ridge plots of fishery (SS FltSvy=1) length compositions for females (left panel) and males (right panel).

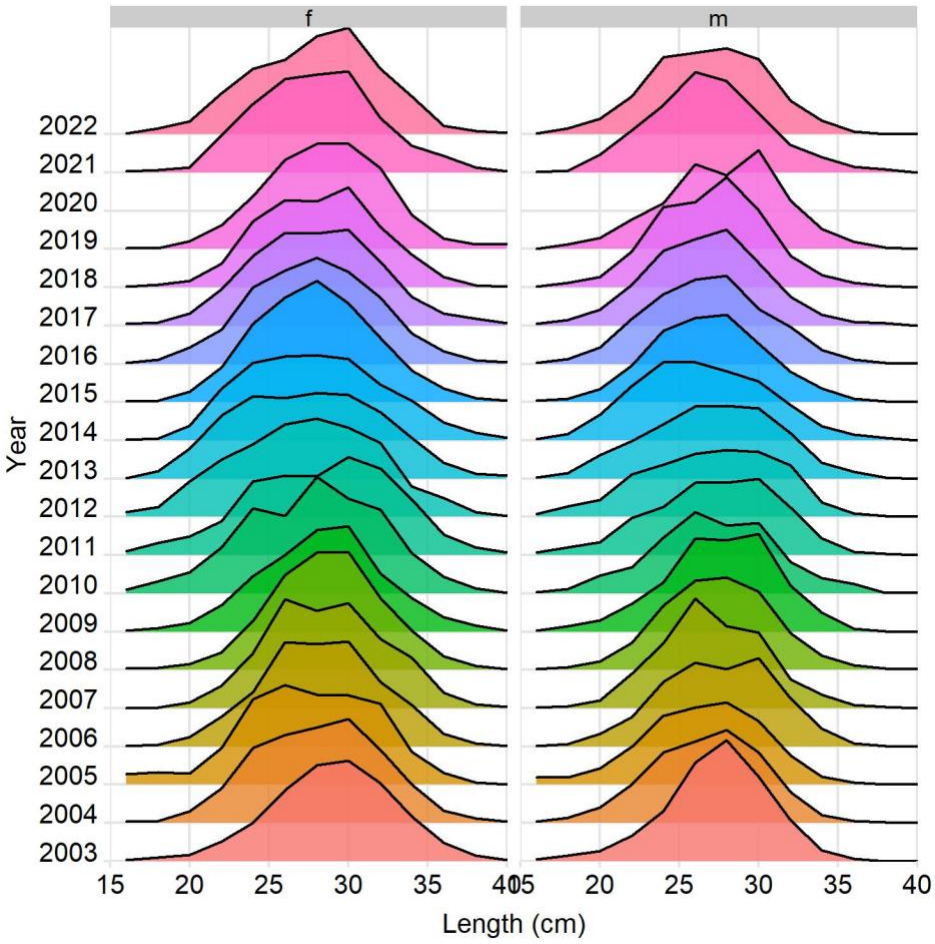


Figure 2. Ridge plots of WCGBTS survey (SS FltSvy=5) length compositions for females (left panel) and males (right panel).

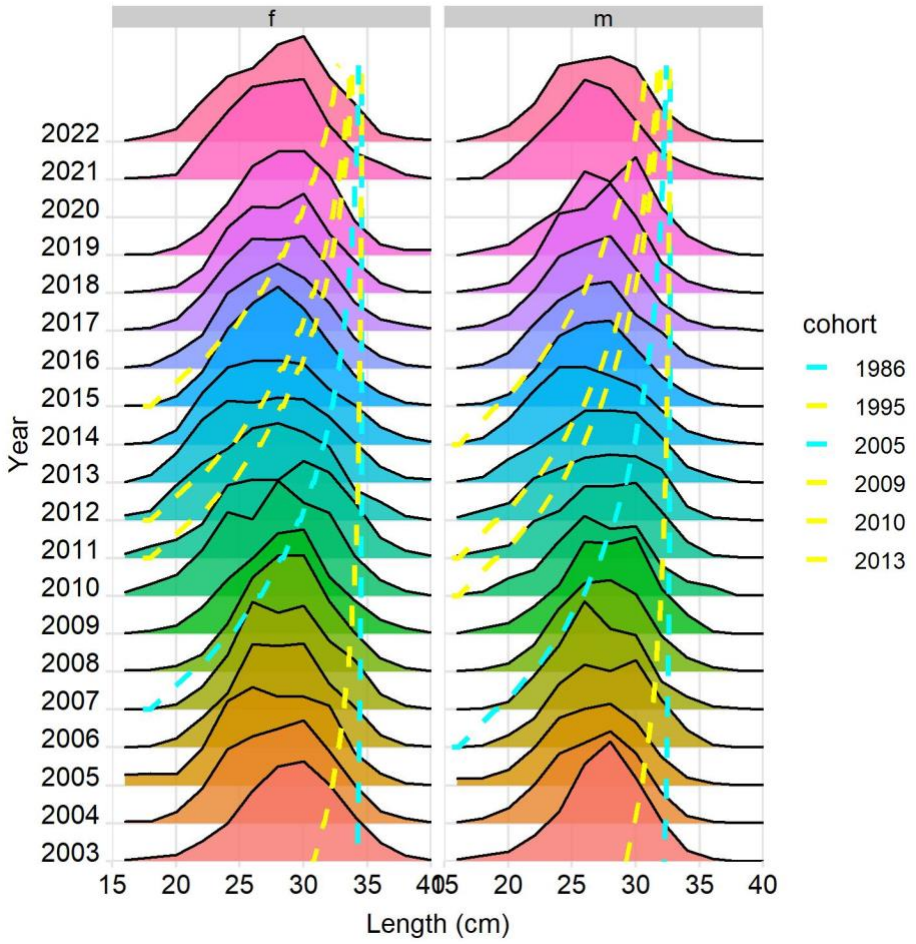


**Figure 3.** Ridge plots of WCGBTS survey (SS FltSvy=5) length compositions for females (left panel) and males (right panel). Dashed lines indicate the expected size of some relatively weak (blue) and strong (yellow) cohorts estimated by the assessment model.

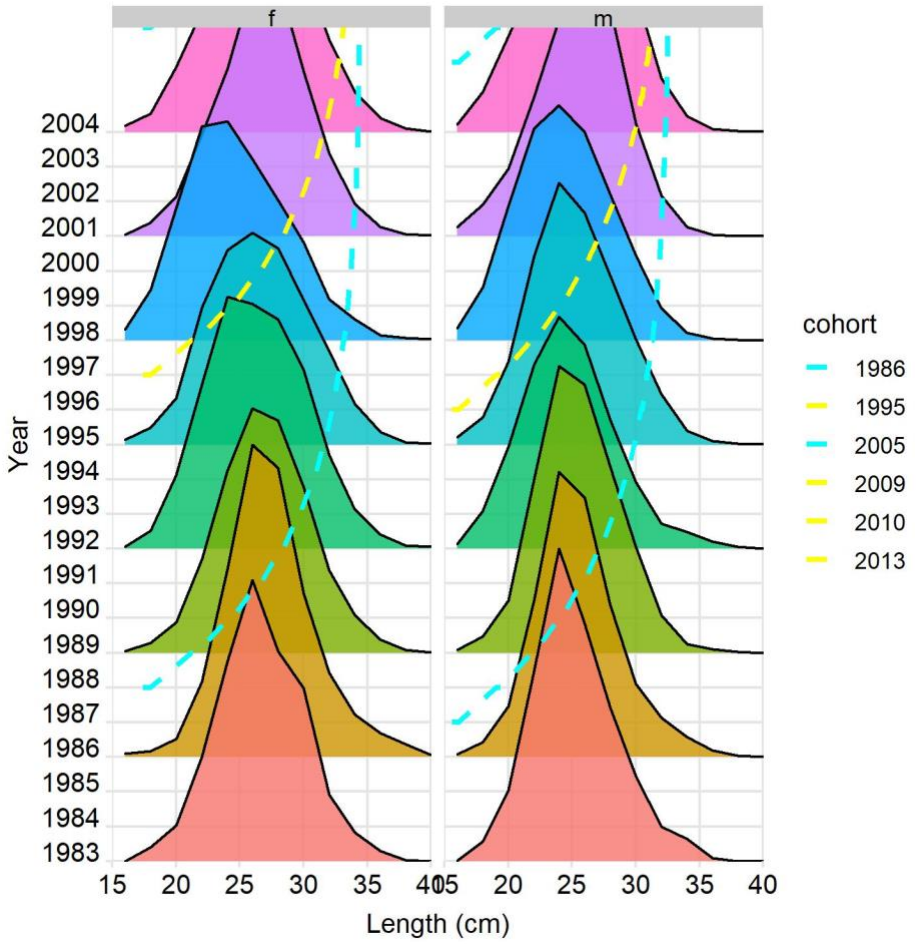


**Figure 4.** Ridge plots of AFSC/NWFSC Triennial survey (SS FltSvy=3+4) length compositions for females (left panel) and males (right panel). Dashed lines indicate the expected size of some relatively weak (blue) and strong (yellow) cohorts estimated by the assessment model.

Standardized proportions at length (SPLY) plots are useful for summarizing cohort information from length composition time-series. These plots are useful for checking which cohorts are relatively strong; however, they cannot be used to compare the size of recent cohorts relative to earlier years. The SPLY statistic, $p_{l|y}^{std}$, is

$$p_{l|y}^{std} = \frac{p_{l|y} - \bar{p}_l}{n^{-1}\sum_y (p_{l|y} - \bar{p}_l)^2}, \bar{p}_l = n^{-1}\sum_y p_{l|y},$$

where $p_{l|y}$ is the proportion at length *l* in year *y* and there are data for *n* years. The SPLY statistics can track cohorts at small sizes but not at larger sizes when the growth dynamics of the fish are nearly finished. These statistics for Rex sole (Figure 5) demonstrate:

1. The 1986 cohort is consistent with 1-2 weak cohorts in a few years of the Triennial surveys;
2. The 1995 cohort is consistent with strong cohorts in the 1998, 2001, and 2004 Triennial survey compositions;

3. A weak 2005 cohort is consistent with WCGBTS survey comps, and to a lesser extent the fishery length compositions;
4. Strong 2009-10 cohorts are consistent with WCGBTS survey comps, but not for the fishery length compositions;
5. The largest cohort in the assessment (2015) was not evident in the WCGBTS length comps at smaller sizes but was evident in the fishery comps.

Overall, I find that the SPLY statistics indicate that rex sole model estimates of recruitment and growth explain the temporal dynamics of deviations in the survey length compositions reasonably well. My only concern is the 2013 cohort, which is the largest estimated in the time-series (but close in size to the 2009-10 cohorts) but has not consistently tracked through the WCGBTS length comps. I suggest that Figure 5 helps explain the assessment results.

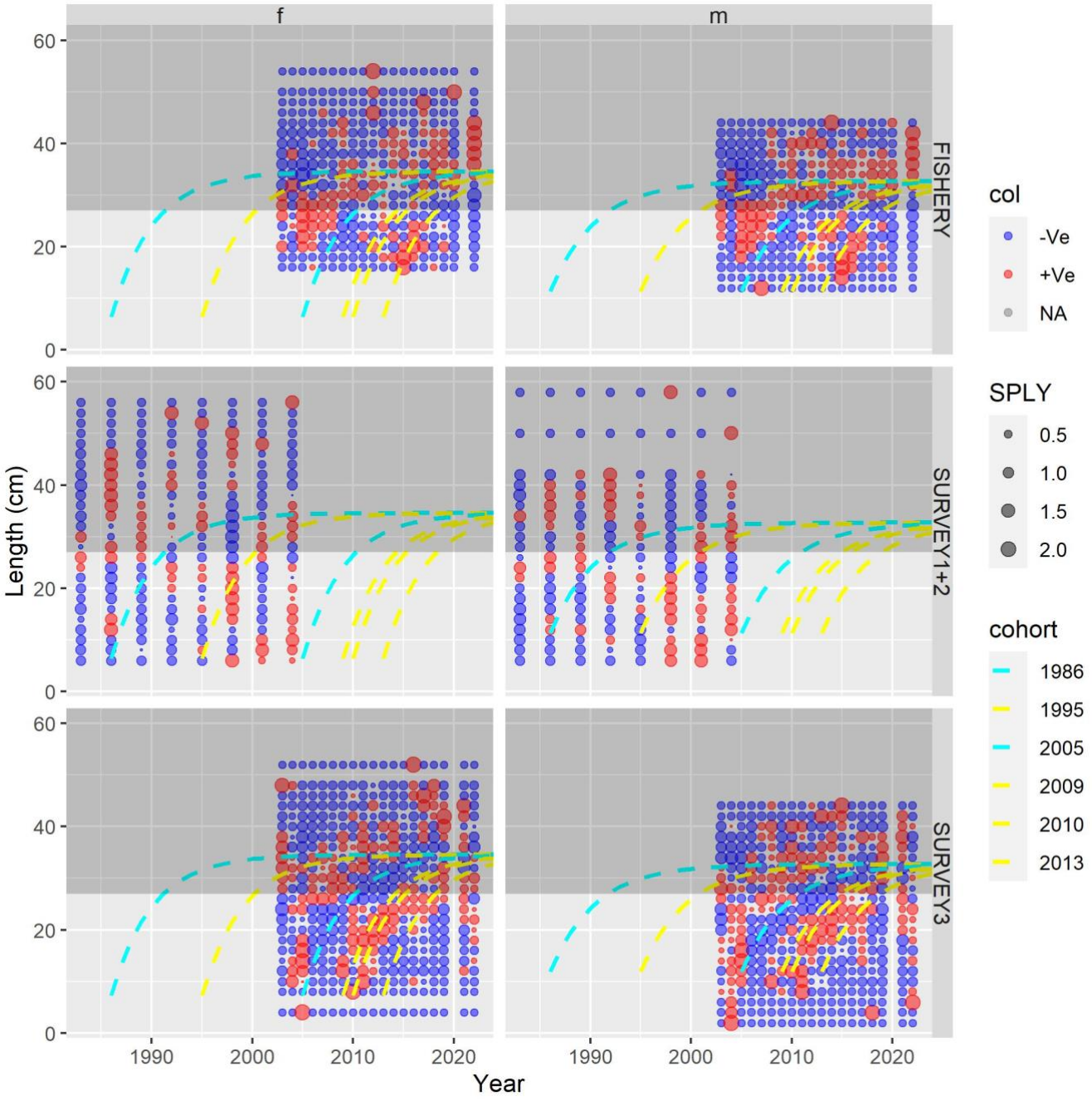


**Figure 5.** SPLY plots for the fishery (top panels; 2003-2022), AFSC/NWFSC Triennial survey (middle panels; 1983-2004) and WCGBTS survey (bottom panels; 2003-2022) length compositions. Dashed lines are Von Bertalanffy predicted lengths (based on assessment parameter estimates) at ages 0-40 for selected weak (blue) and strong (yellow) cohorts which are labelled at the right-hand side. Shaded boxes indicate the fully-grown distribution of sizes of fish, where cohorts will be difficult to track.

*Age compositions – merits and deficiencies*

All four assessments utilized some age information, which is a merit overall.

The north and south copper rockfish assessments used the available age data appropriately. These stocks, especially the northern stock, do not have long time-series of age sampling. This means that the assessments would have little ability to estimate time-variation in growth rates. This is a potential deficiency that should be considered more; that is, is there any evidence that growth rates may have changed, considering changes to thermal habitats, evidence from better sampled species, etc.

**Rex sole**

Length-at-age data were fit external to the base assessment model using the Schnute parameterization of the von Bertalanffy growth function. During the review, the STAT indicated that fish were not selected at random for aging from the WCGBTS catches. The length distribution of aged fish was different than the total survey length distribution of rex sole. In this case the external estimates of the von Bertalanffy growth function may be biased because the age and length data may not reflect the population. This was the motivation for Panel Request No. 5.

I illustrate the bias issue with a simple simulation example of length-stratified age-sampling. I generated a large (N=5000) population of fish of known ages, with lengths derived from a traditional von Bertalanffy equation with to=0, Linf=35 and k=0.2. These are illustrated as the grey points in Figure 6. The parameters were roughly chosen to represent rex sole. I sampled 10 fish per length bin (green points) and estimated the von Bertalanffy growth model from the population values (blue curve) and length-stratified sampled values (red curve). Linf is over-estimated and k is under-estimated based on the length-stratified sample. The problem is that mean length-at-age is biased. This design only provides unbiased estimates of mean age-at-length (see bottom panel in Figure 6).

Many procedures have been proposed to correct for length-stratified age-sampling when estimating a von Bertalanffy growth (e.g., Perreault et al., 2020). I think a good way is to estimate the growth curve internally within a stock assessment model, using the data as conditional age samples. This has additional advantages of also accounting for the effects of gear-selectivity and age-measurement error biases. The STAT did this as part of the Panel Request No. 5, and the results were consistent with the patterns in Perreault et al. (2020) in that Linf was smaller for both males and females when the growth curve was estimated internally. Perreault et al. (2020) also found that Linf was smaller when they "externally" corrected for length-stratified age sampling.

My understanding is that the STAT did not account for age-measurement error because they did not have any information on this available. In retrospect the Panel should have asked for a sensitivity run with an ageing error matrix for another species thought to be similar in this respect. My only rationale for this would be to quantitatively demonstrate the potential impact of including this information when fitting the assessment model. I suspect the M-profile diagnostics would have made more sense, which I describe below.

The impact of age measurement error is the reverse of length-stratified age sampling; that is, with ageing error, Linf is under-estimated and k is over-estimated, whereas the reverse usually happens when length-stratified age-samples are treated as random samples from the population. I illustrate this in Figure 7. The direction of bias is consistent with the simulations results in Dey et al. (2019). The magnitude of the bias will depend on the distribution of age and how well Linf is identified.

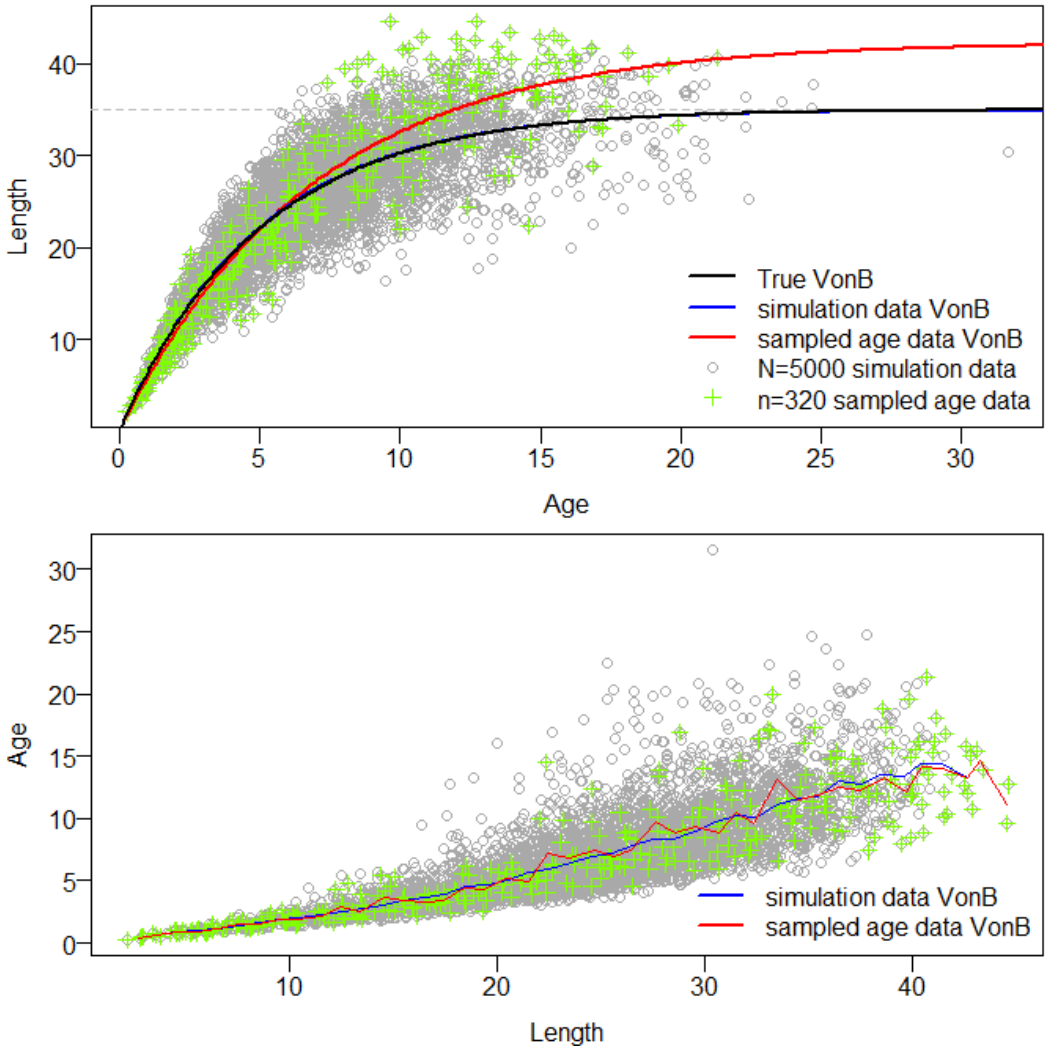


Figure 6. Top Panel: Grey o's are population values of age and length. Green +'s are values sampled via a length-stratified sampling design with 10 fish per 1cm length bin. The black line is the population von Bertalanffy growth curve, with Linf=35, k=0.2, and to=0. The blue curve is the nonlinear least squares estimate of the growth model using the population age-length data, and the red curve is the estimate based on the length-stratified sample. Bottom panel: Population (grey) and sampled (green) age versus length. The blue line segments connect population mean age for each 1 cm length bin. The red line segments connect length-stratified sample mean age per length bin.

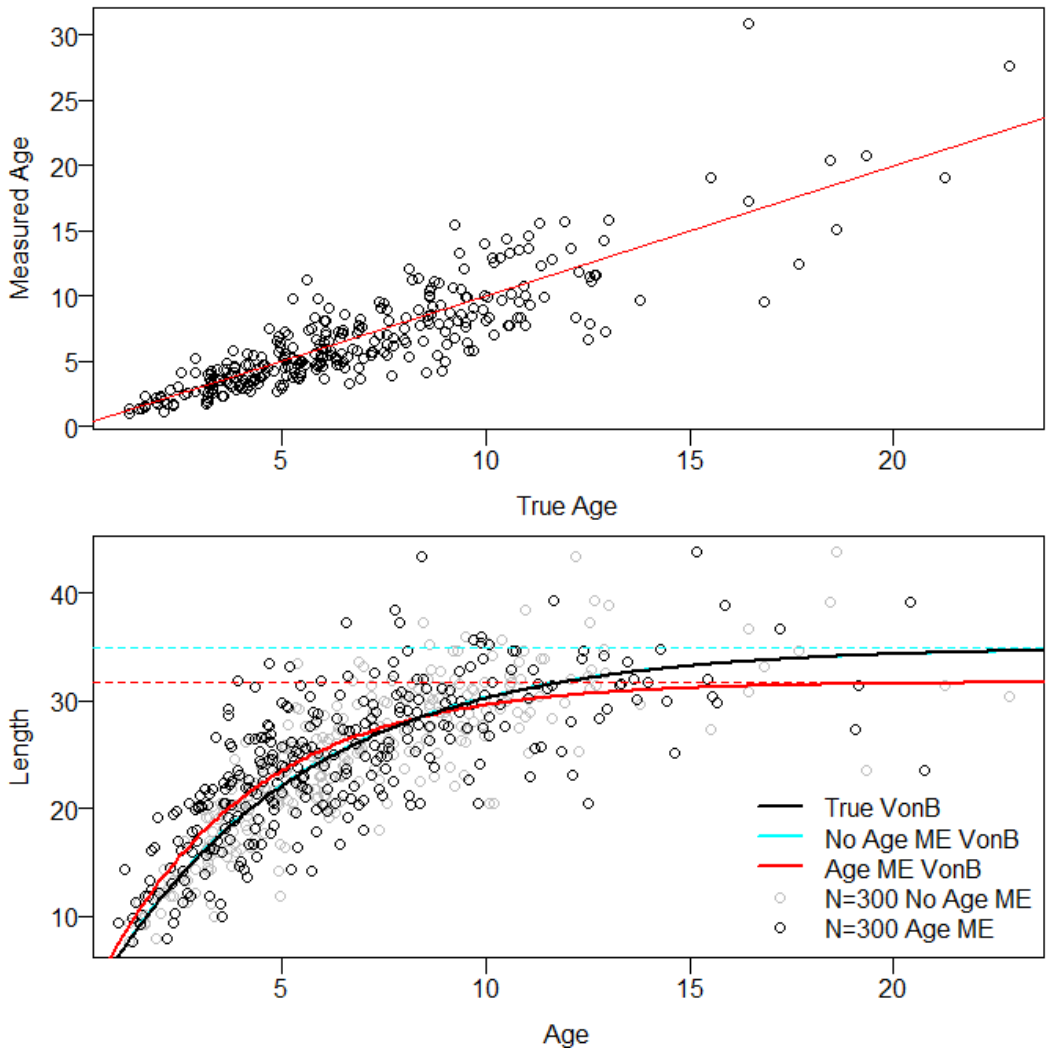


Figure 7. Top panel: Measured age versus true age. Bottom Panel: Grey o's are population values of true age and length. Black o's are values of measured age and length. The black line is the population von Bertalanffy (VonB) growth curve, with Linf=35, k=0.2, and to=0. The cyan colored curve is the nonlinear least squares estimate of the growth model using the population age-length data, and the red curve is the estimate based on the sample with age measurement error (ME).

Dey, R., Cadigan, N. and Zheng, N., 2019. Estimation of the von Bertalanffy growth model when ages are measured with error. *Journal of the Royal Statistical Society Series C: Applied Statistics*, *68*(4), pp.1131-1147.

Perreault, A.M.J., N. Zheng, and N.C. Cadigan. 2020. Estimation of growth parameters based on length-stratified age samples. Canadian Journal of Fisheries and Aquatic Sciences 77(3): DOI:10.1139/cjfas-2019-0129.

**Shortspine thornyhead**

The assessment model used external estimates of a Von Bertalanffy growth curve based on the Butler research age dataset. The ages in these data were averaged from two age-readers. Nonetheless, there will

still be ageing error in the averages. It was also not described how fish were selected for aging or whether they were representative of the overall stock. Age measurement errors and sampling methods are both sources of bias in Von Bertalanffy parameter estimates. The Panel concluded that insufficient age data and high uncertainty associated with the ages used is a technical deficiency of the assessment, which I agree with.

The RP identified a short-term research recommendation that needs to be investigated to achieve a more reliable stock assessment:

*Research into aging methods and availability of reliable age data would be valuable for future stock assessments.*

I fully agree with this recommendation. If the Butler data are used in future assessment models for this stock, then I also recommend that an errors in variables approach (e.g., Dey et al., 2019) be used when fitting growth models to the Butler data. Dey et al. (2019) provided TMB code to fit a Von Bertalanffy growth model with a simple type of age measurement error; however, it seems this code is no longer available on the journal website. I think this could be extended to include the dual age readings that were provided with the Butler data.

*Natural mortality rate*

This is an influential stock assessment parameter, but a difficult one to estimate based on the data typically available for stock assessment. In each of the four assessments, M was assumed to be the same for all sizes and years. This seems to be a common assumption in US west coast stock assessments. A longevity prior on M was used in the four assessments, which is also common practice in US west coast assessments. This was based on the relationship $M_{med} = 5.4/A_{max}$. The median of the prior is $M_{med}$ = 0.108 for the two copper rockfish stocks (s.d. = 0.31) and both sexes. M was fixed at the median of the prior because M was uncertain and poorly informed by the data. Fixed values for both sexes were used for rex sole (M = 0.186) and shortspine thornyhead (M = 0.04).

I appreciate that a lot of research has gone in the studying how to treat M in stock assessment cases (i.e., types of data and life histories) that are common on the U.S. west coast. In reality, M will decrease substantially as size increases for many species. This is one reason why M will vary over time as well, as the size-structure of stocks change in response to exploitation and recruitment. Changes in ecosystem attributes will also contribute to time-varying M. Accounting for variable M has been a major motivation for the use of state-space stock assessment models in the North Atlantic. I understand these methods are being investigated in the US context and I encourage this to continue, to produce more realistic stock assessment model formulations and quantification of uncertainty.

All four assessments concluded that the choice of a value for M was uncertain, which I agree with. All four assessments concluded M was poorly informed by the data. I disagree with this. In fact, M profiles all indicated M was estimable in all four assessments. The problem is that the STATs felt the estimates were unrealistic given historic longevity information. The concern is that the value of M that minimizes the total negative loglikelihood is biased because it is accounting for some other misspecification in the model. This may be true, but I then get concerned about how to assess if a misspecified model is useful for management advice. Of course, all models are misspecified, but some are useful. At least state-space models explicitly account for model misspecification, although the efficacy of this is still a consideration.

For example, in the revised model for rex sole the M profile indicated the MLE was around 0.075. The STAT felt this was much too low compared to the longevity prior median of 0.186. In the section *Age compositions – merits and deficiencies* above I discussed how not accounting for age measurement error may lead to under-estimation of Linf, although this will depend on the distribution of age in the population and the distribution of age measurement errors. Nonetheless, I think a likely outcome of including age measurement error in the rex sole assessment is a slightly higher Linf. In this case, a higher value of M will be required to fit the length compositions as well as the revised model. Hence, I expect a likelihood profile for a model including age measurement error will indicate an MLE for M that is closer to the prior median. This could have been tested with a sensitivity run, as I described above. While this would not have provided a better model formulation, it could have shed light on additional research (i.e., ageing error matrix) that might produce a more reliable model.

The shortspine thornyhead MLE for M was around 0.045 which was close to the prior median of 0.04. Status conclusions for M=0.04 and 0.045 were similar. I am unsure why this assessment did not estimate M. The two copper rockfish assessments indicate M's more different than the prior medians. The status conclusions of the southern component were the same for the prior median M and the MLE. However, for the northern component the fraction unfished was much closer to the target of 0.04 for the MLE of M compared to the prior median of M.

There were too many stocks to review in the 5-day Panel meeting to explore specification of M as much as I would have liked. Nonetheless, the assessment data+models for the two copper rock fish stock components and shortspine thornyhead did not indicate values that were substantially different that the STATs specifications, and I conclude those values are reasonable to use for the assessment of these stocks. For rex sole, the data does suggest a value that is substantially different from the STAT specified M value. However, I suspect the lack of ageing error in the assessment may be contributing to this difference. Hence, I also accept the value in the revised model.

I recommend that research continue about how to account for uncertainty in M (overall level, and size and time variations) for west coast groundfish assessments.

*Length-weight relationship*

The same weight-length relationship was used for the south and north copper rockfish substocks. The plots provided were insufficient to examine goodness of fit. Residual plots should be provided. Also, the plotted weights for females were curious in that there seemed to be duplicate overlayed points, but this could just be the way the plotting symbols displayed. This needs to be checked. North-South differences in the weight-length relationship should be investigated.

Fits to the weight-length data for rex sole were not provided. They should have been provided.

The base model fits to the shortspine thornyhead weight-length data were poor, and during the Panel meeting some influential outliers at small sizes were discovered and removed, which improved the fits.

When sufficient data exists, I also think it is useful to examine for temporal variation in gutted weight-at-length which may indicate temporal variation in condition and possibly temporal variation in M.

*Maturity and Fecundity*

Shortspine thornyhead estimated a maturity curve using a binary GLM with fish length, latitude, and depth as covariates. They predicted the stock proportion mature-at-length by setting the latitude and depth at the values of the center of gravity (using number of fish as a weighing factor) of the population of shortspine thornyhead sampled by the WCGBTS. This may be OK, but a conceptually better approach is to simply get the spatial average proportion mature, with survey numbers as a weighting factor. However, this should be done each year of the survey, which could produce a different maturity ogive each year if the spatial distribution of the population changes.

There is a need to collect more maturity information, especially for rex sole. This is a productivity component that is known to have changed substantially for some North Atlantic flatfish stocks. When sampling is sufficient, spatiotemporal variation is commonly found (e.g., Zheng et al., 2020). This was the case for shortspine thornyhead. However, the maturity-at-length relationship may be more stable than maturity-at-age.

There is a need to provide diagnostics of model fits to maturity data. Gaussian quantiles residuals are good for this.

Zheng, N., Robertson, M., Cadigan, N., Zhang, F., Morgan, J. and Wheeland, L., 2020. Spatiotemporal variation in maturation: a case study with American plaice (*Hippoglossoides platessoides*) on the Grand Bank off Newfoundland. Canadian Journal of Fisheries and Aquatic Sciences, 77(10), pp.1688-1699.

*Indices of abundance*

A variety of fisheries dependent and independent abundance and biomass indices were available for the copper rockfish assessments. This is a merit. The Panel did not review the modelling process involved in producing these indices, nor was there time to do so. This is a deficiency of the assessment process. The application of models to produce abundance indices should be reviewed periodically.

The MRFSS CPFV index of abundance for the southern copper rockfish substock was not used in the final base model. It was confusing that this index was listed in Figure 4 (Summary of data sources used in the base model) and fits to the index were shown in SS output files. However, this index did not appear in profile plots, so it seems it was not used.

The rex sole and shortspine thornyhead assessments had two indices from the triennial surveys and the NWFSC West Coast Bottom Trawl surveys. Indices were derived from fitting spatiotemporal models using the sdmTMB package. The Panel did not review the modelling processes involved in producing these indices, nor was there time to do so. A comparison of design-based and model-based biomass indices was provided for shortspine thornyhead and there were some large differences in 2021-22 that the Panel did not understand. The assessment model also could not fit the last two model-based indices well, which is described below. This comparison was not provided for rex sole. This is a deficiency of the assessment process. The application of models to produce abundance indices should be reviewed periodically.

*Stock Structure*

Copper rockfish were assessed as northern and southern substocks, although there is little evidence of significant stock structure from genetic studies across the west coast. Similarly, shortspine thornyhead genetic studies show few genetic differences along the Pacific coast. Both of these species seem to have limited movements. Hence, the stock structure assumptions seemed reasonable, although I always worry

about the impacts of localized depletions for stock with limited movements. Additional information on larval drift, if available, is useful when considering stock structure assumptions.

The rex sole assessment document did not provide information on stock structure, which is a deficiency.

*Model estimation*

SS3 is a flexible stock assessment modelling framework that can integrate intermittent samples of length compositions, age compositions, and various types of abundance indices. It is an appropriate modelling framework for these stocks.

Growth was estimated within the assessment model for both copper rockfish stocks which is appropriate given the size selectivity of the fisheries and surveys. During the Panel a revised model was requested for rex sole with growth estimated internally to address issues with how fish were selected for aging, and to address impacts of selectivity on the size of caught fish. This is appropriate and produced an improved assessment model. Growth was estimated externally for shortspine thornyheads based on an ageing dataset provided by Butler. Additional information should be obtained about how these fish were selected for sampling (gears, locations, etc.) with a research recommendation of including these data as a growth fleet in future models, if more relevant growth information is not available in the future.

The amount of age data available is rather limited for all four assessments. Hence, annually constant growth rates and size-at-age was a pragmatic assumption. However, it is common to find time-varying growth rates in stocks with more age sampling. This is another source of uncertainty that these assessments are not accounting for. Assumptions like constant growth and natural mortality rates may mean that uncertainty intervals produced by these assessments are too narrow.

I conclude that the time-blocks of selectivity used in these assessment models, including revisions investigated during the Review Panel, were appropriate.

Model convergence was checked and was acceptable for the base models. Convergence was also checked for sensitivity models, and in a few cases, problems were reported. Occasional non-convergence is expected.

*Model fits*

I find it difficult to evaluate the adequacy of the fits to length compositions and conditional age compositions. I am never sure when the composition residuals are too bad to accept. I don't like it if there are common residual patterns across multiple fleets, but the way the residuals are presented in these assessments makes it difficult to check this. If there is evidence of different cohorts passing through different size and/or age comps for different fleets then this is evidence of important and unaccounted sub-stock structure.

I recommend additional graphics be provided that facilitate comparisons of index and length comp residual patterns across fleets.

Copper rockfish north: I could not determine what was preventing the model from better fitting the smooth trends in the Deb Wilson-Vandenberg CPFV survey. The discrepancies in Figure 82 of the base assessment document (copper_rockfish_north_draft_22may2023-pdf) seem to be unlikely to be due to sampling errors. These are issues that STATs should explain.

Copper rockfish south: I conclude the assessment model fit all indices satisfactorily.

Rex Sole: I did not understand why the model could not fit the WCGBTS index better. The lack of fit seems to be more than sampling errors. My initial thought was that $\sigma_R$ was too small to allow enough recruitment variability to match the trends in a comprehensive survey that covers almost the entire distribution of the stock. However, the STAT tried several values of $\sigma_R$ and did not realize much improved fitting. I recommend in future assessments that a better understanding of the conflicts in the data sources be provided to explain why the lack of fit to the WCGBTS index is OK. I appreciate that this assessment had several problems to address and that the STAT made substantial progress during the Review Panel in improving the assessment fit.

Shortspine thornyhead: The Panel was concerned by the lack of fit to the WCGBTS survey index, especially in 2021-22. Removing the constraint on recruitment deviations to sum to one or applying this constraint to the full time-series, somewhat improved the fit, although the last two years were still fit poorly. However, I have some doubt about the sdmTMB modelled-based indices in 2021-22, and why they are substantially higher than the design-based indices in these years, so in the end I decided the lack of fit was acceptable. The differences between model- and design-based indices need to be investigated further.

*Stock-recruitment*

SS can constrain recruitment deviations to sum to zero for some period. The choice of period was a concern, particularly for shortspine thornyhead but also the northern copper rockfish substock. The Panel concluded that the better option for shortspine thornyhead was to use this constraint for the entire assessment model time-period. I am not sure why this would not be the default option, and this needs additional research.

As described above, the Panel investigated if different options for $\sigma_R$ could produce better fits to survey indices. Specification of $\sigma_R$ seemed somewhat ad hoc to me. In state-space models $\sigma_R$ is usually a well-estimated parameter, and I look forward to improved estimation of this and other variance parameters in future versions of assessment software used for U.S. west coast assessment.

For both copper rockfish stocks, I was satisfied that the choice of steepness ($h = 0.72$) was consistent with the data, as determined by likelihood profiles. The most informative likelihood component was the recruitment deviation penalty and I doubt that could provide for reliable estimation of steepness. For the northern sub-stock, the survey indices supported a lower value of steepness in total, but this was not consistent among surveys. The assessment data for rex sole and shortspine thornyhead were basically uninformative about the value for steepness.

*Q*

I appreciated for rex sole and shortspine thornyhead that WCGBTS total survey biomass indices were used, and the STATs considered how reasonable were the values of the estimates Q's. For shortspine thornyhead the estimate for Q was about 1.2 which seemed reasonable to me. For rex sole the estimate from the revised model was 3.97 which seems a little high and needs further investigation.

*Profiles*

A strength of U.S. west coast assessments is routine examination of profile likelihoods to explore the information in the assessment data sources about key assessment model parameters. This is not done routinely in state-space stock assessments I have been involved in, nor is it straight-forward how to do

this when estimation involves the marginal likelihood in which random effects for process errors (e.g., recruitment deviations and cohort survival deviations) are integrated out.

*Retros*

Retrospective plots were provided. Retrospective differences were low and the patterns were not of concern to me.

*Uncertainty*

This was quantified using hessian-based standard errors and sensitivity analyses. I conclude that this was done well for the 4 stocks. STATs performed a range of sensitivity analyses (both to data and structural model uncertainty) before the RP and documented the results in succinct and easy to understand comparison plots.

*New tools or analyses to improve future assessments*.

These were identified above in context to specific parts of the assessment. In this section I summarize new analyses to improve future assessments.

***ToR 4. develop STAR panel reports for all reviewed species-area assessments to document meeting discussion and recommendations.***

This was essentially finalized at the Review Panel.

***ToR 5. The STAR panel and STAT in consultation with Council staff should propose an appropriate method for measuring the scientific uncertainty in the stock assessment, known as "sigma".***

Sigma was set at 0.50 for both copper rockfish sub-area models. For rex sole and shortspine thornyhead, the default sigma for a Category 2 stock, which is 1.0, was recommended. These choices seemed reasonable to me; however, I have little experience in how this sigma affects management advice.

***ToR 6. The STAR panel also makes a recommendation on whether the next assessment of the species should be a full assessment or could be an update assessment and explain reasons for its recommendation.***

The Panel supported designating the copper rockfish in California assessment as Category 1. If the next assessment occurs within 4-years, an update assessment would be appropriate.

The Panel concluded that the assessment model for rex sole estimates current stock status much higher than the management target and even though age data were included, this remains a Category 2 assessment. A limited amount of age data was included in this model and additional age data would likely be very helpful. If additional age data are available, this assessment may be a Category 1 and should be a full assessment the next time it is considered.

The Panel supports the shortspine thornyhead assessment as a Category 2 designation. If no new age data becomes available, an update assessment would be appropriate.

## Conclusions and Recommendations

For all four stocks, the STAR panel and STATs recommended assessment models that will be reviewed by the SSC to determine their merits for supporting management advice. I fully agree with these recommendations.

The base model for the southern copper rockfish substock was unchanged during the Review Panel. The model for the northern substock was revised with a *q* parameter estimated (not as a float) with a time block for the CCFRP survey with a blocking period of 2007-2016 and 2017-2022.

The revised base model for rex sole had some significant differences from the pre-STAR base model. This included some updates to the data, the addition of conditional age-at-length data and internal estimation of growth, forcing all fleets to have asymptotic selectivity, a steepness of 0.7, and a sigmaR of 0.6. Addressing the potential bias in estimating growth externally with length preferential sampling of ages (see Perreault et al. 2020) was a more parsimonious and supported route to pursue that resulted in asymptotic selectivity ogives and more a sensible value for WCGBTS Q.

The revised base model for shortspine thornyhead was modified to include at-sea hake catches, updated selectivity and retention blocks, updated weight-length parameters, specifying the main period of recruitment deviations from 1901-2018, and adjusting the maximum bias correction for recruitment deviations to 0.3. This resulted in a model that had improved fit to the WCGBTS index and length comps.

*Panel Research Recommendations*

There is uncertainty in catch estimates, and more so for historic periods and when interpolations are used to fill in catches for some years. This uncertainty was not quantified and provided to the Panel. There is an important need for STATs to provide information on the quality of the annual catch estimates, and more specifically to quantify the uncertainty in these estimates. This technical deficiency is common to all assessments reviewed by this Panel.

### *Copper Rockfish*

The panel supports the recommendations provided in the pre-STAR draft assessment (reproduced below). Additionally, with respect to recommendation No. 2, the Panel recommends considering the implications of management on each sub-area and how to present these to managers.

STAT Recommendations in pre-STAR draft assessment

1. The NWFSC Hook and Line survey is the only long-term fishery-independent survey in rocky (untrawlable) habitat in the Southern California Bight. Efforts should continue to explore how best to model hook and line catch data to develop indices of abundance. We also recommend evaluating how to structure the NWFSC Hook and Line survey index, given its expansion into the cowcod conservation areas (CCAs) and increase in sites within designated marine protected areas (MPAs), and independent analysis of information content in NWFSC Hook and Line survey across observed species. Finally, increased spatiotemporal sampling around Point Conception would aid in identifying stock boundaries.

2. The assessment area south of Point Conception appears to have a mixture of observations from areas experiencing variable fishing mortality. In the region there are likely a mixture of areas: open access rocky reefs that are close to port that are heavily fished, open access rocky reefs that are inaccessible via day-trips that are fished but likely at lower levels, and rocky reefs that fall within MPAs. A spatially-

explicit assessment model may be able to capture this complexity but will require data (indices of abundance and composition data) from each of the regions.

3. Future nearshore assessments would greatly benefit from additional CDFW remotely operated vehicle (ROV) surveys which could increase the power of these data to inform assessments.

4. There are very limited age data for copper rockfish across California arising from fishery dependent sources. Establishing regular collections of otoliths from the recreational fishery, a large source of mortality, would support future assessments and would improve the understanding of the population structure and life history of copper rockfish.

5. There is limited information for copper rockfish on maturity and fecundity and the variability of these parameters with increasing latitude. The NWFSC WCGBT and Hook and Line surveys provided the only available information on the maturity ogive and the timing of these surveys does not overlap with the expected peak spawning season. The Southwest Fisheries Science Center has egg samples from a total of ten copper rockfish, which is too few to draw conclusions regarding fecundity.

6. Some of the PR mode recreational data that should be available via the Recreational Fisheries Information Network (RecFIN) were found to contain information in that database inconsistent with datasheets available from CDFW. There is also a question if length data collected by the Deb Wilson-Vandenberg onboard observer survey is duplicated within RecFIN and attributed to Marine Recreational Fisheries Statistics Survey (MRFSS) dockside samples of the CPFV fleet.

7. The interpreted substrate data for the areas north of Point Conception within state waters is incomplete. Additional data needs include high resolution interpreted substrate maps for areas outside of state waters. The available interpreted bathymetry data from south of Point Conception is incomplete within state waters around the northern and southern Channel Islands. This poses a challenge for estimating available rocky substrate both by district and also inside and outside closed areas.

8. The genetic stock structure of copper rockfish warrants further investigation to ensure appropriate management of copper rockfish along the U.S. West Coast.

9. The Marine Recreational Fisheries Statistics Survey (MRFSS) index was excluded from both California assessment models. The standardized trends in abundance were marked by extreme peaks in the data throughout the time series that the STAT did not think represented the data. Additional investigations of the MRFSS dataset could help resolve some of the issues.

10. Additional research on the effect of the MPA network on copper rockfish and other nearshore rockfish species needs to be conducted. The trend inside the MPAs in northern California exhibited an increasing trend compared to outside the MPAs, similar to what was observed during the 2021 assessment of vermilion rockfish. However, the trends inside MPAs south of Point Conception varied by location with a number of sites showing no increase in abundance or declining trends.

11. Further investigations of other available fishery-independent data such as the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) kelp forest index would benefit future assessments of nearshore species, including copper rockfish.

12. Larval and smaller young-of-the-year copper rockfish can only be identified with certainty genetically. Existing sources of data (California Cooperative Oceanic Fisheries Investigations [CalCOFI] and Standard Monitoring Units for the Recruitment of Fishes [SMURFs]) where genetic samples can be analyzed would provide key information to inform spawning output estimates for copper rockfish.

13. Continue to improve historical catch reconstructions, including attempting to quantify uncertainty with these and other historical data.

14. Existing catch estimates within the Recreational Fisheries Information Network (RecFIN) that are currently assigned only to "rockfish, general" should be investigated to determine if these removals can be assigned to specific-species.

***Rex sole***

The Panel notes that while q ultimately was estimated within the model at a value that is reasonable, q is still larger (~4) than for other flatfish assessments and remains highly uncertain. In addition, determining an appropriate range of natural mortality is another area of uncertainty for rex sole. The value of natural mortality used in the assessment was determined from a maximum age that came from the published literature. The post-STAR assessment model supported much lower values of M than the value it was fixed at, but seemed unreasonable given the current understanding of the life-history of rex sole and other U.S. West Coast flatfish. An improved understanding of natural mortality will help identify model misspecification. Increased availability of ages for the next rex sole assessment is necessary. Many otoliths are collected from the WCGBTS and are available to be read. Having these data available would better inform biological parameters and the assessment outcomes. Development of an aging error matrix would be a key outcome of this as well.

The panel supports the following recommendations provided in the pre-STAR draft assessment.

STAT Recommendations in pre-STAR draft assessment

1. Limited historical discard data (rate and length compositions) led to unstable models when assuming a single fishery fleet. This was circumvented by splitting the fleet into historical and current fleets, and hard-wiring the discard into the historical fleet to avoid estimating discard rates prior to 2002. Further information on historical discards would be beneficial for future rex sole assessments.

2. Updated biological research of rex sole specifically along the U.S. West Coast would be instrumental. This assessment used improved estimates of growth, maturity, and fecundity parameters for U.S. West Coast rex sole compared to the last assessment. However, the maturity and fecundity assumptions are based on a single study from the 1960s and 1970s, which had limited spatial coverage (Oregon only) and a small sample size for the length-fecundity relationship (Hosie and Horton 1977). Gonads are collected in good numbers from the WCGBTS, but none have been processed for maturity.

3. Catchability is an ongoing concern and major source of uncertainty in the model.

***Shortspine thornyhead***

Maturity predictions were derived from a Bernoulli GLM fit to functional maturity data from the WCGBTS samples. The GLM model included covariate effects for fish length, latitude, latitude squared, depth and depth squared. For the 2023 assessment, a single curve for the coastwide population assessment of shortspine thornyhead was derived by setting the latitude and depth at the values of the center of gravity (using number of fish as a weighing factor) of the population sampled by the WCGBTS. A better approach is to derive a density-weighted average maturity ogive across the stock domain, with density approximated via catches from the WCGBTS. In addition to further research into aging methods (No. 1 below), the Panel suggests the use of an Errors in Variables approach to fit the Butler growth data (e.g., Dey et al. 2019).

The panel supports the following recommendations provided in the pre-STAR draft assessment.

STAT Recommendations in pre-STAR draft assessment

1. Research into aging methods and availability of reliable age data would be valuable for future stock assessments. Otoliths have been collected in good quantities from the NWFSC survey, but there is currently no validated aging method for shortspine thornyhead.

2. Additional investigation into growth patterns would provide valuable information for future population projections. We acknowledge that additional work on aging shortspine thornyhead would be required to make such additional growth research possible.

3. More investigation into maturity of shortspine thornyhead is necessary to understand the patterns in maturity observed in WCGBTS samples.

4. Information on possible migration of shortspine thornyheads would be valuable for understanding stock dynamics. Analysis of trace elements and stable isotopes in shortspine otoliths may provide valuable information on the extent of potential migrations. Possible connections between migration and maturity could likewise be explored.

5. A greater understanding of the connection between thornyheads and bottom type could be used to refine the indices of abundance. Thornyheads are very well sampled in trawlable habitat, but the extrapolation of density to a survey stratum could be improved by accounting for the proportion of different bottom types within a stratum and the relative density of thornyheads within each bottom type.

6. Additional investigation into spatial stock structure could be valuable for determining whether future assessments should develop a spatial assessment model, or if shortspine thornyhead should be assessed at distinct spatial scales in the future.

7. Further research into the Dirichilet-Multinmoial (DMN) data-weighting method for length-composition data is needed for integration with length-based data-moderate assessments like shortspine thornyhead. The DMN method has not, to date, been thoroughly simulation tested with length-composition data, and an attempted sensitivity analysis performed for the 2023 assessment failed to converge entirely. This is a general research need, and is widely applicable to many data-moderate or length-based assessments, not just shortspine thornyhead.

*CIE Reviewer Additional Recommendations*

1. STATs should provide multi-panel "SPAY" plots (e.g. https://rpubs.com/rajeevkumar/SPAY) of length- and age-composition time-series from the various sources, to provide a pre-assessment-model summary of consistency of recruitment and growth information among the data sources.
2. Time-variation in growth and natural mortality rates is important to consider. Describe if there is evidence of this in better sampled species in the area, knowledge of ecosystem changes (predators/prey), etc.
3. Investigate state-space stock assessment models that account for uncertainty in survival processes, etc.
4. Research should continue about how to account for uncertainty in M (overall level, and size and time variations) for west coast groundfish assessments.
5. Provide residual plots for length-weight relationships.
6. When sufficient data exists, examine for temporal variation in gutted weight-at-length which may indicate temporal variation in condition and possibly temporal variation in M.
7. Provide diagnostics of model fits to maturity data.
8. Additional graphics should be provided that facilitate comparisons of index and length composition residual patterns across fleets.
9. Large differences between model- and design-based survey indices need to be investigated further.

**Appendix 1: Bibliography of materials provided for review**

Wetzel, C.R., M.H. Monk, J. Coates. 2023. Status of copper rockfish (Sebastes caurinus) along the U.S. California coast south of Point Conception in 2023. Pacific Fishery Management Council, Portland, Oregon. 344 p.

Monk, M.H., C.R. Wetzel, J. Coates. 2023. Status of copper rockfish (Sebastes caurinus) along the U.S. California coast north of Point Conception in 2023. Pacific Fishery Management Council, Portland, Oregon. 309 p.

Wetzel, C.R., M.H. Monk, J. Coates. 2023. Description of model revisions to the base models for copper rockfish in California. 17 p.

Min, M., E. Sellinger, T. Wang, S.G. Beyer, A. Hayes, A. Rovellini, I. Spies, M. Veron, K. Wang, S.N. Wassermann, V.G. Gertseva, K.L. Oken, O.S. Hamel, M.A. Haltuch. 2023. Status of Rex Sole (Glyptocephalus zachirus) along the US West Coast in 2023. Pacific Fishery Management Council, Portland, Oregon. 126 p.

Zahner. J.A, M.A. Heller-Shipley, H.A. Oleynik, S.G. Beyer, P-Y. Hernvann, M. Véron, A.N. Odell, J.Y. Sullivan, A.L. Hayes, V.G. Gertseva, K.L. Oken, O.S. Hamel, M.A. Haltuch. 2023. Status of Shortspine Thornyhead (Sebastolobus alascanus) along the US West coast in 2023. Pacific Fishery Management Council, Portland, Oregon. 139 p.

## Appendix 2: CIE Statement of Work

### Performance Work Statement

### External Independent Peer Review by the Center for Independent Experts

### Stock Assessment Review (STAR) Panel 1 (CLIN 0001) Copper Rockfish in California, Shortspine Thornyhead, Rex Sole

**Background:**
The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1].

**Scope:**
The National Marine Fisheries Service and the Pacific Fishery Management Council will hold three stock assessment review (STAR) panels and potentially one mop-up panel (if needed), to evaluate and review benchmark assessments of Pacific coast groundfish stocks. The goals and objectives of the groundfish STAR process are to:

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[1] https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf

1) ensure that stock assessments represent the best available scientific information and facilitate the use of this information by the Council to adopt Overfishing Limits (OFLs), Allowable Biological Catches (ABCs), Annual Catch Limits (ACLs), Harvest Guidelines (HGs), and Annual Catch Targets (ACTs);
2) meet the mandates of the Magnuson-Stevens Fisheries Conservation and Management Act (MSA) and other legal requirements;
3) follow a detailed calendar and fulfill explicit responsibilities for all participants to produce required reports and outcomes;
4) provide an independent external review of stock assessments;
5) increase understanding and acceptance of stock assessments and peer reviews by all members of the Council family;
6) identify research needed to improve assessments, reviews, and fishery management in the future; and
7) use assessment and review resources effectively and efficiently.

A benchmark stock assessment will be conducted and reviewed for Copper Rockfish in California. Length-based data-moderate assessments will be conducted and reviewed for Shortspine Thornyhead, and Rex Sole; these assessments will include length data, survey indices and externally-estimated growth, but not age data. These stocks were identified within the top twenty-five rankings for assessment consideration during the Pacific coast groundfish regional stock assessment prioritization process:

(https://www.pcouncil.org/documents/2022/05/f-3-attachment-2-nmfs-assessment-prioritization-workbook-electronic-only.xlsx/)

which was based on the national stock assessment prioritization framework

(http://www.st.nmfs.noaa.gov/Assets/stock/documents/PrioritizingFishStockAssessments_FinalWeb.pdf).

Copper rockfish off the coast of California was assessed in 2021 in data-moderate assessments as two separate sub-stocks split at Point Conception. The stock status for management decisions was based on combined estimates of stock size and status from the two California area assessments. The combined stock status in 2021 of copper rockfish in California was 31.7 percent. In 2021, data sources available for the assessments were limited, but given the low status and uncertainty in the model, the decision was made to revisit the assessment with further California-specific data sources not typically used; preference has been given to NMFS survey data. Copper rockfish is a medium- to large-sized nearshore rockfish found from Mexico to Alaska. The core range is comparatively large, from northern Baja Mexico to the Gulf of Alaska, as well as in Puget Sound. Copper rockfish have historically been a part of both commercial and recreational fisheries throughout its range. Copper rockfish is one of the many rockfish species that is included in the commercial live-fish fishery.

Shortspine Thornyhead was last assessed in 2013, as a single, coast wide stock. The 2013 stock assessment estimated the Shortspine Thornyhead spawning stock biomass to be at 74.2 percent of its initial, unfished biomass. Thornyheads are assessed using length-based models due to the absence of age data, as a reliable means of ageing available otoliths has not been identified. Shortspine and Longspine Thornyheads have historically been caught with each other and with Dover sole and sablefish on the continental slope, comprising a "DTS" target fishery for the trawl fleet.

Rex Sole was last assessed in 2013 in a data-moderate, index-based assessment. Rex Sole is a right-eyed flounder ranging from central Baja California to the Aleutian Islands and the western Bering Sea. They are distributed over mud and sand bottom habitat in deeper depths, are commonly found in waters up to at least 500 m, and range down to more than 1,100 m. Rex Sole grow slowly and are relatively long-lived for a flatfish species with a maximum age of 29 years. The 2013 assessment indicated the stock was healthy: spawning stock biomass was estimated to be 80 percent of unfished levels.

Assessments for these stocks will provide the basis for the management of the groundfish fisheries off the West Coast of the U.S., including providing scientific basis for setting OFLs and ABCs as mandated by the Magnuson-Stevens Act. The technical review will take place during a formal, public, multiple-day virtual meeting of fishery stock assessment experts. Participation of external, independent reviewers is an essential part of the review process. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

**Requirements:**
Two CIE reviewers will participate in the stock assessment review panel. One CIE reviewer, requested herein, shall conduct an impartial and independent peer review of the assessments described above and in accordance with the Performance Work Statement (PWS) and Terms of References (ToRs) herein. Additionally, one "common" CIE reviewer will participate in all STAR panels held in 2023 and the PWS and ToRs for the "common" CIE reviewer are included in **Attachment A**.

The CIE reviewers shall be active and engaged participants throughout panel discussions and able to voice concerns, suggestions, and improvements, while respectfully interacting with other review panel members, advisors, stock assessment technical teams, and other participants. The CIE reviewers shall have excellent communication skills in addition to working knowledge and recent experience in fish population dynamics; with experience in the integrated-analysis modeling approach, using age- and size- (and possibly spatially-) structured models, and methods for quantifying uncertainty. Familiarity with environmental, ecosystem and climatic effects on population dynamics and distribution may also be beneficial. The CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

**Tasks for Reviewers:**
The CIE reviewer shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the NMFS Contracting Officer Representative (COR), who forwards this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the PWS and ToRs to the CIE reviewer. The NMFS Project Contact is responsible for providing the CIE reviewer with the background documents, reports, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the PWS in advance of the panel review meeting. Any changes to the PWS or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an File Transfer Protocol (FTP) site to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the PWS scheduled deadlines specified herein. The CIE reviewer shall read all documents in preparation for the peer review.

Documents to be provided to the CIE reviewers prior to the STAR Panel meeting include:

- The current draft stock assessment reports;
- Previous stock assessments and STAR Panel reports for the assessments to be reviewed;
- The Pacific Fishery Management Council's Scientific and Statistical Committee's Terms of Reference for Stock Assessments and STAR Panel Reviews;
- Stock Synthesis (SS) Documentation;
- Additional supporting documents as available;
- An electronic copy of the data, the parameters, and the model used for the assessments (if requested by reviewer).

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the PWS and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the PWS and ToRs cannot be made during the peer review, and any PWS or ToRs modifications prior to the peer review shall be approved by the Contracting Officer (CO), Contracting Officer's Representative (COR) and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the review panel's virtual meeting, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., video or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The
CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements. The agenda will be made available two weeks prior to the start of the Panel Review Meeting.

Contract Deliverables - Independent CIE Peer Review Reports: The CIE reviewer shall complete an independent peer review report in accordance with the PWS. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. The CIE reviewer shall complete the independent peer review addressing each ToR as described in **Annex 2**.

Other Tasks – Contribution to Summary Report: The CIE reviewer should assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. The Chair is not provided by the CIE under this contract. A CIE reviewer is not required to reach a consensus with other members of the Panel, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

**Place of Performance:**
The CIE reviewers shall conduct an independent peer review during the panel review meeting scheduled for the dates of June 5-9, 2023. The meeting shall take place in Seattle, Washington. In the event that conditions at the time warrant, this meeting will be conducted instead as a virtual meeting, with technical assistance provided by staff from the Pacific Fishery Management Council.

**Period of Performance:**
The period of performance shall be from the time of award through **July 2023**. The CIE reviewers' duties shall not exceed 14 days to complete all required tasks.

**Schedule of Milestones and Deliverables:**
CIE shall complete the tasks and deliverables described in this PWS in accordance with the following schedule.

| | |
|---|---|
| Within two weeks of the award | Contractor selects and confirms reviewers. This information is sent to the COR, who then transmits this to the NMFS Project Contact |
| Approximately two weeks later | Contractor provides the pre-review documents to the CIE reviewers |
| **June 5-9, 2023** | **Panel Review Meeting, Seattle, Washington** |
| Approximately two weeks later | Contractor receives draft reports |
| Within two weeks of receiving draft reports | Contractor submits final CIE independent peer review reports to the COR |

Note: The Chair's Summary Report shall not be submitted to, reviewed, or approved by the Contractor.

**Applicable Performance Standards**
The acceptance of the contract deliverables shall be based on three performance standards:

(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

**Travel:**
All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $10,000.00.

**Restricted or Limited Use of Data:**
The contractors may be required to sign and adhere to a non-disclosure agreement.

**NMFS Project Contact:**
Andi Stephens, NMFS Project
Contact National Marine Fisheries
Service, Newport, OR 97365
Andi.Stephens@noaa.gov
Phone: 843-709-9094

## Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

   b. Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Performance Work Statement
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

## Annex 2: Terms of Reference for the Peer Review Stock

## Assessment Review (STAR) Panel 1

The specific responsibilities of the STAR panel are to:

1. Become familiar with the draft stock assessment documents, data inputs, and analytical models along with other pertinent information (e.g., previous assessments and STAR panel report when available), and the Pacific Fisheries Management Council Terms of Reference for the Groundfish Stock Assessment Review Process for 2023-2024 prior to review panel meeting.
2. Discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting.
3. Evaluate model assumptions, estimates, and major sources of uncertainty.
4. Provide constructive suggestions for current improvements if technical deficiencies or major sources of uncertainty are identified.
5. Determine whether the science reviewed is considered to be the best scientific information available.
6. When possible, provide specific suggestions for future improvements in any relevant aspects of data collection and treatment, modeling approaches and technical issues, differentiating between the short-term and longer-term time frame.
7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations.

## Annex 3: Agenda

Stock Assessment Review for Copper Rockfish in California, Rex Sole, and Shortspine Thornyhead

National Oceanic and Atmospheric Administration
Northwest Fisheries Science Center
Auditorium and Online
2725 Montlake Boulevard E
Seattle, WA 98112
260-860-3200

June 5-9, 2023

This groundfish stock assessment review (STAR) meeting is hosted by the Pacific Fishery Management Council (Council) and the National Oceanic and Atmospheric Administration (NOAA) Northwest Fisheries Science Center (NWFSC) and will follow the Council's Terms of Reference (TOR) for Groundfish Stock Assessment Reviews. This STAR panel will review 2023 stock assessments for copper rockfish in California, rex sole, and shortspine thornyhead. STAR Panel meetings are open to the public and a public comment period is scheduled for each day. Additional public comments and breaks will be taken at the discretion of the Chair. Dates and times (Pacific Daylight Time) on this agenda are subject to change once the meeting begins.

The meeting will be conducted in person with a web broadcast that provides the opportunity for remote listening and public comment. In the event an outage occurs, or technical issues arise that impact the experience of remote attendees, we will attempt to resolve them but ultimately we cannot guarantee that they will be resolved satisfactorily. Specific meeting information, materials, visitor protocols, and instructions for how to connect to the meeting remotely will be available on the Council's website in advance of the meeting.

### Monday, June 5, 2023

| | | |
|---|---|---|
| 8:30 am | Welcome, Logistics, and Introductions | Schaffler/Hamel/Bellman |
| 8:45 am | Review the Agenda and Discuss Meeting Format | |
| | Administrative matters, Terms of Reference, etc. | |

| | | |
|---|---|---|
| 9:00 am | Copper Rockfish in California (CA): STAT Presentation (Part 1: Biology, Fisheries, and Data) | Stock Assessment Team (STAT) |
| 10:00 am | BREAK | |
| 10:15 am | Copper Rockfish in CA: STAT Presentation (Part 2: Assessment Modeling and Performance for the Area North of Point Conception) | STAT |
| | STAR Panel Requests to the STAT | |
| 12:00 pm | LUNCH | |
| 1:00 pm | Copper Rockfish in CA: STAT Presentation (Part 3: Assessment Modeling and Performance for the Area South of Point Conception; Current Status of the California Stock) | STAT |
| | STAR Panel Requests to the STAT | |
| 2:45 pm | Discussion and Requests: Copper Rockfish in CA | All |
| 3:30 pm | Public Comment | Schaffler |
| 3:45 pm | BREAK | |
| 4:00 pm | Rex Sole: STAT Presentation | STAT |
| 5:30 pm | Adjourn for day | |

## Tuesday, June 6, 2023

| | | |
|---|---|---|
| 8:30 am | Review Agenda for the day; STAR Panel Discussion | Schaffler/Panel |
| 9:00 am | Discussion and Requests: Rex Sole | All |
| 10:00 am | BREAK | |
| 10:15 am | Shortspine Thornyhead: STAT Presentation | STAT |
| 12:00 pm | LUNCH | |
| 1:00 pm | Discussion and Requests: Shortspine Thornyhead | All |

| | | |
|---|---|---|
| 2:30 pm | Response to Requests and Discussion: Copper Rockfish in CA | STAT/Panel |
| 4:15 pm | BREAK | |
| 4:30 pm | Public Comment | Schaffler |
| 5:00 pm | Initial Report Writing and Work Session, as needed | All |
| 5:30 pm | Adjourn for day | |

## Wednesday, June 7, 2023

| | | |
|---|---|---|
| 8:30 am | Review Agenda for the day; STAR Panel Discussion | Schaffler/Panel |
| 9:00 am | Initial Report Writing and Work Session, as needed | All |
| 9:45 am | BREAK | |
| 10:00 am | Response to Requests and Discussion: Rex Sole | STAT/Panel |
| 12:00 pm | LUNCH | |
| 1:00 pm | Response to Requests and Discussion: Shortspine Thornyhead | STAT/Panel |
| 2:30 pm | Response to Requests and Discussion: Copper Rockfish in CA | STAT/Panel |
| 3:45 pm | BREAK | |
| 4:00 pm | Public Comment | Schaffler |
| 4:30 pm | Initial Report Writing and Work Session, as needed | All |
| 5:30 pm | Adjourn for day | |

## Thursday, June 8, 2023

| | | |
|---|---|---|
| 8:30 am | Review Agenda for the day; STAR Panel Discussion | Schaffler/Panel |
| 9:00 am | Discussion and Requests | All |

| | | |
|---|---|---|
| 10:00 am | BREAK | |
| 10:15 am | Discussion and Requests | |
| 12:00 pm | LUNCH | |
| 1:00 pm | Response to Requests and Discussion | STAT/Panel |
| 3:00 pm | Public Comment | Schaffler |
| 3:15 pm | BREAK | |
| 3:30 pm | Initial Report Writing and Work Session, as needed | All |
| 5:30 pm | Adjourn for day | |

## Friday, June 9, 2023

| | | |
|---|---|---|
| 8:30 am | Consideration of Remaining Issues | Schaffler/Panel |
| | Review Basis for Decision Tables for all assessments | |
| 10:00 am | BREAK | |
| 11:00 am | Review First Draft of the STAR Panel Report | All |
| | Panel agrees to process for completing the Final STAR Report for Council's September Meeting Briefing Book (Advance Deadline August 9, 2023) | |
| 12:00 pm | LUNCH | |
| 1:00 pm | Continue Drafting Report, as needed | Panel |
| 3:00 pm | BREAK | |
| 3:15 pm | Public Comment | Schaffler |
| 4:00 pm | STAR Panel Adjourns | |

**Appendix 3: Panel Membership or other pertinent information from the panel review meeting.**

**STAR Panel Members**

Jason Schaffler, Muckleshoot Indian Tribe (Chair)
Allan Hicks, International Pacific Halibut Commission
Noel Cadigan, Center for Independent Experts
Joseph Powers, Center for Independent Experts

**Stock Assessment Team (STAT) Members**

**Copper Rockfish in California**
Chantel Wetzel, National Marine Fisheries Service Northwest Fisheries Science Center
Melissa Monk, National Marine Fisheries Service Southwest Fisheries Science Center
Julia Coates, California Department of Fish and Wildlife

**Rex Sole**
Marcus Min, University of Washington School of Aquatic and Fishery Sciences
Emily Sellinger, University of Washington Quantitative Ecology and Resource Management
Terrance Wang, University of Washington School of Aquatic and Fishery Sciences
Sabrina Beyer, University of Washington School of Aquatic and Fishery Sciences
Adam Hayes, University of Washington School of Aquatic and Fishery Sciences
Alberto Rovellini, University of Washington School of Aquatic and Fishery Sciences
Ingrid Spies, University of Washington School of Aquatic and Fishery Sciences
Matthieu Veron, University of Washington School of Aquatic and Fishery Sciences, National Marine Fisheries Service Alaska Fisheries Science Center
Kun Wang, University of Washington School of Aquatic and Fishery Sciences
Sophia N. Wassermann, University of Washington School of Aquatic and Fishery Sciences, National Marine Fisheries Service Alaska Fisheries Science Center
Vladlena Gertseva, National Marine Fisheries Service Northwest Fisheries Science Center
Kiva L. Oken, National Marine Fisheries Service Northwest Fisheries Science Center
Owen Hamel, National Marine Fisheries Service Northwest Fisheries Science Center
Melissa A. Haltuch, National Marine Fisheries Service Alaska Fisheries Science Center

**Shortspine Thornyhead**
Joshua A. Zahner, University of Washington School of Aquatic and Fishery Sciences
Madison Heller-Shipley, University of Washington School of Aquatic and Fishery Sciences
Haley A. Oleynik, University of British Columbia Institute for the Oceans and Fisheries
Sabrina G. Beyer, University of Washington School of Aquatic and Fishery Sciences
Pierre-Yves Hernvann, University of California-Santa Cruz Institute of Marine Sciences' Fisheries Collaborative Program, National Marine Fisheries Service Northwest Fisheries Science Center
Matthieu Véron, University of Washington School of Aquatic and Fishery Sciences, National Marine Fisheries Service Alaska Fisheries Science Center
Andrea N. Odell, University of California-Davis
Jane Y. Sullivan, National Marine Fisheries Service Alaska Fisheries Science Center

Adam L. Hayes, University of Washington School of Aquatic and Fishery Sciences
Vladlena Gertseva, National Marine Fisheries Service Northwest Fisheries Science Center
Kiva L. Oken, National Marine Fisheries Service Northwest Fisheries Science Center
Owen Hamel, National Marine Fisheries Service Northwest Fisheries Science Center
Melissa A. Haltuch, National Marine Fisheries Service Alaska Fisheries Science Center

**STAR Panel Advisors**

Melanie Parker, California Department of Fish and Wildlife, Groundfish Management Team representative
Gerry Richter, B&G Seafoods, Groundfish Advisory Subpanel representative
Marlene A. Bellman, Pacific Fishery Management Council representative
Todd Phillips, Pacific Fishery Management Council representative