External Independent Peer Review
for the
Center for Independent Experts (CIE)
Stock Assessment Review (STAR) Panel 1
of
Copper Rockfish in California, Shortspine Thornyhead and Rex Sole
June 5-9, 2023
Northwest Fisheries Science Center
2725 Montlake Boulevard E
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by
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Executive Summary

i. Four assessments (copper rockfish in North California and in South California, rex sole and shortspine thornyhead in Oregon, California, and Washington) were reviewed during a formal, public meeting of fishery stock assessment experts from 5-9 June 2023. Two Center for Independent Experts (CIE) reviewers were included in the Review Panel.

ii. Copper Rockfish models were two-sex age-structured model operating on an annual time step. The models were conditioned on commercial and recreational catch (and discards) among four fleets, fishery-dependent and fishery-independent indices of abundance and length and age composition data from fishery-independent and fishery-dependent sources. The models also incorporate an updated length-based maturity schedule and externally estimated length-weight relationship and fecundity-at-length function. The assessments fix values for natural mortality of females and males at 0.108 yr^{-1} and steepness at 0.72. Estimates sex-specific growth parameters and recruitment deviations were derived internally to the assessment models. The Panel explored model alternatives for selectivity/catchability, M, steepness and sigmaR. Based on results a final base model was recommended incorporating a change using two time blocks for catchability (2007-2016 and 2017-2022; same as selectivity) in the CCFRP index of abundance in the North model in order to address possible underfitting and to allow some characterization of survey expansion during this time period.

iii. The Rex Sole model used two fishing fleets: one historical coastwide fishery (removals from 1916-2001 including landings and discards) and one current coastwide fishery (landings and discards modeled separately for 2002-2022). Length compositions of landings and discards were available since 2003 (with some omissions). The assessment included a newly available catch reconstructions for the earlier period and abundance indices were calculated and fixed or externally estimated biological parameters and length, weight age relationships. After exploratory analyses, the re-defined base model included 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.

iv. The Shortspine thornyhead model used three fishery fleets and coastwide Non-trawl, and three survey fleets. A new maturity analysis and fecundity relationship was available. Steepness was fixed at 0.72, M was fixed at 0.04 (slightly modified from 0.0505 in the 2013 assessment). After further analyses, the Panel recommended a re-defined base model which included: a) inclusion of updated catches, b) updated selectivity and retention blocks, c) updated weight-length parameters, d) main period of recruitment deviations specified as 1901-2018, and e) the maximum bias correction for recruitment deviations at 0.3.

v. These modified assessment models represent the best science available given the existing data as the assessment goes forward to the final model runs for the SSC.

vi. The need for more aging, size samples and expanded surveys are ubiquitous in these

assessments

vii. Implicit within all these assessments is that migration at pre- or post- recruitment time periods are not important to the dynamics (i.e. that the stock-delineation is correct). Thus, copper rockfish have purported individual stocks in north and south California and rex sole and shortspine thornyhead have single coast-wide stocks in Washington, Oregon and California. While it is important to augment research on stock identification, it is also important to explore management procedures which are robust to stock-id mis-specifications.

viii. As usual the axes of uncertainty are focused on natural mortality and steepness. There is a need for simulation research on best practices regarding the joint choice of h, M and SigmR in the stock recruitment relationship including statistical structure of the sigmas (alternatives to lognormal, shifting sigmaR with spawning output, etc).

ix. The review meeting was constructive and productive with effective excellent co-operation from the STAT teams. Meeting facilities were good, and the local staff provided great support to the reviewers. There were no major disagreements between Panel members or the STATs

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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.

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: 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.

This report addresses the 1st of the STAR reviews which met June 5-9, 2023, in-person at the Northwest Fisheries Science Center Auditorium with a remote participation option to facilitate public comment and participation for those unable to travel to Seattle, WA. In addition to full benchmark assessments for Copper Rockfish in California, the panel also reviewed data-moderate assessments for Rex Sole and Shortspine Thornyhead. The panel operated under the Pacific Fishery Management Council's (PFMC) Terms of Reference for the Groundfish and Coastal Pelagic Species Stock Assessment Review Process for 2023-2024.

Description of the Individual Reviewer's Role in the Review Activities

The STAR Panel for the June 5-9 review was comprised of Jason Schaffler (Muckleshoot Indian Tribe (Chair)), Allan Hicks (International Pacific Halibut Commission), Noel Cadigan (CIE) and myself, also as a designate of the CIE. Additionally, I was designated as the "common" CIE reviewer for the three STAR Panel groundfish reviews to be conducted in June and July 2023. The Panel's (and, thus, my) responsibilities were to examine the documentation provided prior to the meeting and then to interact within the meeting to evaluate details of the assessments,

suggest alternatives to the base model if appropriate and provide feedback on possible improvements in modeling, research and data, both short- and long-term.

Thus, as a CIE reviewer, I am to submit a report addressing the Terms of Reference for this CIE review as noted in the Performance Work Statement (Appendix 2). The report herein is my evaluation addressing the first of the STAR Panel meetings.

Summary of Findings for each ToR in which the weaknesses and strengths are described

The **Terms of Reference** for this CIE review include the specific responsibilities of the STAR Panels, as well as additional tasks assigned to the CIE reviewers. These are listed below. My response to each **TOR** is provided after each item in the list. This item-by-item response to each **TOR** is required by the CIE Performance Work Statement (Appendix 2). However, several of these **TORs** are fairly generic (for example "become familiar", "discuss … during the open meeting", etc). Therefore, my responses to those items were that those events did, indeed, occur. Hence, my technical comments and discussions are mostly grouped under **TORs 3, 4** and **6**. Additionally, **TOR 5** is a response to the best available science question. Discussions and conclusions that support that response are included in the other **TOR**s. Finally, **TOR 7** is essentially asking for the same information that is in the **Executive Summary** and in **Conclusions and Recommendations** section. Thus, there is a great deal of redundancy in those three sections.

Terms of Reference

TOR 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

*Note, the **Pacific Fisheries Management Council Terms of Reference for the Groundfish Stock Assessment Review Process for 2023-2024** are terms of reference for the scope and details of the assessments, not to be confused with the CIE Terms of Reference for this review*).

Background documentation as listed in Appendix 1 were provided two weeks prior to the STAR 1 Panel meeting, as well as the PFMC's guidelines for conducting assessments and reviews of those assessments for the 2023-2024 STAR cycle. These were reviewed prior to the meeting. Thus, I became familiar with the assessment approaches, data inputs and basic STAR Panel requirements.

TOR 2. Discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting.

I participated in the STAR Panel 1 discussions during the meeting about technical merits, limitations of input data and analytical methods. The results of those discussions are summarized in the above **Executive Summary** and in **TOR 7** below. The technical details of those discussions and my thoughts on those issues are contained in responses to **TORs 3**, **4** and **6**.

TOR 3. Evaluate model assumptions, estimates, and major sources of uncertainty.

Four separate stock assessments were reviewed: North California Copper Rockfish, South California Copper Rockfish, Rex Sole and Shortspine Thornyhead. Model assumptions, estimates and major sources of uncertainty were evaluated at the June 5-9 meeting by the Panel making requests of the STAT to conduct short-term analyses. The results of these analyses provided the CIE reviewers and other Panel members further understanding of the implications of assumptions, model structure and uncertainty estimates (or ranges). The scope of those requests and outcomes are summarized for each stock assessment, below.

North and South California Copper Rockfish

The recreational fishery in California is the primary source of mortality for copper rockfish where private/rental (PR) vessels are the primary source of historical removals across the state. Catches by commercial passenger fishing vessels (CPFV) ramped up between the 1960s to the 1980s across the state. In recent years, the recreational removals north of Point Conception have been split between CPFV and PR vessels. In contrast, the CPFV fleet south of Point Conception is the primary source of mortality for copper rockfish.

The stocks of copper rockfish in waters off California were assessed using two sub-area models that captured distinct dynamics split north and south of Point Conception, 34°27' N. lat.

These assessments use Stock Synthesis 3 (version 3.30.21.00). Each assessment model is a two-sex age-structured model operating on an annual time step covering the period 1916 to 2022, with a twelve-year projection, and assumes an unfished population prior to 1916. Population dynamics are modeled for ages 0 through 50, with age 50 being the accumulator age. The models are conditioned on catch from two sectors, commercial and recreational, divided among four fleets, and is informed by both fishery-dependent and fishery-independent indices of abundance. The models are fit to length composition data from fishery-independent and fishery-dependent sources, as well as age compositions as marginals or conditioned on length. Discards from the commercial and

recreational fleets were estimated externally and added to landings to represent total catch. The commercial fishery is subdivided based on the landed condition of copper rockfish, live or dead. The recreational fishery is split into two fleets, a CPFV and PR boat modes where the PR fleet includes very minimal catch from manmade and beach/bank modes. The models also incorporates an updated length-based maturity schedule and externally estimated length-weight relationship and fecundity-at-length function. The assessment fixes values for natural mortality of females and males at the median of the prior (0.108 yr^{-1}) and estimates sex-specific growth parameters. Year-class strength is estimated as deviations from Beverton-Holt stock-recruitment relationship beginning in 1965 in the south and in 1970 north of Point Conception. Steepness of the Beverton-Holt stock-recruitment relationship is fixed at the mean of the prior, 0.72.

Within model uncertainty is explicitly included in this assessment by parameter estimation uncertainty, while among model uncertainty is explored through sensitivity analyses addressing alternative input assumptions such as data treatment and weighted, and model specification sensitivity to the treatment of life history parameters, selectivity, and recruitment.

At the meeting, the STAT was requested to run analyses on 1) examining the observed maturity data and its impact on assessment results; 2) sensitivity of alternative selectivity specifications for the "growth" fleet (unassociated size samples); 3) provide profiles for SigmaR, use plotting functions in panel format to review results, using a 0.1 step size from 0.1 to 1 in order to understand model fits and possible improvements; 4) Use two time blocks for catchability (2007-2016 and 2017-2022; same as current selectivity) in the CCFRP index of abundance in the North model in order to address possible underfitting and to allow some characterization of survey expansion during this time period; 5) revision of the structure of the relative abundance table needed to support management decisions; and 6) to expand final decision tables using P*'s of 0.35 and 0.4 in addition to the default of 0.45 for managers. Of these requests, 4) was the only outcome where it was recommended that that approach should be incorporated into the final base model.

Age data are limited and consequently growth estimates are uncertain and the available age data contains insufficient information to reliably estimate natural mortality. There is some tension among limited data sources and types inferred by the likelihood profiles, with age data suggesting a higher natural mortality rate and length data suggesting a lower value, particularly for the area north of Point Conception. Conflicting signals in the information between length and age data is commonly encountered for many U.S. West Coast groundfish stock assessments. The mechanisms driving these differences are uncertain.

Each of the sub-area models estimates high recruitment events over the most recent decade, especially relative to previous time periods. The base model for the sub-area north of Point Conception estimated overall lower variation in recruitment relative to

the model south of Point Conception. Oceanographic conditions likely drive periods of either poor or above average recruitment, particularly for rockfish species. However, it is unclear what conditions may be contributing to the differing levels of recruitment variation across the California coast.

As with most assessments, major axes of uncertainty are steepness, M and limitations of aging data. These are discussed further in **TOR 6**.

Rex Sole

The rex sole assessment is for the assumed single stock of r the West Coast of the United States from the U.S.-Canada border to the U.S.-Mexico border. A single fishery was modeled with landings starting in 1916, length compositions of landings since 2003 (none in 2021), discard rates from 2002 through 2021, and discard mean weights from 2002 through 2021 (Figure 18). For the catch data, this assessment included a newly available catch reconstruction for Washington landings from 1948-1980 and an updated catch reconstruction from Oregon for 1929-1980. Abundance indices were calculated using Species Distribution Models.

Two fishing fleets are defined in the model: one historical coastwide fishery (removals from 1916-2001 including landings and discards) and one current coastwide fishery (landings and discards modeled separately for 2002-2022). This change was made to facilitate the inclusion of discard data from the West Coast Groundfish Observer Program (WCGOP), which began collecting data in 2002.

Biological parameters and relationships were determined from published literature and recent data collections. Maturity and fecundity parameters were updated to U.S. West Coast-specific parameter values. The length-weight relationship was estimated externally using data from 2007 to 2022 collected by the West Coast Groundfish Bottom Trawl Survey (WCGBTS). Age data from the NWFSC West Coast Groundfish Bottom Trawl Survey (WCGBTS) were used to estimate sex-specific growth curves for U.S. West Coast rex sole using 620 age-length observations collected from the years 2007 to 2019. The otoliths were sampled to represent a wide range of lengths and thus preferentially sampled small and large fish. The majority of these data came from the years 2017-2019. Earlier years were used to fill in ages for the smallest and largest lengths. Natural mortality was determined from the median of the Hamel and Cope (2022) prior using a maximum age of 29, which was consistent with the literature and the 2013 assessment (although one fish from the WCGBTS was aged at 33 years old).

The stock assessment for rex sole used Stock Synthesis version 3.30.21 and estimated R_0, selectivity, retention, extra standard error for the early and late Triennial surveys, and recruitment deviations. The assessment was classified as a data moderate Category 2

assessment, meaning that age data are encouraged to be used externally to inform parameter values.

Fits to the data were poor in the pre-STAR assessment and the catchability (q) for the WCGBTS was fixed at 3 because it was estimated at a value greater than 19. Patterns in residuals were observed in the fits to the WCGBTS index and in the Pearson residuals for the fits to the WCGBTS length compositions. The predicted length comps overpredicted the proportion of large fish and underpredicted the proportion of small fish.

At the meeting, the STAT was requested to conduct a number of analyses including: 1) updating latitudinal strata for length data and revised historical catch reconstructions available after the pre-STAR assessment draft was completed; 2) examine sex-specific graphics of growth fits; 3) implement dome-shaped selectivities for the Triennial fisheries, while estimating a float catchability with asymptotic selectivity for the WCBTS index; 4) estimate dome-shaped selectivities with the float option for all fisheries; 5) fit female and male growth curves in the assessment model using conditional age-at-length from the WCGBTS (e.g. the same data that were used for the external analysis); 6) Investigate whether a higher sigmaR can improve fits to the WCGBTS indices and length compositions; and 7) based on previous requests implement a reweighting of the models with conditional age-at-length data and internally estimated growth for selectivity assumptions, a) estimating dome-shaped selectivity for all fleets and b) fixing selectivity asymptotic for all fleets. These were the exploratory analyses designed to redefine the base model.

The re-defined base model incorporated differences from the pre-STAR proposed model. These included 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. This model emerged after the exploration of various attempts to improve the fits to the data, reduce the estimated value of catchability for the WCGBTS index, and provide a converged model. Exploring dome-shaped selectivity also improved the fits to the data and reduced catchability for the WCGBTS index.

Additionally, the Panel had the STAT determine values of natural mortality (M) that would correspond to the 12.5% and 87.5% percentiles of the 2023 overfishing limit (OFL) estimate from this new base model and then revise the structure of the decision tables to include P*'s of both 0.4 and 0.45.

As with most assessments, major axes of uncertainty are steepness, M and limitations of aging data. These are discussed further in **TOR 6**.

Shortspine Thornyhead

The base model was implemented using three fishery fleets: North trawl (the waters off Washington and Oregon), South trawl (the waters off California), and coastwide Non-trawl, and three survey fleets: the Alaska Fisheries Science Center (AFSC)/NWFSC West Coast Triennial Shelf Survey (Triennial Survey) from 1980-2004, which was divided into early (pre-1995) and late period (post-1995) to account for a change in depth-sampling, and the NWFSC West Coast Groundfish Bottom Trawl Survey (WCGBTS), from 2003-2022.

New maturity analyses of samples collected in the WCGBTS in 2011, 2013, 2014, 2016 and 2018 were available for this assessment. The larger number and better spatial coverage of these samples allowed the use of statistical modeling to better understand the spatial variation in the proportion of females spawning. This assessment also assumes a new fecundity relationship, in which fecundity is modeled as a power function of length. New growth curves were estimated which were similar to the curves assumed in the 2005 and 2013 assessments. This assessment fixed steepness at 0.72. Natural mortality (M) was also slightly updated, from 0.0505 in the 2013 assessment, to be fixed at 0.04.

This assessment uses Stock Synthesis 3 (version 3.30.21) and estimated 180 parameters. The log of the unfished equilibrium recruitment, $ln(R0)$, controls the scale of the population and annual deviations around the stock-recruit curve (135 parameters) allow for more uncertainty in the population trajectory. In addition, 43 selectivity and retention parameters for the three fishery fleets and three surveys allowed for estimation of annual length compositions and discards rates. Two catchability parameters were analytically computed from the data, and one additional parameter, representing additional variability in the early Triennial survey, was directly estimated by the model.

The STAT was to requested to conduct a number of analyses including: 1) organizing a table of sensitivity results for ease of comparison; 2) provide graphics of the data a fits of the length-weight relationships for easier evaluation; 3) additional sensitivities of M=0.045 and 0.05 with the suite of consequences as in the table mentioned in 1); 4) investigate alternative time blocks for periods prior to 2000 for selectivity and q determinations; 5) examine predicted recruitment and recruitment deviations for the time blocks; and 6) compare to a model with recruitment deviations beginning at the starting year.

Given those results, the re-defined base model included: a) inclusion of at-sea hake catches, b) updated selectivity and retention blocks, c) updated weight-length parameters, d) main period of recruitment deviations specified as 1901-2018, and e) the maximum bias correction for recruitment deviations at 0.3.

Additionally, the Panel had the STAT determine values of natural mortality (*M*) that would correspond to the 12.5% and 87.5% percentiles of the 2023 overfishing limit (OFL)

estimate from this new base model and then revise the structure of the decision tables to include P*'s of both 0.4 and 0.45.

As with most assessments, major axes of uncertainty are steepness, M and limitations of aging data. These are discussed further in **TOR 6**.

TOR 4. Provide constructive suggestions for current improvements if technical deficiencies or major sources of uncertainty are identified.

I am interpreting suggestions for "current" improvements to be those improvements that can be made to the final base model that is submitted to the SSC and supporting information to be presented to the Council. Therefore, current improvements are the changes to the base model recommended by the Panel and by me as a Panel member and modifications that were given in **TOR 3** and highlighted here.

Copper Rockfish

The Panel recommended that the base model use two time blocks for catchability (2007-2016 and 2017-2022; same as current selectivity) in the CCFRP index of abundance in the North model in order to address possible underfitting and to allow some characterization of survey expansion during this time period.

Rex Sole

The re-defined base model incorporated differences from the pre-STAR proposed model. These included 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.

Shortspine Thornyhead

The Panel recommended a re-defined base model that included: a) updated at-sea hake catches, b) updated selectivity and retention blocks, c) updated weight-length parameters, d) main period of recruitment deviations specified as 1901-2018, and e) the maximum bias correction for recruitment deviations at 0.3.

Additionally the Panel suggested appropriate ranges of uncertainty for M in decision tables and the inclusion of alternative values for P* for all stocks.

TOR 5. Determine whether the science reviewed is considered to be the best scientific information available.

North California Copper Rockfish

In my scientific opinion the science reviewed at the June 5-9 meeting and the recommended modifications to the base model given in the Summary Report represent the best scientific information available for North California Copper Rockfish

South California Copper Rockfish

In my scientific opinion the science reviewed at the June 5-9 meeting and the recommended modifications to the base model given in the Summary Report represent the best scientific information available for South California Copper Rockfish

Rex Sole

In my scientific opinion the science reviewed at the June 5-9 meeting and the recommended modifications to the base model given in the Summary Report represent the best scientific information available for Rex Sole

Shortspine Thornyhead

In my scientific opinion the science reviewed at the June 5-9 meeting and the recommended modifications to the base model given in the Summary Report represent the best scientific information available for Shortspine thorny head.

TOR 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.

Following is the list of research suggestions made by the STATs and agreed to by the Panel (including further Panel suggestions for research directions) with each of these assigned a long- or short-term time frame. Note these assignments are my opinions and not necessarily those of the Panel, at large. At the end of the response to TOR 6, I include a more detailed discussion (including some analytical support) about stock-recruitment and future research.

Copper Rockfish

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. ***(short-term).*** Finally,

increased spatiotemporal sampling around Point Conception would aid in identifying stock boundaries ***(long-term).***

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 ***(long-term).***

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 ***(long-term).***

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 ***(long-term)***.

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 ***(short-term).***

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 ***(short-term or determined to be unresolvable).***

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 ***(long-term).***

The genetic stock structure of copper rockfish warrants further investigation to ensure appropriate management of copper rockfish along the U.S. West Coast ***(long-term).***

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 ***(short-term to decide if it is a useful avenue).***

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 ***(long-term).***

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 ***(long-term).***

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 ***(long-term).***

Continue to improve historical catch reconstructions, including attempting to quantify uncertainty with these and other historical data. 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***(short-term to determine whether alternative reconstructions are "better" and to propose variance estimates. This technical limitation is common to all assessments in this review).***

There is a need to consider the implications of management on each sub-area and how to present these to managers ***(short-term).***

Rex Sole

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 ***(short-term to suggest alternative reconstructions, but unlikely to get "further information on historical discards").***

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. Gonads are collected in good numbers from the WCGBTS, but none have been processed for maturity ***(short-term to examine existing samples and one-off maturity studies).***

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 ***(short-term).***

Catchability is an ongoing concern and major source of uncertainty in the model ***(long-term ongoing need to investigate alternative modeling approaches).***

Shortspine thornyhead

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. Additional investigation into growth patterns would provide valuable information for future population projections ***(long-term).***

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 ***(long-term).***

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 ***(long-term).***

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 ***(long-term).***

Further research into the Dirichlet-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 ***(short-term).***

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. ***(short-term).***

General Comments on stock-recruitment (SR), SS3, steepness (h) and reference points.

This section is a discourse on the specifications of SR and their role in assessments. This leads to some suggestions for medium-term simulation research leading to "best practices for future stock assessments

The SR model used in these (and most) assessments is the Beverton-Holt (BH) model whose underlying dynamics is driven by the equation $dR_t/dt = -ARt-BR_t^2$. When the initial condition for R is denoted by the spawning output S, then the BH SR function is $R_{\Delta t}= S \exp(-A\Delta t)/ (1 + B S (1-\exp(-A\Delta t))/A\Delta t)$ where Δt is the duration of the recruitment process. This collapses into the more normally used form of R=alpha S/(1+beta S). An important feature of a BH process noted by Beverton-Holt themselves is that a series of BH-processes interjected with density-independent mortality periods is collectively a BH process. Thus, we model the entire recruitment duration using parameters alpha and beta without having to know details of the parameters in the subintervals of Δt.

Again normally, we assign $\Delta t=1$ and the parameters are scaled accordingly. Thus, if we impose a density-independent mortality factor -M at the end of a BH process, it too is a BH process and the steepness remains the same. Therefore, any perceptions (priors) for steepness are not affected. But this is not the case if the adjunct period is density-dependent.

So this brings us to SS3. The standard application of BH in SS3 is that BH process starts with spawning output at a specific time during a year (usually at the beginning of the year), then covers an undefined period $\Delta t1$ in which the BH model is imposed and where $\Delta t1$ is less than the one year of age 0. Then this is followed by a factor $\exp(-(M')\Delta t2)$ where again $\Delta t2$ is undefined but implicitly the two delta periods end up at the beginning of age 1. Again normally, the $(M')\Delta t2$ is characterized simply as M, whose basis relates to

natural mortality of ages 1 and older. Since BH parameters self-scale to the process duration, this usually is not important, as long as the Δt2 period is density-independent. In these applications of SS3, recruitment is depicted as the R when the density-dependent phase (Δt1) is completed. Then the phi=S0/R0 derived from life history relates to the R0 at the end of the undefined period Δt1.

This raises the question how long is (Δt1)? Is it very short 1 or 2 days? In which case in the rest of the year you have a natural mortality rate like M=0.2? Or is (Δt1) long , in which case (M')Δt2)=0.2 implies an extremely high M' for just a couple of days. Obviously, this is unanswerable and the solution is to simply model BH recruitment as occurring at age 1 and let any density-independent stages during age 0 (if they exist) be absorbed into the BH parameterization. This avoids having to decide if there is a lagging density-independent stage during age 0.

Despite my above discussion, the implications for the relevant aspects of an assessment are usually not a big issue. This appears to be the case here with the four assessments. Where one could go wrong, though? The first instance would be if the M=(M')Δt2 were large. Then interactions of R deviations (and sigmaR) with M=(M')Δt2 could be important. The second instance would be if a Lorenzen M at age model is used. The theory behind Lorenzen is based on life-history characteristics that relate to allometric-type weights at age and other life history characteristics and NOT to the mortality processes of recruitment. And the third case is when there are catches or discards occurring during age zero at the same time density-dependence occurs. When this happens an alternative catch equation should be used. And the assumption that the Δt2 period is density-independent becomes more critical. Fortunately, in the case of these four assessments there does not appear to be any significant F on age 0.

Steepness and reference points:

In these four assessments, the steepness was specified per the guidance of the SSC and then evaluated through likelihood profiles. The guidance specified priors for h that were to be used and then noted that without further statistical support that h be specified from the mean of the prior. Given those marching orders, the assessments were constructed and outcomes were compared to SSC and Council reference points. Here, I note that the specification of h in a BH model fully specifies the equilibrium relationship between S/S0 and SPR and the SPRmsy and Smsy/S0 is also "almost completely" specified by h. The equilibrium relationship between SPR and S/S0 using a BH SR function is

$$\frac{S}{S_0} = \frac{SPR - ((1-h)/(4h))}{1 - ((1-h)/(4h))}$$

Additionally, using the concept of maximum excess recruitment (MER where the slope of the SR function is equal to R0/S0), then

$$SPR_{MER} = \sqrt{(1-h)/(4h)}$$

SPR_{MER} differs from SPR_{MSY} due to selectivities of the various fisheries, but those differences are usually small as was the case in these four assessments. So, the point is that the specification of h is tantamount to specifying Smsy/S0 and SPRmsy and that given h, the choice of a particular FSPR as a management target or as a buffer implies a specific equilibrium SPR and S/S0 outcome. And you don't have to do an assessment to determine this. These concepts are largely to be considered in the Council/SSC fora. I am simply arguing that if h is specified, then the associated reference points should probably be consistent with that specification. I am also arguing that if h is specified, then, theoretically, there is no need for a surrogate for FMSY and for Smsy/S0. By specifying h, those quantities have already been chosen. Or alternatively, if a surrogate of Smsy/S0 is being used that is different from the one derived from h , then the implication is that h must therefore be mis-specified.

As examples of the relationships, results choosing h=0.72 (the groundfish prior) and the SPR S/S0 relationships for alternative h are shown in Table 1 and Figure 1.

Table 1
Steepness=0.72

SPR MER	0.312		
SMER/S0	0.238		
	SPR		S/S0
SPR given S/S0=0.1	0.188	S/S0 given SPR=0.1	0.003
SPR given S/S0=0.2	0.278	S/S0 given SPR=0.2	0.114
SPR given S/S0=0.3	0.368	S/S0 given SPR=0.3	0.225
SPR given S/S0=0.4	0.458	S/S0 given SPR=0.4	0.335
SPR given S/S0=0.5	0.549	S/S0 given SPR=0.5	0.446
SPR given S/S0=0.6	0.639	S/S0 given SPR=0.6	0.557
SPR given S/S0=0.7	0.729	S/S0 given SPR=0.7	0.668
SPR given S/S0=0.8	0.819	S/S0 given SPR=0.8	0.778
SPR given S/S0=0.9	0.910	S/S0 given SPR=0.9	0.889

Relationship between equilibrium R/R0 with SPR and S/S0 for alternative steepness.

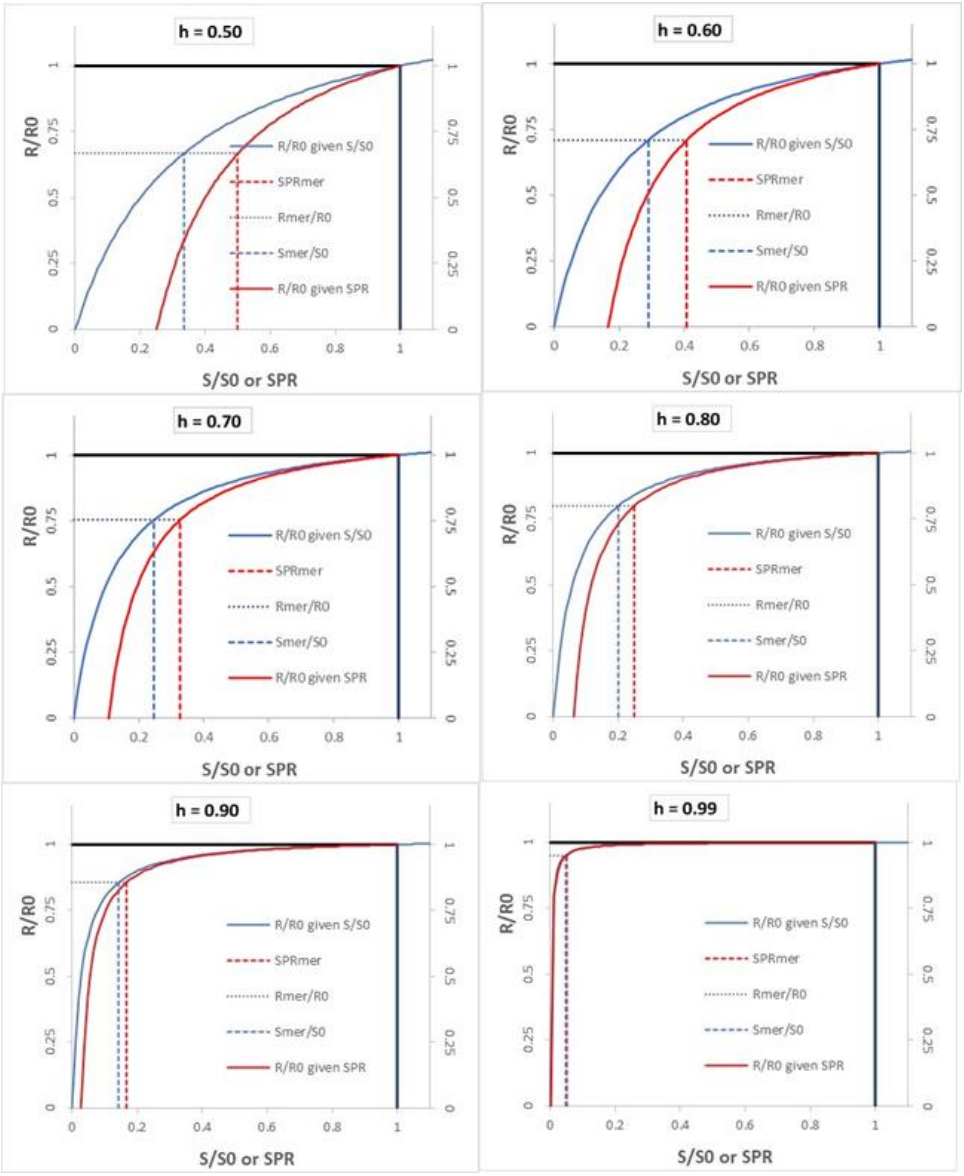

Figure 1. Relationship between equilibrium R/R0 with SPR and S/S0 for alternative steepness.

I note that the standard terminology used in these assessments used in the figures and tables was “management target” which was S/S0 =0.4 for copper rockfish and thornyhead and 0.25 for rex sole. As noted in the above table, S/S0 =0.4 with h=0.72 implies an equilibrium SPR of 0.458.

As an aside, it was unclear to me what “management target” meant in the continuum of ABCs, ACLs, OFLs and ACTs. But those more familiar with the process seemed to have a common understanding. And these were simple calculations and not a factor of the assessment analyses, themselves.

SigmaR, recruitment deviations, M and h:
Key "axes of uncertainty" in these assessments, and in almost all assessments are M and steepness. I would argue more generically that these axes are manifestations of the SR function. *To wit*: h fully specifies the SR function on scaleless axes of R/R0 and S/S0. Then the two scales are established by estimating R0 and the life-history based ratio (S0/R0). In determining (S0/R0) the factor with least support from data is the M vector over the life span of the fish.

Standard practices are to assume lognormal deviations from the SR model with the size of the deviations driven by sigmaR. This allows us to utilize size and age data to better define year-class strength which is important in determining recent/current population levels and the effects of short term projections. However, unless the time series of size/age data are very long, imposing deviations are seldom (if ever?) informative about the shape of the SR function. On the one hand these assessments assume h is known and on the other hand allowing sigmaR's of 0.5 and higher are giving the model flexibility to somewhat "ignore" the h specification.

During the meeting, sigmaR likelihood profiles of 3 of the stocks were examined. Results Additionally, the constraint that ln(R deviations) should sum to 0 was examined for one stock. The panel conclusion was, in that case, to keep the constraint as it had little effect. I agree with that way to go forward for that assessment, but I am reminded that this is based upon assuming that the SR model (i.e. h) is correct. Given what little information is available to define h either internal to an assessment or externally, it would seem that imposing the constraint sum(ln(R deviations))=0 is a bit much to ask. For example, what is the basis for our assumption that sigmas for R deviations at small stock sizes are the same as at large stock sizes? It may make the estimation process a bit more stable, but it is unlikely to model the underlying SR process adequately.

My recommendation from this discussion is that there is a need for simulation research which explores the relationship of h, M and SigmR and the statistical structure of the sigmas (alternatives to lognormal, shifting sigmaR vs S, etc) . We usually consider these choices independently from one another, or not at all. This research is beyond the scope of a single assessment and could probably be achieved in 2-4 years.

TOR 7. Provide a brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations.

The review was conducted in a constructive manner and the STAT teams were responsive to the requests from the Panel for additional analyses with all the essential runs being completed during the meeting. Those issues were referred to in the TOR 3 response

These included: late updates of catch and size data sets, alternative selectivity assumptions that better explained the observed data, appropriate assumptions on natural mortality, steepness and sigmaR and discussions on the states of nature for decision tables. Overall, there was effective engagement from all members of the Panel, the STATs and the Panel advisors. This led to improvements in the configuration of the base models.

TOR 8. CIE Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

The review process functioned well in that the meeting time was fully utilized, interactions were collegial and productive and important elements of the four assessments were explored. The meeting itself was constructive and productive with effective and excellent co-operation from the STAT teams. Meeting facilities were good, and the local staff provided great support to the reviewers.

In terms of scheduling. the guidance given in the Pacific Fisheries Management Council Terms of Reference for the Groundfish Stock Assessment Review Process for 2023-2024 (PFMC TORs) is: *"The number of groundfish assessment models reviewed per panel should ideally be two, except in extraordinary circumstances if the SSC and NMFS agree that it is advisable, feasible, and/or necessary, taking into account multiple area models per species or the potential for also reviewing data-moderate assessments in the STAR panel".* In the present case of STAR Panel 1, four assessments were evaluated within the 5 day meeting: copper rockfish of North California, copper rockfish of South California, Rex Sole and Shortspine Thornyhead. The former two were full benchmark assessments, whereas the latter two were designated data-moderate. It is unclear in the guidance whether data-moderate assessments require more or less time for evaluation/review than benchmarks. Nevertheless, under the advice and leadership of the STAR Panel 1 chair, we spent approximately one day for evaluation and re-evaluation (based on request responses by the STAT) plus ¼ day for Summary Report writing for each of the four stocks. The SSC/NMFS/Council must have considered STAR Panel 1 an "extraordinary circumstance", but judging by the schedule for upcoming STAR Panels 2 and 3, those circumstances are not really so extraordinary. Clearly, the SSC/NMFS/Council is aware of the trade-offs of this type of scheduling, but they bear repeating here. Time limitation did not allow some detailed examination of (for example) some index data, joint interactions of choices for steepness and M (typically the axes of uncertainty in assessments) and with SigmaR. These

items and others were highlighted in **TOR 6** and in the **Panel Summary Report** and were, thus, relegated to future analysis/research. This is not a complaint by me as a CIE reviewer or by the Panel. It is just a statement that this review, as all reviews, provide best advice under the organizational constraints given. But I wish to give my support to the original guidance in the PFMC TORs that the number of assessments for a single STAR Panel meeting should ideally be two.

Conclusions and Recommendations in Accordance with the ToRs.

The assessments of copper rockfish, rex sole and shortspine thornyhead represent the best science available given the existing data. The analyses were thorough and considerable work had gone into making good use of data from a variety of sources. The limited amount of age data and lack of informative fishery independent abundance indices means that despite the complexity and detail of the assessments, there remains some uncertainty in estimated stock trends. If these stocks are of sufficient importance, the research suggestions in TOR 6 form a template to address that uncertainty.

As usual, natural mortality and the stock-recruitment (h, M and sigmaR). There is a need to examine through simulation the best practices for specifying their relationships.

STATs and other assessment bodies should consider the implications of the duration of recruitment in their assessment models.

SS3 has a wide use and has a large array of options and diagnostics. Some additional thought is needed on the trade-offs of model complexity and the management needs for short-term forecasts of sustainable catches.

The review meeting was constructive and productive with effective excellent co-operation from the STAT teams. Meeting facilities were good, and the local staff provided great support to the reviewers. There were no major disagreements between Panel members or the STAT.

Appendix 1: Bibliography of Materials Provided for Review

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, Oregon. 309 p.

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, Oregon. 344 p.

Min, M., E. Sellinger, T. Wang, S. Beyer, A. Hayes, A. Rovellini, I. Spies, M. Veron. K. Wang, S. Wassermann, V. Gertseva, K. Oken, O. Hamel, M. Haltuch. 2023. Status of rex sole (*Glyptocephalus zachirus)* along the U.S. west coast in 2023. Pacific Fishery Management Council, 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. 139p.

Additionally, zipped files of model runs were provided.

Appendix 2: CIE Performance Work Statement

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 and 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:

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),

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

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-assessmentprioritization-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.

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

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.