Center for Independent Experts (CIE) Stock Assessment Review (STAR) of Vermilion and Sunset Rockfishes

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Paul A H Medley
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1 Executive Summary

- Four stock assessments were reviewed for the combined vermilion and sunset rockfish in California South, California North, Oregon and Washington waters.
- The stock assessments met the requirements laid out in the "Terms of Reference for the Groundfish and Coastal Pelagic Species Stock Assessment Review Process for 2021-2022".
- During the review meeting, apart from the wide-ranging sensitivity analyses conducted by the stock assessment team (STAT), various additional technical issues were explored including evaluation of the effect of early data, effects of natural mortality assumptions, and various alternative treatments for the available index data, particularly selectivity, in relation to management controls known to have been introduced. Technical issues with these assessments were resolved to the mutual satisfaction of the STAR and STAT.
- I believe that the stock assessments provided the best scientific information available and are adequate for use in setting catch limits and other controls for these stocks.
- My main recommendation is to extend the NWFSC fishery independent hand line survey coastwide. This will provide important information on relative abundance along the coast and over time for several rockfish species.
- This report provides my findings, conclusions and recommendations, and can be read independently of the separate Review Panel's summary report.

2 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 marine living resources in US waters based upon the best scientific information available (BSIA). For stocks within waters under the auspices of the Pacific Fishery Management Council, scientific advice is obtained through a stock assessment review (STAR) process, which includes a review panel meeting. STAR panel meetings are technical reviews of completed assessments, but may include reasonable alternative sensitivity runs, additional analyses as well as additional details on the proposed base model.

To ensure scientific advice is independent and credible, a formal external process for independent expert review forms an important part of the STAR process. To this end, qualified scientific experts are recruited to the CIE program and charged with conducting their peer review impartially, objectively, and without conflicts of interest. The reviewers were independent of the development of the science, and without influence from any position that the agency or constituent groups may have. Further information on the CIE program may be obtained from www.ciereviews.org.

This report addresses the Vermilion and Sunset Rockfish Complex (*Sebastes miniatus* and *S. crocotulus*) assessment STAR panel meeting. These cryptic species were assessed as a single species. Until 2008, when sunset rockfish were formally identified by genetic analysis, they had always been considered a single species, and most data sources do not distinguish between them. Sunset rockfish are generally seen only as far north as Point Conception,

California (34° 26’ N. Lat.), the northern extent of the Southern California Bight and tend to be found in deeper water.

Vermilion rockfish, a commercial and recreational species, is managed as part of the two Shelf Rockfish Complexes, which are delineated as occurring North and South of 40° 10’ N. Latitude. A previous assessment for vermilion rockfish was conducted in 2005, for California stocks north and south of Point Conception, and determined that the stock status at that time for the northern stock was between 41% and 89% of unfished biomass, and the southern stock was estimated to be between 30% and 88% of unfished biomass.

The assessments subject to this review cover the U.S. West Coast, from the U.S.-Canada border to the U.S.-Mexico border, divided into four stocks: Washington, Oregon, and California north and south of Pt. Conception. It is believed that only the southern California model will have any significant contribution of Sunset Rockfish. 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 took place during a formal, public, multiple-day virtual meeting of fishery stock assessment experts 26-30 July 2021. The STAR panel review produced a consensus panel report. This report does not repeat that report but provides my personal findings and recommendations on the stock assessments. There were no conflicts between my findings and the other panelists. The structure of this report is different in that it follows the ToR for independent reviewer (see Appendix 2. Individual Independent Peer Reviewer Report Requirements).

3 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) prior to review panel meeting.

Full documentation, including the data and model, were provided ahead of the meeting so it could be reviewed before the meeting took place. The documentation was very good and included background information that explained various decisions leading to the stock assessment approach. The detail was complete, including the SS3 data and control files, with full output. This made it easier to follow the assessment process and check details rapidly, reducing the number of requests from the STAT, saving time which was at a premium given the meeting had to be carried out remotely.

Although the number of stock assessments to review exceeded the default number in the STAR panel Terms of Reference for 2020-22, the assessments were all effectively for the same species and applied very similar models. Reviewing all four simultaneously was very efficient because many of the components and issues were shared. It was recommended that a similar approach should be applied in future for these stocks.

The stock structure (4 separate management units) was reasonable and consistent with habitat distribution, current exploitation and history, and known genetics. The stock structure was reasonably well supported, and it is unlikely that this is an important source of uncertainty, except the California South stock might be shared with Mexico where catches are substantial. However, it has not been fully determined and climate change could create problems for separate harvest strategies in future. For example, it may prove useful to

restructure the separate assessments as linked stock components, particularly if sunset historical catches might be reasonably separated from vermilion catches, for example. Continuing to conduct stock assessments for all four populations at the same time will help with future decisions on this issue.

All models were two sexes (some differences in growth were accounted for). However, the California South model, at least, was combining two species, and it is unclear what the relative proportions are in the fishery. The two species are very similar. They are difficult to tell apart and very likely have similar life history and biology, so the population dynamics should also be similar. It is therefore reasonable to combine these species in the stock assessment where data have not separated them historically until it can be shown that there is a better approach.

The main differences between the assessments were:

- The California South assessment included a mix of two species: vermilion and sunset rockfish, whereas the California North, Oregon and Washington assessments would be expected to be predominantly vermilion and therefore more like a single species assessment.
- The California assessments had fishery independent and dependent abundance indices, whereas Oregon used a single fishery dependent index and Washington had no abundance index.
- The data sets decreased in size generally in line with the decreasing catches from South to North. Washington is considered close to the edge of the effective northern range for vermilion rockfish, so stock size and productivity was expected to be lower in this region. However, the species is reported from Alaska, so it is widespread even if not abundant in the north.
- Oregon and Washington had to borrow information from California (on maturity, fecundity, and priors on mortality, growth and steepness), which makes the population dynamics more similar.

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

In general, both data and models were of high quality and no significant deficiencies were found during the review. Catches in the Northern stocks, particularly Washington, were very small and therefore the fisheries and data sets were small, albeit they make up an important component of the shelf rockfish complex. Given the size of the fishery, the amount of information in terms of data was relatively high. These fisheries benefit from the data collection system covering all rockfish stocks.

The data obtained from the recreational fishery was particularly good. Obtaining data from these fisheries is often difficult, but information presented and model diagnostics suggest these fisheries data are accurate and the methods used to obtain them sound. Recreational fishery data was available for all four assessments and included age, length, total catch and catch-effort data, although not every type of data was available in all cases. For example, age data were missing for recreational fishery in California, but available for the recreational fishery in Washington and Oregon, dependent on the State sampling programs.

The commercial fishery was significant in California only, but again provided significant total catch, length and catch-effort data where it was available. The more recent data collection programs have recorded more variables on trips (for example, the CDFW CPFV onboard observer surveys provide consistent information on location and depth), which should lead to improvements in abundance indices and other information from these fisheries.

Information on discarding appeared to be relatively good compared to many fisheries. The onboard observer programs helped with this. Discards are unlikely to be a significant source of error for these fisheries.

Although the fishery data were of good quality, significant gaps were identified, usually in historical data. Early landings needed to be reconstructed for all fisheries. In common with most fisheries, early data collection included species groups, so some assumed proportional separation is required. This can add to uncertainty, but in this case these early catches that had not been properly divided were small, so the uncertainty made little difference. For example, vermilion rockfish catches were estimated in Oregon back to 1891 but were negligible to 1930. Such reconstruction is standard practice and generally results are robust to this if the reconstructed catches are not large and in the distant past, as in this case. In any case, this issue was explored to some extent by estimating the recruitment deviates for the full time series (see below).

The hand line surveys provided the most useful fishery independent data for the Californian stock assessments. This type of survey is well-suited to the species and vermilion / sunset rockfish formed a significant portion of the catch. The trawl survey indices were not used with good reason, but the length and age compositions were useful. Catches of vermilion were very small and the trawl actively avoids vermilion habitat making it inappropriate as an index.

Some concern was expressed during the meeting over the NWFSC California handline survey. It is multispecies, and it is possible that there is competition for or saturation of hooks, so the abundances of species at various sites affect each other's catch rates. A single model estimating the abundance of all species simultaneous rather than separate models for each species may work better as such a model would be able to account for this sort of affect if it is present, as well as being more parsimonious and make use of correlations between species as used in the VAST model. However, given the sampling protocol (the fisherman can retrieve a standard hooked drop line up to or before 5 minutes bottom time is up), it seems unlikely that results would be significantly different to the single species index.

The available length-age data were relatively good considering that the catches for some fisheries were low. These data were clearly informative on growth and mortality, which provided the main supporting information for the stock assessments. The Committee of Age Reading Experts (CARE) exchange program appeared to help improve readings as well as provide good estimates of errors. In the case of Washington, the estimated age reading errors appeared to large and were not used in the assessment, but this did highlight an age reading problem which otherwise might have been missed.

Oregon and Washington catches have been much lower than California, so data were more limited. For example, maturity and fecundity ogives were borrowed from California, which was reasonable given this is the same species.

For the catch-effort standardization, data were filtered to remove records which were unlikely to be contributing information on the abundance of the target stock. It was unclear to me whether this was always the best approach.

Some reservations were expressed by members of the STAT over use of the Stevens-MacColl filtering for identifying trips to be included in the fishery dependent indices. The species associations may not work so well for hook and line recreation which may include live discards, for example. Clearly, some records need to be excluded as not relevant to these stock assessments, but more use might be made of the standardization model to make relevant corrections where a wider range of data are included. However, where this issue was explored (removal of seasonal data in Oregon), it made little difference to the results. In general, I found that the STAT had made well-reasoned choices, and this is a minor quibble. It was also indicated that there would be a workshop on this issue and more generally this underlines that fishery independent indices are useful as checks on these sorts of problems that occur in fishery dependent data.

The SS3 software is mature, flexible and robust, and a significant improvement on previous data-limited stock assessments applied to these fisheries. There is considerable support for the modelling framework, so diagnostics and results are fully reported. In my experience, the main limitation with SS3 is the assessment of uncertainty, although this may not be a significant problem dependent on how results are presented. Uncertainty was well captured in sensitivity runs, likelihood profiles and other diagnostics. However, in data limited situations (e.g., the Washington stock assessment), observation and process error may be better captured with Bayesian framework. For example, the asymptotic variance assumption (estimates are normally distribution and their variance is estimated from the Hessian matrix) can be a poor approximation of the probability density of parameters where they are bounded, and the standard errors are large. Techniques such as MCMC will address this but can be difficult to implement.

The fact that many parameters could be fitted as opposed to being fixed, even for the low data assessments, supported the conclusion that the data were of high quality and the stock assessments were well founded.

Management interventions to adjust exploitation of difference species in the rockfish complexes affects the information going into the stock assessments. This is unavoidable. Fishery dependent information is particularly sensitive to this issue and is one of the arguments for having fishery independent surveys.

While the assessments were well founded and seemed to be robust to uncertainties that have been identified, this was the first full assessment and first time an integrated stock assessment model had been fitted successfully for these fisheries. Therefore, it made sense to recommend a full assessment for all four stocks again. New research and data collection is being conducted which could have implications for these stocks, including a workshop on the hand line survey and new genetics research (e.g., Saltonstall/Kennedy research).

As well as the work reviewed by the panel, additional exploratory analyses were reported by the STAT before settling on the proposed approaches which they presented. These included alternative modelling approaches for the catch-effort standardization (e.g., compound Poisson-gamma instead of the delta log-normal, Bayesian GLM) and stock assessments (Bayesian catch-at-age model). This demonstrated an active search for improvement.

5 ToR 3: Evaluate model assumptions, estimates, and major sources of uncertainty.

Within the US waters, the assumed stock structure is reasonable and small adjustments on boundaries are not likely to make much difference. A more significant issue relates to shared stock with Mexico in the south and to a lesser extent Canada in the north. This can only be addressed in the long term by setting up joint stock assessment meetings where data are shared. In absence of international stock assessment, what has been done is precautionary, but there is still considerable uncertainty over how much control the California fishery has over exploitation levels for the southern stock.

For California South, it is assumed that vermilion and sunset rockfish population dynamics are very similar so that they can be reasonably treated as a single unit. This is a reasonable assumption, but it is unclear what the full implications are. While the life history and associated model parameters are likely to be very similar, it is also assumed that they are similarly catchable, so that they would be harvest to the same comparable level.

For all the assessments, natural mortality was a critical uncertainty. For California South, steepness was also identified as critical and related to natural mortality. These parameters indicate stock productivity, so significantly affect management decisions.

Given that results were sensitive to natural mortality, the significantly higher natural mortality estimated for California South was a concern. It might be expected to observe clines in parameters across a species range, but there appeared to be a discrete change between North and South California. It is possible that this is because the Mexico catches are unaccounted for.

Particularly for habitat-limited site-attached species, it is possible that density dependence extends into the adult stage. There was no evidence that natural mortality was decreasing with age, which is a pattern that might be expected if density dependence is a factor in mortality. A test of length specific natural mortality requested by the review panel also provided a general test of model structure in relation to differences in mortality of younger versus older fish. A concern was that the life history is not that well understood, and juvenile dynamics may be different, which would probably result in their higher mortality. The results suggested that this made little difference. This does not necessarily mean that the life history of juveniles is well modelled because the fisheries selected older fish, but it did indicate that this factor had little impact on the conclusions of the stock assessment. This is not a definitive test but does suggest that this issue is not worth pursuing at this stage.

Most selectivities are domed, which is reasonable for hook-based fisheries. If the asymptotic selectivity is close to the L_∞, it will make little difference anyway since the downward slope of the selectivity coincides with the reducing proportion of larger fish. At the asymptotic size, the selectivity curve is primarily confounded with the CV on the length at age.

There were no conflicting trends among the wide range of abundance indices in the California assessments. Several abundance indices were included in both assessments. Only one abundance index was available for Oregon and none for Washington, which was a concern.

Where applied, standardization did not alter the CPUE trends much. The standardization methods applied were rigorous and probably improved the precision of the index. However, the type of fishing and catchability had probably not changed much over the time series. The main concern on the fishery dependent indices were changes to regulations that could

potentially change selectivity. This was mainly expressed in the review panel requesting alternative selectivity blocks reflecting changes in fishing spatial distribution.

For California North, it was suggested to split the CCFRP abundance index selectivity based on introduction of MPAs. However, this does not account for potential interactions between selectivity and catchability. If possible, the standardization should perhaps attempt standardizing selectivity rather than introducing time blocks into the stock assessment. While sometimes necessary, time blocks may undermine the value of time series data.

A time block was introduced as a sensitivity run for the catch selectivity based on depth restrictions introduced in 2004 in Washington resulted in a small improvement in fit. However, the STAT tried alternative random time blocks and got similar results within a range (slightly better or slightly worse), suggesting that the original selectivity block was not explaining any real effect even if slightly "statistically significant". This was a useful test for introducing this sort of addition to the model, since it tested the original justification for the change.

For California South, stock-recruitment steepness was also an important uncertainty. This parameter is also linked to productivity and is used to derive the maximum sustainable yield reference points, so can have a significant impact on setting catch limits. Whereas estimates of natural mortality may be improved by directed research or by improved data collection, opportunities to estimate steepness are limited. This might be only achieved by depleting the stock to low levels and monitoring the recovery ideally multiple times, which management wishes to avoid, or might be achieved by detailed understanding of fecundity, growth mortality through all pre-recruitment stages, which would probably only be achievable in the longer term.

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

No major deficiencies or major sources of uncertainty were identified that could be fixed in the short term. Longer term recommendations include extending the California hand line survey coastwide, revisiting the fishery dependent index standardization in some cases, and developing alternative Bayesian modelling approach (see ToR 6 and 11 Recommendations).

The estimates of stock status and productivity appeared reasonably precise, despite the uncertainties that were identified. The projected catches and attainments appeared to be a more significant uncertainty for the projections given mixed species catches and the effect of the COVID-19 pandemic on fishing activity.

7 ToR 5: Determine whether the science reviewed is considered to be the best scientific information available.

Within the constraints of the available data, the vermilion stock assessments reviewed represented the best science available. Specifically:

- The model made use of all relevant data and information on the species. A wide range of available data were considered and valid reasons for rejecting certain data were given.

- The STAT demonstrated rigorous analyses of their data from initial evaluation through to final results. The stages were well documented, and the full model and data were provided.
- The stock assessment software (SS3) has rigorously tested and is robust.
- Full diagnostics for the fits were undertaken and reported. These highlighted uncertainties in the fits and demonstrated the likely range of outcomes for future catches.
- No major conflicts were identified which might lead to a rejection of the assessment.
- All short-term improvements have been implemented in the stock assessments as far as could be ascertained. This was demonstrated by the wide-ranging sensitivities conducted by the STAT as well as additional runs requested by the STAR panel. Remaining recommendations are focused on longer term improvements.

8 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.

8.1 Short term recommendations

The fishery independent California hand line surveys provided important information for the California assessments. A workshop on these surveys' design and use in stock assessments would be valuable. The CCFRP is a hook-and-line survey that monitors groundfish populations at pairs sites inside and outside MPAs along the California Coast. The NWFSC hook-and-line survey provides abundance information across the Southern California Bight.

In the short term, it would be worth holding a workshop to discuss survey methods for the existing hook and line surveys in rockfish stock assessments and how to improve them for the future. Both the CCFRP and NWFSC surveys have potential value if they are expanded using broadly the same survey methodology. In addition, indices may benefit from a single multispecies model that estimates relative abundance for rockfish species simultaneously.

As soon as possible, the NWFSC hook-and-line survey should be expanded to cover rockfish habitat coastwide. This would provide data not only for vermilion and sunset, but all co-habiting rockfish species in similar habitat. The survey provided important information for the California South stock assessment.

For standardizing fishery dependent indices, it may be worth considering trying to standardize selectivity at the same time. There were a number of cases where it was thought that selectivity might have changed during the time series and alternative selectivity blocks proposed. However, this is a fairly blunt way to deal with this issue where catchability and selectivity are confounded. A change in selectivity changes the exposure of the population to exploitation dependent on its length and age composition, so the apparent catchability will also change. Accounting for these changes independently as catchability first, then selectivity second, may introduce inaccuracies. A standardization model could attempt to standardize the catch-at-length, which would remove more subtle changes in selectivity, such as changes only applying to part of the fleet, which otherwise the stock assessment model would struggle to explain consistently.

If possible, catches reported by Mexico of vermilion could be included in the California South stock assessment. If catches are unavailable, import data might provide a substitute. To a lesser extent for this species, the same argument applies to Canada where BC data reported for a species might be included in a sensitivity run to see whether it makes much difference to the management advice. There are a number of species in the Mexican Gulf as well as the Pacific that are shared stocks with bordering countries and the implications of this, if any, should be explored. If possible, joint meetings with Mexico could be convened to share data or discuss data collection initiatives on shared stocks of interest. However, even including gross catch estimates (based for example on import data) in sensitivity runs might be informative.

The review panel generally felt that Canadian catches would not be significant, but there is a significant recreational rockfish fishery in British Columbia and while catches of vermilion may be small, they may still be considerable relative to the small Washington catches. This is clearly not as important as the Mexican catch but testing whether including Canadian British Columbia catches improve the model fit may still be worth testing.

The asymptotic variance assumption (estimates are normally distributed) can be a poor approximation. It may be better to use a Gamma distribution, but it is not clear without research that this would be better. It would prevent confidence intervals including negative values where these are not possible (as for SSB for example), and the Gamma is very similar to the normal distribution when the CV is low. However, the normal distribution is derived from the central limit theorem and there is no equivalent argument for the Gamma. It may still be worth exploring this as a better approximation for these specific stock assessment indicators that have a boundary at zero which are clearly skewed.

8.2 Long term recommendations

The CCFRP survey is being used to evaluate various MPAs that have been introduced for conservation purposes. The survey also provides a useful rockfish abundance index in California waters. However, the survey could be particularly useful in providing contrast between fished and unfished areas, which might help estimate natural mortality and reference points (dependent on ongoing results from the tagging and survey). It may also be worth considering using the same survey catch method to apply intensive fishing to small areas to achieve a detectable depletion (a “depletion experiment”), which may then help estimate selectivity and species catchability.

Bayesian modelling could be usefully developed using the small Washington or Oregon data set as a test case. The test case could include a Bayesian SS3 model in Stan (I understand that this has been done). It could also include the standardization (for Oregon recreational data) within the stock assessment (so the model fits to the raw data as far as possible). The review panel gave this a “low priority”, but I think it should be considered a more long-term project to develop a Bayesian approach.

There are potential advantages in this approach. Specifically, it allows the decision making to account for uncertainty more accurately, in terms of parameter uncertainty. So, for example, rather than accounting for uncertainty in terms of a single input parameter (in this case natural mortality), the marginal probability of an output variable (e.g., current SSB) might be reasonably used to construct the decision table. This would be a more explicit illustration of risk.

The most important disadvantages of this approach are the difficulties with fitting and the lack of support for interpretation. While I have found Stan very effective in developing MCMC for bespoke stock assessments using non-standard data, the MCMC may still potentially take a long time to fit and may not fully converge within some reasonable timeframe. In practice this would require a standard procedure to deal with these circumstances which are bound to occur. Secondly, unlike SS3, output from Stan still need bespoke software. For this approach to mature, a package like "r4ss" is required, and some research might be useful on producing appropriate diagnostics equivalent to the wide range available from SS3. Therefore, further development would be necessary in Stan (or other reliable MCMC software) before complete assessments as presented in this case could be carried out.

For the California South stock assessment, it may be worth considering management strategy evaluations (MSE) to account for the likely impact of managing two cryptic species as the same stock. MSE have a reputation for turning into big, costly simulation exercises. In this case, I would suggest conducting a small, focused simulation using the stock assessment model as the simulation model and considering two populations with different sets of parameters varying by realistic amounts (considering the species similarity) to understand when this might create a problem for management. A problem could be defined as, strictly, the indicators show the stock is in good condition whereas one of the species is overexploited. By holding a workshop to determine the precise terms of reference for the MSE, it would keep the simulations focused on this particular issue and not attempt to deal with a wider range of uncertainties, which would expand into a much larger project. The simulations could be used to help determine the circumstances under which closely related species cannot be managed together as well as perhaps a pre-cursor for multispecies rockfish stock assessment.

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

The meeting was carried out virtually, so interactions between attendees within the meeting were limited. There were no technical problems encountered throughout, and meeting activities were completed without a problem.

For each of the four stock assessments, the STAT presented a summary of the stock assessment, including catch-effort standardization if any. This was followed by questions which led to relevant discussions on the data and how to best to extract information from the data using the model. For each stock assessment, the review panel identified possible concerns and requested runs to evaluate whether the model and results were sensitive to those concerns. Additional sensitivity runs that were requested were focused on:

- Changes to regulations that could have changed selectivity. In these cases, additional selectivity blocks were proposed.
- Freeing recruitment deviations at the start of the time series so that the initial structure could be fitted exactly. This reduced the effect of early data (which may be less reliable) on the stock assessment results.
- An alternative natural mortality model, making it length specific (following the Lorenzen model in SS3).

- Alternative weighting between the length, length-age, catches and index data. These were in addition to the considerable number of alternative weights (e.g., exclusion of particular data or applying more nuanced alternative weights between different information sources) run by the STAT.

Other sensitivities which in my opinion were less important consisted of attempting to estimate fixed parameters (steepness), and removal some data with justification, suspected to have been affected by unaccounted for factors. To support the construction of decision tables, the STAT was requested to produce some additional outputs and correct the recent Oregon recruitment deviate bias.

All sensitivities were relatively easy to implement in SS3 and were conducted within 24 hours of the request. All sensitivities and the results are described in the panel report.

The remaining time at the meeting was spent writing various sections of the panel report. This activity was continued into the following week.

10 Conclusions

Full age structure stock assessments were completed using Stock Synthesis 3 for vermilion/sunset rockfish in the four regions California South, California North, Oregon and Washington. The stock assessments were well documented, used all the available relevant data as far as I am aware and showed good robustness to uncertainty. Therefore, they represent the best scientific information available for management of these stocks.

There are a number of research initiatives carried out by the STAT that were mentioned during the review that led to their proposed base models. These illustrated to me that the STAT team had actively searched for ways to improve the assessments, which was commendable.

11 Recommendations

The following is a highlight of important recommendations. The STAR panel and ToR 6 provide more recommendations.

- Future stock assessments for these four stocks should be reviewed together in a similar process. Given this is the first full stock assessment using a full statistical age structure model, the next assessments should be full assessments.
- The NWFSC handline survey ideally would be extended coastwide. A consistent fishery independent survey would help monitor abundance for California North, Washington and Oregon as well as assess uncertainties in relation to stock structure and other issues.
- California South should seek and include Mexico vermilion/sunset catch estimates into the stock assessment.
- The standardization of fishery dependent CPUE should consider including length composition data in the standardization. The interactions between the abundance indices and the change in selectivity may continue to be an issue. The relative fraction of the stock being exploited depends on the selectivity function, which might be accounted for as a change in catchability and accounting for these separately may hide such an effect.

Appendix 1. Bibliography

Documentation for the meeting, stock assessment reports and all reports generated by the meeting were shared via the Pacific Fishery Management Council FTP site[1].

Meeting Documents

- accepted-practices-and-guidelines-for-groundfish-stock-assessments-february-2021.pdf
- Agenda stock-assessment-review-star-of-vermilion-and-sunset-rockfishes.pdf
- agenda-item-g-3-supplemental-revised-attachment-3-accounting-for-increased-uncertainty-in-setting-precautionary-harvest-limits-from-past-assessments.pdf
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OR

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OR Vermilion rockfish stock assessment_STAR.pdf

Presentations & Requests

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Copy of STAR Day 1 and 2 Requests_ Northern CA.pptx

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Response to Panel Requests, Southern CA, round 1.docx

Response to Panel Requests, Southern CA, rounds 1-2.docx

STAR Day 1 and 2 Requests_ Northern CA.pdf

STAR Day 1 Requests_Northern CA_Responses.pdf

STAR panel Day 1_ Vermilion biology, fisheries, data.pdf

STAR Panel Day 1_ Vermilion North CA model.pdf

STAR Panel Day 1_ Vermilion South CA model.pdf

WA_Vermilion_2021_STAR.pdf

WA

WA Vermilion Reference model-20210712T203431Z-001

Appendix 2. Individual Independent Peer Reviewer Report Requirements

Performance Work Statement

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Review (STAR) Panel 3 - Virtual

Vermilion and Sunset Rockfish

July 26-30, 2021

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. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).
Further information on the CIE program may be obtained from www.ciereviews.org.

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 OFLs, ABCs, ACLs, (HGs), and 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.

The Vermilion and Sunset Rockfish Complex (*Sebastes miniatus* and *S. crocotulus*) are to be assessed as a single species. Until 2008, when Sunset Rockfish were formally identified by genetic analysis, they had always been considered a single species, and most data sources do not distinguish between them. Sunset Rockfish are generally seen only as far north as Point Conception, California (34° 26' N. Lat.), the northern extent of the Southern California Bight.

Vermilion Rockfish have always been important both commercially and in the recreational fishery, going back to the 1940s. They are managed as part of the two Shelf Rockfish Complexes, which are delineated as occurring North and South of 40° 10' N. Latitude. One previous assessment for Vermilion Rockfish was conducted in 2005, for California stocks north and south of Point Conception, and determined that the stock status at that time for the northern stock was between 41% and 89% of unfished biomass, and the southern stock was estimated to be between 30% and 88% of unfished biomass.

The geographic range of the combined stock is from Prince William Sound, Alaska to central Baja California, Mexico, however this assessment will cover the U.S. West Coast, from the U.S.-Canada border to the U.S.-Mexico border. Four models will be used for this assessment: one for the Washington fisheries, one for Oregon, and two for California, north and south of Pt. Conception. Of these four models, only the southern California model will have any significant contribution of Sunset Rockfish.

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 an external, independent reviewer is an essential part of the review process. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

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 ToRs herein. Additionally, one "common" CIE reviewer will participate in all STAR panels held in 2021 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, and stock assessment technical teams. 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 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 with 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).

Test: Additionally, two weeks prior to the peer review, the CIE reviewers will participate in a test to confirm that they have the necessary technical specifications provided in advance of the panel review meeting.

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 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.

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 July 26-30, 2021. Due to current uncertainties in the state of the COVID-19 pandemic at that time, this meeting will be conducted 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 **September 2021**. 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.

Schedule	Milestones and Deliverables
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
July 26-30, 2021	**Virtual Panel Review Meeting**
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

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:
No travel is necessary, as this meeting is being held remotely.

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 3

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) 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.

1. The independent Peer Reviewer report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The report must contain a background section, description of the individual reviewers' roles 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. The independent report shall be an independent peer review, and shall not simply repeat the contents of the Peer Reviewer Summary Report.

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

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

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

   d. The report may include recommendations on how to improve future assessments.

3. The report shall include the following appendices:

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

Appendix 3. Panel Membership

STAR Panel Members

John Budrick, California Department of Fish and Wildlife (Chair)
Allan Hicks, International Pacific Halibut Commission
Matt Cieri, Center for Independent Experts
Paul Medley, Center for Independent Experts

Stock Assessment Team (STAT) Members

E.J. Dick, National Marine Fisheries Service Southwest Fisheries Science Center
Melissa Monk, National Marine Fisheries Service Southwest Fisheries Science Center
John Field, National Marine Fisheries Service Southwest Fisheries Science Center
Tanya Rogers, National Marine Fisheries Service Southwest Fisheries Science Center
Jason Cope, National Marine Fisheries Service Northwest Fisheries Science Center
Ali Whitman, Oregon Department of Fish and Wildlife
Kristen Hinton, Washington Department of Fish and Wildlife
Theresa Tsou, Washington Department of Fish and Wildlife
Corey Niles, Washington Department of Fish and Wildlife

STAR Panel Advisors

Mel Mandrup, California Department of Fish and Wildlife, Groundfish Management Team representative
Gerry Richter, B&G Seafoods, Groundfish Advisory Subpanel representative
John DeVore, Pacific Fishery Management Council representative