Center for Independent Experts (CIE) Independent Peer Review for the Sunset and Vermilion Rockfish STAR Panel

Matthew D. Cieri

October 2021

Executive Summary

The STAR Panel convened from July 23-27 via an online meeting software, The Ring Platform, to examine the assessments for a cryptic-species pair, vermilion rockfish, and sunset rockfish. Both species co-occur in generally the same locations and habitats and are difficult to distinguish from each other without genetic analysis. Because these two species are difficult to distinguish, both species are assessed as the Vermilion/Sunset rockfish complex. Across all regions, the assessments used Stock Synthesis to both generate stock status as well as reference points. Assessment units were examined as Southern California (S. CA), Northern California (N. CA), Oregon (OR), and Washington (WA).

Data elements and model complexity varied by region. Southern California had the most data associated with it, and thus the most complex model. The least complex and the model with the least data availability was the Washington assessment. Most assessments had length, conditional length at age data, and at least one fishery-dependent index to work with as far as data inputs. Most, but not all, assessments had a recreational and a commercial fleet with selectivity blocks. However, there was more data available for Southern California which had some of the fleets broken out by major gear type, while Washington only had one removal fleet and no indices.

In general, the models performed well for each region. Each STAT presented several sensitivity runs which highlighted each model's behavior, sensitivities to data elements, and overall performance. Overall, each region was above their management targets for stock status. After considerable discussion and some minor modifications to the Southern and Northern California models, the Panel recommended that all the models be considered best available science and used for management purposes. All the models were recommended as Category 2, except for the Oregon model which was recommended as Category 1. All models were also recommended to go through a full benchmark during the next cycle.

There were a number of issues and uncertainties that came up during this review, however. Some of these are region-specific, such as lack of data or improper fits to the indices; but these were mostly minor. More broad issues included natural mortality, the cline in data and model complexity among the regions, the lack of age and index data for northern areas (Washington and Oregon models), the tension in data elements for the Southern and Northern California models, as well as others.

Each of these, as well as other issues, had research recommendations associated with them in the hopes that some could be resolved by the next assessment. This reviewer, in particular, made a number of recommendations that hopefully will prove useful. Chief among these were recommendations on revisiting the Category status for OR sunset/vermilion, thoughts on workshops to examine spatial management and its consequences to catchability/availability in fishery-dependent indices, and Further work on defining stock structure.

This was a thoroughly enjoyable review. The issue of having two cryptic species being assessed by region interests not only this reviewer but many others on the Panel. Both STATs did a wonderful job bringing the assessments together, running sensitivity analyses, and were amendable to the multitude of requests given to them. This was a complicated review and a complicated subject. There was a vast improvement in how this assessment was conducted and its quality, over past data-poor attempts.

Background

The STAR Panel convened from July 23-27 via an online meeting software, The Ring platform, to examine the assessments for cryptic-species pair of species vermilion rockfish (*Sebastes miniatus*) and sunset rockfish (*Sebastes crocotulus*). Both species generally co-occur in the same locations and habitats, and are difficult to distinguish from each other without genetic analysis. In general, Vermillion tends to be found in shallower waters with a more northerly distribution (Mexico to WA), while Sunset tends to be found in deeper waters with a more southerly distribution (South of Point Conception). Both appear to have similar life-history parameters, including natural mortality, longevity, growth, etc.

Because these two species are difficult to distinguish, resulting in landings and survey information to be combined, both species are assessed as the Vermilion/Sunset rockfish complex. Unless otherwise noted, the term vermillion will refer to both species throughout this report.

Complicating stock structure further, there appear to be distinct populations by latitude based on genetic work. Because of this, the complex was partitioned into four assessment units, Southern California from the Mexican border to Point Conception, Northern California from Point Conception to the OR border, OR from the southern OR border to WA, and WA from the southern WA border to the Canadian border.

There is limited information on the complex residing any further north than northern WA, though abundance quickly tapers off from OR to the Canadian border. Mixing between these two cryptic species is also latitude-dependent, with sunset being more prevalent in the south and declining as one moves north. It has been suggested that there is little to no sunset found north of Oregon. Data, sample, and survey availability also has a latitudinal cline, with more data, sampling, and survey information in Southern California and declining as one moves north. As such, model complexity decreases from south to north.

Two groups, or STATs, ran the different assessments; one based out of the South West Fishery Science Center for the two California assessments, and one based out of the North West Fishery Science Center for the Oregon and Washington Assessments.

Model structure

Across all regions, the assessments used Stock Synthesis to both generate stock status as well as reference points. Assessment units were examined as Southern California (S. CA), Northern California (N. CA), Oregon (OR), and Washington (WA). As noted earlier there is a cline in data availability with higher data coverage in the south and declining as one moves north. This also results in a decrease in model complexity as one moves from south to north.

Data elements:

The number of data elements varies markedly from south to north. A full list of data amounts in each element and time span for each region can be found in Figures 1-4.

Important data elements for the S. CA model included landings and sampling from both commercial and recreational fisheries. Commercial fisheries were partitioned into the commercial hook and line, trawl, and net fisheries. Recreational caches and discards were available from both the party charter fleet as well as the private rental fleet. Abundance information was available from the fishery-independent North West Fishery Science Center Hook and Line survey (NWFSC-HKL), while fishery-dependent information on abundance came from three sources, the Recreational; Party/Charter Fleet (Rec-PC), the Recreational Private/Rental Fleet (Rec-PR), and the Party/Charter Onboard observer Program (Rec-PC-ONBOA). Conditional length at age sampling data and length compositions are available from many of the above-mentioned data sources as well as others (see Figure 1). Selectivity time blocks for some fleets were used (1875-2001, 2002-2016, 2017-2020).

Data and survey information for the S. CA model was similar to the N. CA model (Figure 2). One important difference, however, is the lack of a fishery-independent index of abundance index in N. CA.

From the OR border north is where the data starts to become much less available. Here only recreational and commercial catches are available, with only one recreational fishery-dependent index to track abundance. Further, length and conditional age at length compositions are only available from the recreational and commercial fisheries (Figure 3).

WA is even more data challenged, with only one fleet (commercial and recreational combined), no abundance index, and only fishery-based conditional age at length and length compositions (Figure 4). While the recreational and commercial fleet is combined here, it is noted that the commercial activity in this region is very low, with vermilion being mostly an incidental catch at the northern part of its range.

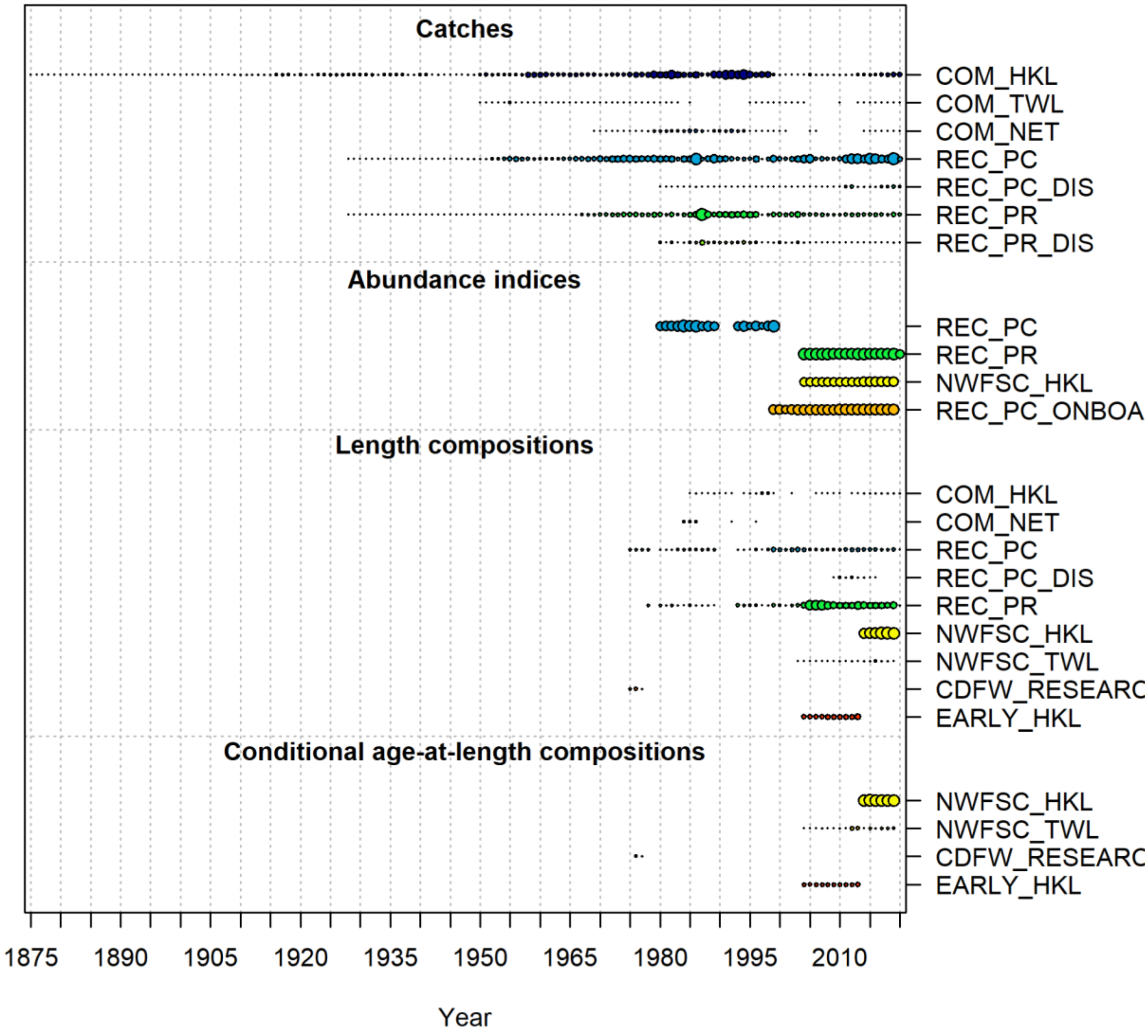

Figure 1: Summary of data sources used in the Southern CA stock assessment. Circles indicate the years that data were available, and the size of the circle is relative to the amount of data used (Dick et al., 2021).

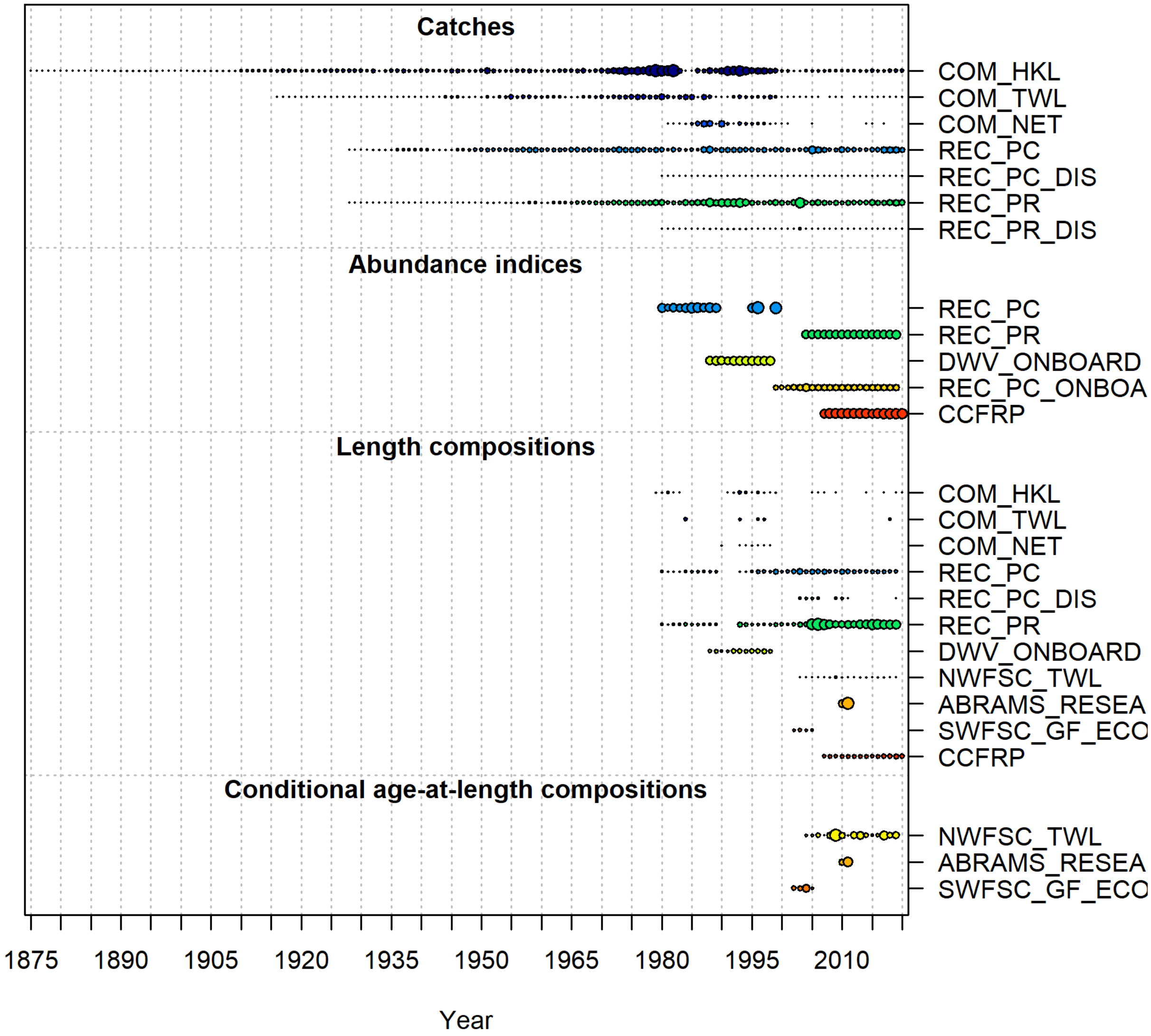

Figure 2: Summary of data sources used in the Northern CA stock assessment. Circles indicate the years that data were available, and the size of the circle is relative to the amount of data used (Monk et al., 2021).

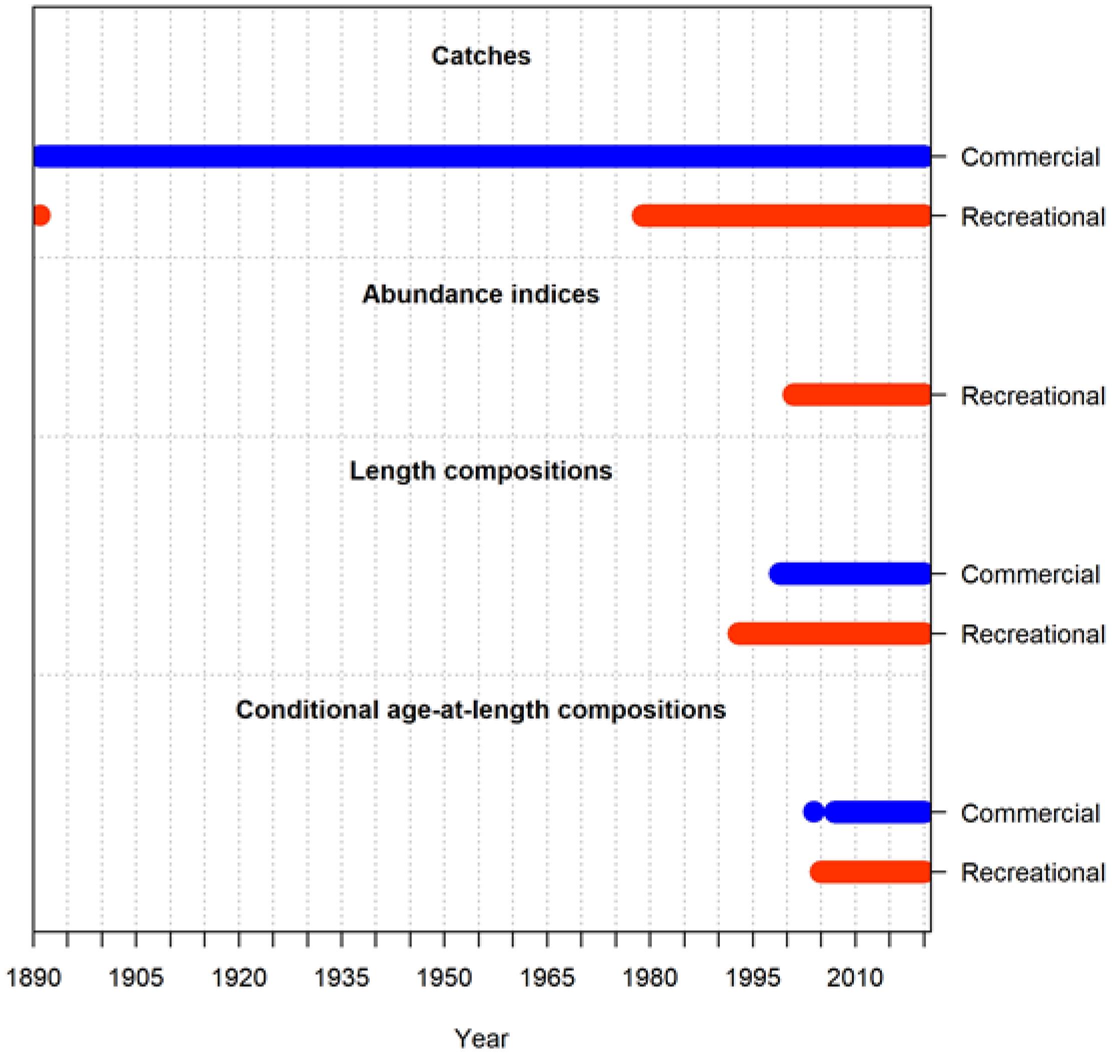

Figure 3: Summary of data sources used in the Oregon base model (Cope et al., 2021b).

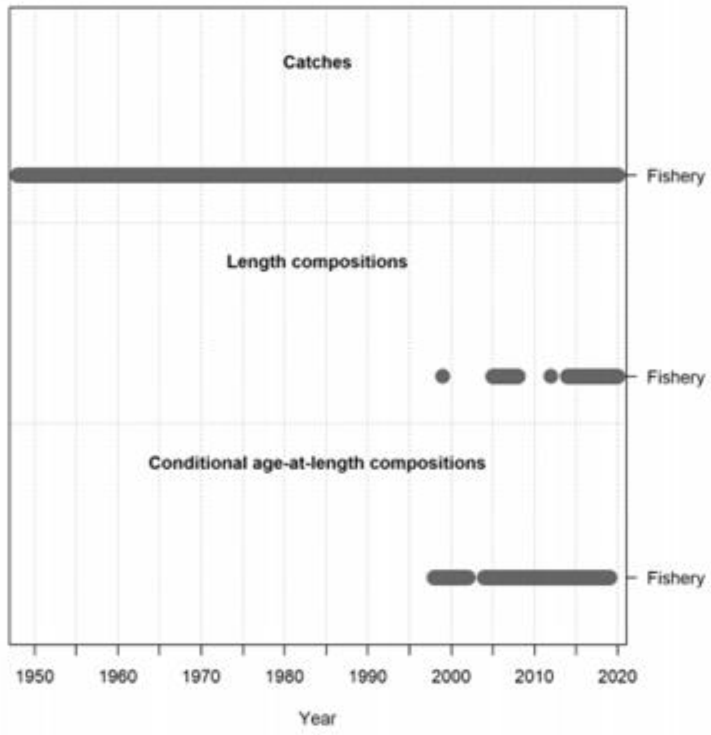

Figure 4: Summary of the sources and temporal availability of data used in the Washington base model (Cope et al., 2021a).

Parameterization:

Key parameters by models can be found in Table 1. It is noted that there is a diversity in how these important parameters were treated by assessment unit. Specifically, if they were estimated, estimated with a prior, or fixed. Another important facet is the change in natural mortality as one moves from south to north, with a general decline in M from S CA to WA. Likewise, there is a general decline in the estimate of B0, and therefore stock size, as one moves from south to north.

Table 1: Parameters and management reference points across vermilion/sunset rockfish assessment areas. Values in standard text are estimated, those in bold font are estimated with a prior, those in italics are fixed and those that are a result of an offset between sexes are underlined.

Parameter	S CA	N CA	OR	WA
M_female	**0.13**	**0.087**	**0.08**	**0.085**
L_at_Amin_Fem	8.568		-17.078	1.968
L_at_Amax_Fem	55.378		57.184	57.106
VonBert_K_Fem	0.156		0.146	0.093
CV_young_Fem	0.089		*0.1*	0.09
CV_old_Fem	0.077		0.054	0.053
M_male	*0.13*	**0.084**	**0.073**	**0.087**
L_at_Amin_Male	*0*		-29.898	-2.671
L_at_Amax_Male	-0.062		54.193	54.24
VonBert_K_Male	0.137		0.18	0.109
CV_young_Male	*0*		*0.1*	0.149
CV_old_Male	-0.286	*0.07*	0.045	0.037
LN(R0)	6.697	6.058	2.793	0.908
h	*0.73*	*0.72*	*0.72*	*0.72*
sigma_R	*0.5*	*0.5*	*0.6*	*0.6*
Recr_1998	-0.434		1.758	-0.049
Recr_1999	1.353		0.759	0.52
Recr_2000	0.678		-0.383	1.37
Recr_2015	0.03		1.738	-0.177
Recr_2016	0.895		-0.324	-0.044
Derived				
B0	978		29	3
FracUnfished(2021)	0.482	0.427	0.73	0.56
OFL_FSPR 2021	169		8	1

Sensitivities, diagnostics, and uncertainty

Each assessment ran a multitude of sensitivities and diagnostics.

For S CA sensitivities included a “Drop one” where an index or data element was removed from the model, estimating steepness rather than fixing it, starting recruitment deviations five years earlier and five years later, comparisons between McAllister-Ianelli data weighting and the Francis method, and mirroring the discard selectivity to the retained selectivity for recreational fleet rather than fitting it length compositions. Additionally, the STAT ran other sensitivities including fixing natural mortality to 0.07 (based on maximum observed age in the samples), setting all length selectivities to a two-parameter asymptotic relationship, setting all length selectivities to a four-parameter domed shaped relationship, and using a three-parameter Ricker stock-recruitment relationship. A retrospective analysis was also performed where data was dropped sequentially from the terminal year of the model back for five years, and sensitivity to historical removal data was tested by halving and then doubling the pre-1980 catches. Likelihood profiles were also completed on natural mortality, steepness, and R0.

Results from these analyses suggest that the S CA model wasn’t very sensitive to dropping data elements except for the REC PC index, which tended to lower stock status to near the threshold biomass. Steepness and data weightings had moderate effects, while changes in natural mortality had the biggest effects. The S CA model had some retrospective pattern with an underestimation of the stock status relative to the terminal year. Likelihood profiling indicated that the indices overall were not very informative. Conflict, however, was seen between age and length composition data, as length data suggested lower natural mortality for this stock while age data suggested natural mortality was higher. Likelihood profiling also suggested that both age and length data supported higher steepness, while the index data itself supported lower steepness. The model was sensitive to natural mortality, steepness, and changes in the historical catch. Overall fits to the indices were good, and little if anything stood out as being amiss in the model (but see below for further discussion).

The Northern California assessment ran exactly the same sensitivities as the S CA, except for adding a sensitivity around directly estimating both growth and natural mortality for males, and reducing the variance on the NWFSC-HKL to force a better fit to that survey. An additional sensitivity of 10% or 20% of the historical pre-1969 catches was also performed.

Results from these analyses were also similar to the S CA assessment. The model was only somewhat sensitive to dropping the PC REC index and to the 10% and 20% pre-1969 catches. Like with the S CA model, this assessment was sensitive to data weightings, steepness, and natural mortality. Likelihood profiling revealed that length compositions preferred a lower natural mortality value while age data tended to push the model toward higher natural mortality; the exact opposite of the S CA model. The N CA model had almost no retrospective pattern or uncertainty in contrast to the S CA model.

The Oregon model had similar treatments to both the California models as far as sensitivities, including;

Data removal (fixed life history, no recruitment estimation)

- Fishery length data only (no catches)
- Catch and lengths only
- Catch and lengths only with Francis weighting
- Catch, lengths, and ages with Francis weighting

- Catch, length, age, and indices with Francis weighting
- Catch, length, age, and indices with Francis weighting and extra index variance
- Catch, length, age, and indices with Francis weighting estimate life history

Data weighting

- Dirichlet data-weighting
- McAllister-Ianelli data weighting
- No data-weighting

Ageing error

- Using ageing error from CARE exchange

Length treatment

- Use option sex = 3 to maintain sex ratio in commercial data

Life history estimation

- Fix natural mortality (M)
  - Fix M
  - Fix M and CV_{old}
  - Fix M, t_0 and CV_{old}
  - Fix M, k, t_0 and CV_{old}
- Fix growth parameters
  - Fix all growth parameters
  - Fix L_∞, k, and t_0
  - Fix k, and CV_{old}
  - Fix L_∞ and CV_{old}
  - Est L_∞ for females only
  - Est L_∞ for males only
  - 5 growth platoons instead of one
- Recruitment estimation and variability (σ_R). All years are estimated with bias correction applied.
  - No recruitment estimation
  - No recruitment estimation and fixed life-history parameters
  - σ_R = 0.45
  - σ_R = 0.75
- Miscellaneous
  - Fecundity proportional to weight
  - Estimate dome-shaped selectivity

Likelihood profiles were also completed across many important parameters including steepness R0, natural mortality, and growth parameters. A ten-year retrospective analysis was also performed similarly to both California assessments.

Results of these sensitivity analyses for Oregon suggested that natural mortality was the most sensitive aspect of the model. The use of different data weighting schemes also had an effect. There was little conflict between each of the data elements in the model with respect to pushing it to higher or lower natural mortality, likely the result of insufficient data.

Like with OR, many sensitivities were analyzed for the WA model. These included:

Data removal (fixed life history, no recruitment estimation)

- Fishery length data only (no catches; L)
- Catch and lengths only (CL)
- Catch and lengths only with Francis weighting (CL_Fr)
- Catch, lengths, and ages with Francis weighting (CLA_fixed)
- Catch, length, and age with Francis weighting and estimated recruitment (CLA_fixed_recs)

Data weighting

- Dirichlet data-weighting
- McAllister-Ianelli data weighting
- No data-weighting

Catch histories

- Catch using original 1967 catches
- Minimum historical (1949-1977) catch series
- Maximum historical (1949-1977) catch series

Length treatment

- Use option sex = 3 to maintain sex ratio in commercial data

Ageing error

- Using ageing error from CARE exchange

Life history estimation

- Fix all life-history parameters
    - Fix natural mortality (M)
    - Fix M
    - Fix M, k, $t0$, and CVs
    - Fix M, $t0$, and CVs
    - Fix M and CVs
    - Fix female M and growth parameters
    - Fix male M and growth parameters
- Fix growth parameters
    - Fix all growth parameters
    - Fix $L\infty$ and CVs
    - Fix k and CVs
    - Fix CVs
    - 5 growth platoons instead of one
- Recruitment estimation and variability (σR). All years are estimated with bias correction applied.
    - No recruitment estimation
    - σR = 0.45
    - σR = 0.75

Miscellaneous

- Fecundity proportional to weight
- Estimate dome-shaped selectivity

Overall, the WA model was most sensitive to natural mortality. Sensitivities did suggest that while the model was uncertain in key aspects such as data treatment, almost all of that uncertainty suggested a larger stock size and a more optimistic population outlook. That said, the model has a very high level of uncertainty.

After examination of all of the sensitivities for S. CA, N. CA, OR and WA, the Panel had many requests to examine model behavior, as well as to potentially resolve some of the ongoing issues in each of the proposed models. These requests included (by region) below with both STAT response and panel conclusions summarized for brevity.

Results

It is important to highlight the changes from the proposed base model for each region; as well as summarize the overall stock status and uncertainty bounds.

For Southern California, two changes to the base model were incorporated 1) implement a time-block in 2017 to represent changes in selectivity for the commercial hook-and-line fishery resulting from regulatory changes, and 2) estimate steepness. These changes improved the model fits to the data. The estimated steepness was 0.73 and was very similar to the base run with the steepness fixed. These changes did not substantially affect the stocks status, which was estimated to be above the management target for spawning biomass.

Northern California was very similar to Southern California. Stock size was near the target value at 42.7%, however, the uncertainty around this estimate ranged from near the minimum stock size threshold to well above target. The base model had three important changes after discussions with the Panel. These included: 1) adding a time block to the CCFRP index in 2017 after the survey was expanded, 2) having the CCFRP length compositions re-weighted to reflect the weighting used in the index, and 3) removal of the last year of the private/rental index (2020) due to sampling constraints during the COVID-19 pandemic.

The Oregon model had no changes from the base model proposed by the STAT. Results indicated that the stock was well above its management target (73%). However, the uncertainty range was very large, from near B0 to 50% depletion.

Like the OR model, the Washington model also had no changes from the proposed base. Stock status appears to be above the management target, though the uncertainty bounds are even larger than in the OR model. Stock was estimated to be near 55% while the uncertainty bounds raged from above B0 to near extinction.

Conclusions

The Southern California model as changed represented the best available data for management advice. It was recommended that this be treated as a Category 2 stock (PFMC, 2020), due to the prevalence of sunset rockfish in the region. Further, it was also agreed that this stock should not be updated for its next assessment, but rather go through a full benchmark process. This was in part due to ongoing research that would clarify the stock boundaries if successful.

After careful consideration, it was recommended that the Northern California assessment also be considered the best available science after changes to the base model. Further, it was recommended that this model be placed in Category 2 (PFMC, 2020), owing to the potential presence of sunset rockfish in the area as well as the possibility of stock substructure within the vermilion rockfish present in the region.

Likewise, it was recommended that the Oregon assessment should be considered the best available information from which management advice could be derived. It was also agreed that this assessment should move forward in the future as a benchmark rather than as an update; given the uncertainties around stock structure, the potential for sunset rockfish to be within the region (even if only in small amounts), and the sheer magnitude of the models estimated uncertainty.

The Panel also concluded that OR model should be placed in Category 1 given the range of data utilized, the sample sizes for the composition data including length-age data, and the favorable model diagnostics. While this reviewer mostly agrees with that recommendation, given the range of the uncertainty estimated by the model, the uncertainty surrounding the stock structure in this region, the knowledge that all of the other assessments for these stocks in the region were listed as Category 2, this reviewer made the case that it should also be listed as a Category 2. That case is still, in this reviewer's opinion, valid. Moreover, satisfactory model diagnostics are likely the result of lack of data, rather than model specification. These points suggest that caution be applied here, and a recommendation on this subject is made elsewhere.

Like the OR model, the Washington assessment was found to be best served by being placed in Category 2 (PFMC, 2020). This was in part due to the overall high uncertainty within the model, the fact that it’s near its northern range, and the uncertainty associated with being an incidental catch in other fisheries. For these same reasons and given the potential for updated information on stock structure, the Panel and this reviewer recommended that this stock be not be updated in the next assessment, but rather go through a full benchmark and peer review process.

Description of the Individual Reviewer’s Role

This reviewer’s role was to read all provided materials on the 2021 assessment for vermilion and sunset rockfish, engage in the online discussion of the strengths and weaknesses of the proposed approach, and were possible provide suggestions on improvement of the models. Additionally, this reviewer assisted in writing the draft Panel report for presentation to fishery managers, the public, and SSC. A full write-up, this report, is also part of the terms of reference, where this reviewer makes an independent assessment outside of review Panel consensus, highlighting their own unique opinion of the assessment.

Summary of Findings

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.

This reviewer received and read all of the documents for this review prior to the start of the meeting. Further reading and preparation were also required to refresh knowledge of this region's management, in particular to the Category system used by the Science and Statistical Committee (SSC) to provide management advice and how it handles cryptic species.

A good amount of information was available on the FTP site before the start of the meeting. The pre-assessment documents were well prepared and well organized. The sheer amount of information, however, was quite large; requiring a long time to download, let alone go through. This as well as the amount of work in this review lead to three recommendations.

Recommendation: Workload. This was a lot of work to review these models. Two STATs, four region-based models, with multiple indices and data streams, for two species, is much to take in. It was also a lot to review in five days. This reviewer is uncertain how this amount of work would have been packed into a meeting had it been any shorter on account of travel. If it were not for the fact that the Oregon and Washington models were relatively data-poor, it’s not clear how this could have all been reviewed in a week. As such it is recommended that the overall workload of these four assessments be reevaluated for the next assessment: keeping in mind the next recommendation. Having a week and a half; one in person and a few days remote to start might be a good way forward.

Recommendation: Continue to have these regions assessed and reviewed together. Both SWFSC and NWFSC worked very well together and brought a lot to the table during this review. Having them continue to work together is likely a good idea for future assessments. Further, having them done and reviewed at the same time is also important, allowing for a better “big picture” of issues and results across multiple regions along the coast.

Recommendation: The use of an FTP site to share information. As stated earlier, there was a lot to go through for this review. Often it seemed as if using an FTP site was problematic, both for uploading and downloading important information. Please reconsider the use of FTP as a medium of exchange for this type of review. If possible, reconsider the amount of information that is given to reviewers and the public during this process. One possible addition would be to include a document list with links, that would allow people to get at the data and reports they need, without having to download large-sized file folders.

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

The reviewer attended and participated in the meeting, discussing many aspects of the model's behavior as well as making some requests to the STAT during the process.

Strengths

Across all assessment, there was a number of strengths:

- For each region, a wide array of data was explored. The STATs did an excellent job of finding data that could be useful, be region, fully exploring it, and then standardizing it for incorporation if it was appropriate.
- The STATs explored many alternate modeling approaches within Stock Synthesis, including Bayesian modeling approaches. Doing so increases the quality of the assessments now and for future investigations.
- Incorporation of age and length information, as well as index abundance in some cases, dramatically improved the assessments by region. Overall, these assessments are a vast improvement over the data-poor approaches previously used for these two species in these regions.

In addition, this reviewer would like to highlight a few key strengths that are worth noting, including:

- That the Southern California model had multiple data sources and was overall robust to many of the uncertainties examined. It also estimated both natural mortality and steepness.
- The Northern California model had both high-quality onboard observer data as well as a multitude of sensitivity analyses which help further examine the issues of uncertainty in the model structure.
- The OR model incorporated the age data it had very well, and it proved to be an informative data source. The addition of using age error estimations using within-reader comparisons was well done.
- Despite a lack of information including a lack of indices and a combined fleet structure, the Washington model was surprisingly robust to many sources of uncertainty.

Weaknesses

While all the models presented by the STATs were acceptable as a framework for management advice, in some cases after some changes, some unresolved issues and weaknesses simply could not be addressed during this process. Highlighting some of the most important is useful in gaining an overall picture of some of the uncertainties and difficulties with how these assessments were approached.

First and foremost is the issue of an assessment of two cryptic species with different habitat preferences and with different ranges. It's not unforeseeable that there may be a cline in the mixing between these two species by region, with more sunset in the south rapidly tapering off as you move north. This has important implications if sunset and vermilion differ in key biological or population-level parameters such as age, growth, and natural mortality. Changes in modeled parameters by region might simply be the result of more or less sunset rockfish being available. As such, small changes in either the stocks or harvester behavior can dramatically change the outputs of any model if the differences in those parameters are even moderate.

Overall, stock boundaries are a major concern. The relationship between the Southern California region and Mexico is unknown. Further, the relationship between Southern and Northern California is also unclear. Likewise, the boundary between these stocks and the OR/CA border would seem rather artificial and may not represent a biological break. While WA seems to be its own isolated population, given its spatial centroid, OR and its relationship to N CA is very unclear.

Two additional deficiencies or sources of uncertainty include the changing spatial management in the region and the reliance on fishery-dependent indices and the lack of ecosystem information. These changing management regimes have a substantial impact on how fishery-dependent indices operate, are analyzed, and are interpreted. Recommendations on how to address this issue can be found elsewhere in this report. Likewise, ecosystem information is not well accounted for in any other these assessments. As the climate in this region continues to change, one would expect to see changes in both species' ranges, availability to the fishery, and availability to any fishery-independent indices in the region. While this issue of ecosystem effects was mentioned in the Panel's report, after consideration, this reviewer thinks that these ecosystem issues are not as important as some of the other issues raised in this and the Panel's report. As such there are no recommendations at this time from this reviewer on this issue.

Taking a broader perspective, there is an issue with the number of clines in this region for these species. There is a reduction in the amount of sunset rockfish likely informing these models as you move north. There is also a reduction in available data and model complexity as you move north. And there appears to be an increase in the population substructure within vermilion rockfish as you move north. All these combined make it very difficult to determine if these clines are attributable to population-level differences, differences in data availability, or differences in model complexity and structure.

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

Model assumptions appeared to be in line with best practices and the models used appeared appropriate.

Most estimates appeared to be in line with expectations for a stock with similar life histories and exploitation patterns, though natural mortality differences are odd. The differences in natural mortality between Northern and Southern California assessments is difficult to understand (Table 1). They are two adjacent stocks, which may have some connectedness between them given the inshore-offshore distributions, yet they have fairly different implied natural morality parameters.

All models examined during this review were sensitive to natural mortality. As seen by the differences between Northern and Southern California, natural mortality doesn't appear to be very well informed in any of the models examined. While used as an axis of uncertainty for all of the assessments, this lack of understanding about natural mortality is an important uncertainty to address. And it was key to make natural mortality the (or one of the) axis of uncertainty in all models.

One uncertainty, perhaps the greatest, is the assumption on the unit stock. The issue of assessments on two cryptic species cannot be understated. While it is often convenient to ignore this fact to provide management advice it is not without consequences. It is understandable, given that these two species are closely related and are harvested by the same fleets, why they are combined into one assessment within a region. However, it is also important to remind both scientists and managers of this fact. Small changes in fish distribution and targeting by harvesters can dramatically change the relative abundance of these two species, model estimations of key biological parameters, species-specific exploitation relative to each other, and management targets. Unfortunately, this issue is not solvable in the near future. Even if these stocks could be distinguished in the field next year, there will always be uncertainty about the historical relationship between these two species, by region, in catches and surveys.

The boundaries used to distinguish one region from the other are likely wrong, in this reviewer's opinion. While there is some genetic information to distinguish north and south of Point Conception, evidence that there are differences between Northern California and OR are just not very convincing. While it might be understandable based on exploitation patterns, the boundary at the CA-OR border is particularly less informed. This issue is the subject of a recommendation.

Recommendation: Stock boundary issues. Throughout this report stock boundaries and the unit of assessment has been a major uncertainty. While there are some genetic studies ongoing, these should be augmented with larval and tagging studies to determine the biology important units for these assessments. As stated previously, the arguments for splitting stocks along state boundaries appears, at least to this reviewer's mind, rather weak. Fully exploring this issue and defining the stock boundaries in a more biologically meaningful way will be important before the next assessment for these two species. Fortunately, research is currently ongoing, so results may be more available during the next assessment.

As stated previously, the cline in data availability, presence of sunset rockfish, model complexity, and even STAT composition, compound these uncertainties. Changes seen in model outputs, and diagnostics, are not easily attributed to population changes. Instead, these may be more related to data availability, model complexity, the mix between these two cryptic species, or even modeling styles. Despite this, no feasible recommendation on addressing this can be designed by this reviewer. It's a very complicated issue with what is at this point an unresolved path forward. Perhaps progress on other recommendations could, in the future, assist with a better understanding of these clines.

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

This reviewer provided a number of suggestions or assisted in developing suggestions, during the course of the discussion. During those discussions, a multitude of requests were made by this reviewer as well as other Panel members as a collaborative effort. These including Rationale, Responses, and Conclusions. Because this was a lengthy discussion, only summaries are provided.

Southern California

- Implement a selectivity time block for the COM_HKL fishery starting in 2017 through the present.
  Rationale: Management changes allowing fishing in deeper depths may have changed the composition of catches from that point on.
  Response: The revised model produced better fits to the COM_HKL length compositions from 2017-2020. The new time block captured the shift to larger sizes after 2016 and resulted in a doubling of the Francis weight estimated for the COM_HKL length composition data (from 0.3 to 0.6 based on one iteration).
  Conclusion: It was agreed that the addition of a time-block on the COM_HKL fleet in 2017 was useful because it improved fits to the length compositions and the newly estimated selectivity was as expected given opportunities in deeper water since 2017. The panel supported adding this to a revised base model.

- Turn on the estimation of early recruitment deviations from the start year of the model to one year before the current defined main period in the base model. Tune the bias adjustment ramp, if possible. Compare the uncertainty intervals of the SSB and depletion to the base model. Also, compare the pattern of estimated recruitment deviations.
  Rationale: To examine how the estimation of these early, uninformed recruitment deviations affect the estimation of uncertainty and the recruitment patterns in the 1970s to see if these early recruitment deviations account for model misspecification.
  Response: The pre-STAR base model was modified to allow for estimation of early recruitment deviations for the period 1875-1964 (90 additional parameters, penalized given σR = 0.5). Relative to the pre-STAR base model, estimates of uncertainty in spawning output and relative spawning output increased before about 1980. There was no effect on estimated recruitment deviations after 1964 (the 'main' period), and only minor changes in deviations before the main period. The estimated bias adjustment based on the new model called for a linear ramp from 1912 to 2018. Given that there was no change in recruitment deviations during the main period (1965-2020), and estimates of uncertainty in recent decades were unaffected, the STAT concluded that, in this case, estimation of early recruitment deviations was unnecessary.
  Conclusion: It was agreed that the estimated spawning output trajectory is minimally affected when estimating early recruitment deviations from the start of the model. However, the estimated uncertainty of the spawning output from the beginning year to 1980 was larger and there was an appropriate level of uncertainty in the historical estimated fraction of unfished spawning output. It is suggested that estimating early recruitment deviations be a discussion topic for the end of the year process review and for consideration for the next iteration of best practices guidelines for groundfish stock assessments for the PFMC.

- Fit strongly to the HKL survey index. This should be done by reducing the influence of the other indices by reducing their likelihood contribution with lambdas. The selectivities for the fishery-dependent catches should be fixed as estimated in the current base model.
  Rationale: Only one abundance index appears to be well fitted. This sensitivity will provide results when the model is forced to these fishery-independent data as well as it can in contrast to when the other indices are included.
  Response: A model run was conducted during which all selectivity parameters for fleets other than the NWFSC hook-and-line survey were fixed at the base model values, the ExtraSE parameter for the REC_PR index was turned off, and all lambdas for non-HLK survey data types were set equal to zero. Unsurprisingly, the fit to the NWFSC HLK index improved and fits to the other indices degraded, and annual recruitment strength was estimated only for years with data from the survey.
  Conclusions: Although the hook and line survey index was fit better, there was still a pattern of misfitting, especially in 2017 and 2018. It was concluded that the hook and line survey was not in major conflict with other data sources and the integration of all data was useful. The hook and line survey appears to be an important source of fishery-independent data for vermilion and sunset rockfishes in Southern California and it would be worth holding a workshop to discuss methods for incorporating existing hook and line surveys in rockfish stock assessments and improving them for the future.

- Run the first three requests with steepness estimated.
  Rationale: To evaluate the effect of estimating steepness.
  Response: Model fits for requests 1-3, now with steepness estimated, are compared to the pre-STAR base model. Steepness estimates for the four model runs are 0.777, 0.731, 0.778, and 0.728.
  Conclusions: The Panel noted that steepness was estimated to be in the 0.7 to 0.8 range in all of these models, and the addition of a time block in 2017 on the selectivity for the COM_HKL fleet resulted in a decrease in the estimated steepness from 0.777 to 0.731. The estimates of M were similar to the pre-STAR base model with steepness fixed at 0.72. The data appear to contain information about steepness, which may be a result of data available informing year class strengths before, during, and after the stock was at its lowest values in the late 1990s. The hook and line survey, in particular, began in 2004 when vermilion recruited in 1999 was five years old and has provided samples of many year classes for 16 years while the stock was increasing from below 20% of unfished spawning output. Estimating steepness in the base model was agreed and the base model was changed to do so.

- Examine length-dependent natural mortality using the Lorenzen M option in SS. Use the age of 10 years as the reference age. Use the time block of 2017 for the COM_HKL fishery and estimate steepness in the new base model.
  Rationale: There is the potential for M to vary with length given the greater potential for natural mortality at smaller size. This request will help determine whether length-varying M has an impact on model parameters and results. This request is also needed to evaluate the effect of estimating steepness.
  Response: It was noted that male and female M were equal at the reference age (male offset = 0), so a model with greater differences in growth may be sensitive to the choice of reference age if the male offset is fixed at 0. M at age 10 under the Lorenzen model is 0.14 yr-1.
  Total likelihood increased by 1.94 under the Lorenzen assumption, with no change in the number of parameters. Higher natural mortality rates for younger (smaller) fish are offset by increased estimates of unfished recruitment.
  Conclusions: It appears that estimating M with a Lorenzen parameterization did not result in better fits to the data overall, and simply rescaling the size of the stock to account for the higher mortality at young ages was sufficient to fit the data with minimal effects on the estimates of older fish and spawning output.

- Explore a bivariate decision table structure across the log-likelihoods of M and h using the new base model. Use the following catch streams: default harvest control rule (sigma = 1.0, P* = 0.45), P* = 0.4, and constant catch under an MSY (FMSY of 50% SPR). Also, report the model-specific sigma for the new base model (based on the estimated 2021 OFL).
  Rationale: Natural mortality and steepness are the major axes of uncertainty and this structure appears to be a good one for the decision table since these estimates directly affect estimation of OFLs. The catch streams appeared to be within a reasonable range. The model-specific sigma is needed to ensure it is lower than the proxy for a category 2 stock (1.0).
  Response: Projections were provided for the base model using four different catch streams: the harvest control rule predicting an OFL which was reduced based on a P* of 0.45 and a category 2

sigma of 1.0, the harvest control rule predicting an OFL which was reduced based on a P* of 0.40 and a category 2 sigma of 1.0, and constant catches equal to the equilibrium yield using an FSPR = 50% with and without a buffer based on a P* of 0.45 and a category 2 sigma of 1.0.
Conclusions: It was agreed that natural mortality and steepness were the major axes of uncertainty and a decision table was constructed from the bivariate likelihood of these two parameters. The revised base model estimated steepness and included a time block on the commercial hook-and-line fleet in 2017, which is a better representation of the current changes in fishery selectivity due to recent management changes and this was carried into the projections. Appropriate catch streams were discussed with the GMT and GAP representatives and it was noted that it is difficult to provide catch streams for a stock that is managed within a complex. The catch streams used an expected mortality in 2021 and 2022 of 211 mt for each year, which was provided by the GMT.

Northern California

- Introduce a time block for the CCFRP survey before and after the expansion of the survey in 2017. Reweight after implementing the time block.
  Rationale: The index is not fitting the later time frame well after the addition of sample locations resulting in a pattern of residuals at larger lengths. The expansion of sampling to include additional sites in central and northern California might have resulted in the observed pattern. Examination of the site-level data may inform which locations are contributing to differences in patterns observed.
  Response: The model was re-weighted once after adding the time block (2007-2016, 2017-2020), with five additional estimated selectivity parameters. The new model does not fit well with the last few years of the index that indicates the increase in relative abundance. There were no substantial changes to the recruitment deviations. The stock status changes even though the model cannot reconcile the steep increase at the end of the time series.
  Conclusions: It was noted that the increase in those five parameters improved the fit to the length compositions but worsened the fit to the overall index. Fits to the later time period were improved. This was found to be a difficult issue, as changes in the survey's footprint impact not only selectivity but also availability. After much discussion, it was decided to discard the time block but to make a further request to examine the issue more fully. Additionally, a research recommendation was also made during these deliberations.

- Implement a selectivity time block for the COM_HKL fishery starting in 2017 or 2018 through the present.
  Rationale: Management changes allowing fishing in deeper depths may have changed the composition of catches from that point on.
  Response: The time block was added in 2017 (1875-2016, 2017-2020), estimating two additional parameters (the peak and ascending limb) and the selectivity pattern remained asymptotic. The time block has no effect on management quantities, spawning output, or recruitment deviations.
  Conclusions: It was noted that the response had completed this request fully. There was a lengthy discussion on the appropriateness of adding in selectivity blocks when there were management changes but no real tangible selectivity changes in the model. However, it was

also suggested that small time blocks at the end of a time series results in some model diagnostics (i.e., retrospective analysis) becoming difficult to interpret. It was agreed that while a time block is not needed currently from 2017-2020 in the hook and line fishery, such a selectivity block could be important in either a future update or benchmark given the potential importance of this change in management.

- Drop the 2020 recreational PR index values from the analysis.
  Rationale: Sampling protocols changed dramatically during the COVID pandemic preventing speciation of retained catch resulting in unaccounted encounters. This single year was likely influencing the overall weight of the index in the assessment.
  Response: There are no sampler examined unidentified rockfish (species = RFGEN or NOXXX) in the PR1 data after 2018. Sampling in 2020 was quartered, but the percent of vermilion observed in the total observed catch is very similar. The index just slightly changes when 2020 is removed. The overall pattern is identical. The index just slightly changes when 2020 is removed. The overall pattern is identical and the fit to the index does not improve. The NLL changes by less than 1 and there are very few discernible changes to the model (for the re-weighted model vs. the base model.
  Conclusions: It was agreed that dropping 2020 did little to improve the fit to the index, nor did it change the model results. After discussion, a new request was formulated to examine unidentified fish back to 2004.

- Provide a plot of recruitment deviation estimates for the M sensitivities, as was provided for the leave one out sensitivities.
  Rationale: The equilibrium age-structure is a product of M, and recruitment deviations may alter the early age structure to account for misspecification. This will allow for the examination of the correlation between M and early recruitment deviation patterns.
  Response: Recruitment deviations for the natural mortality (M) profile are provided. Lower natural mortality rates resulted in lower recruitment deviations in the 1970s and increased deviations in the 1990s-2000s. There is a sum to zero constraint on recruitment deviations. The estimates of relative biomass and spawning stock biomass are sensitive to natural mortality assumptions.
  Conclusions: After discussion, it was agreed that the overall sensitivity to natural mortality was as expected; there were no significant changes to the pattern of estimated recruitment deviations and there seemed to be little asymmetry. It was concluded that this was not a feasible avenue for further exploration.

- Exclude the new sites added in 2017 from the CCFRP index and rerun the model and evaluate the resulting model fit.
  Rationale: The fit of the model deviates from the index in the later years of the time series consistent with the expansion of the survey northward with additional sites. The requested analysis will provide an indication of the ability of the model to fit the resulting index when the new sites are omitted.
  Response: The index of abundance was constrained to the four areas sampled consistently since 2007 by MLML and Cal Poly. The trend in the index, estimated relative spawning biomass, and

estimated spawning biomass is the same without the newer sampling areas, and the increasing trend is still strongest inside the MPAs.
<u>Conclusions</u>: It was agreed that dropping the new areas surveyed did not seem to improve the base model overall. Based on the discussions, a similar method to what was employed with the NWFSC hook and line survey in southern California to the CCFRP survey.

- Provide a model structure treating the CCFRP index by employing methods analogous to the HKL survey index treatment in the Southern California model (i.e., add a separate fleet for the later years and use that selectivity for the entire time series) with and without reweighting.
  <u>Rationale</u>: The fit of the model deviates from the index in the later years of the time series consistent with the expansion of the survey northward with additional sites. The requested analysis will provide an indication of the ability of the model to fit the resulting index with the proposed model structure.
  <u>Response</u>: The unweighted model was not retained. The unweighted model had an NLL much larger than the weighted model. It was recommended that the results from this request not be incorporated in the base model.
  <u>Conclusions</u>: It was agreed that this change improved the fits to mean length as well as the length composition data. It was noted that this slightly increased stock status from the precautionary zone to slightly greater than target biomass in the terminal year, as well as the natural mortality, but concluded that overall this was an improvement over the pre-STAR base model for this region. The proposed changes to the base model were accepted.

- Evaluate the number of unidentified rockfish (RFGEN) reported from 2004-2020 in RecFIN north and south of Point Conception.
  <u>Rationale</u>: To evaluate the potential effect of the COVID-19 pandemic on sampling protocols that may have resulted in under-reporting of vermilion rockfish and poor fits to the PR index.
  <u>Response</u>: There was only access to data back to 2015, which should be sufficient to look at the issue. The proportion of angler-reported unknown species was higher in 2020 both north and south of Point Conception.
  <u>Conclusion</u>: It was noted that there was a large increase in the number of unidentified fish in angler reported catch in 2020. Based on this finding, it was concluded that 2020 should be dropped from the PR index as proposed and evaluated in an earlier request.

- Explore a decision table structure across the log-likelihood of M using the new base model. Use the following catch streams: default harvest control rule under a category 2 designation (sigma = 1.0, P* = 0.45), P* = 0.4, and constant catch under an MSY (FMSY of 50% SPR). Also, report the model-specific sigma for the new base model (based on the estimated 2021 OFL).
  <u>Rationale</u>: Natural mortality is the major axis of uncertainty and this structure appears to be a good one for the decision table since these estimates directly affect estimation of OFLs. The catch streams appeared to be within a reasonable range. The model-specific sigma is needed to ensure it is lower than the proxy for a category 2 stock (1.0).
  <u>Response</u>: Projections were provided for the base model using four different catch streams: the harvest control rule predicting an OFL which was reduced based on a P* of 0.45 and a category 2 sigma of 1.0, the harvest control rule predicting an OFL which was reduced based on a P* of 0.40

and a category 2 sigma of 1.0, and constant catches equal to the equilibrium yield using an FSPR = 50% with and without a buffer based on a P* of 0.45 and a category 2 sigma of 1.0.
Conclusions: This request was completed satisfactorily. Natural mortality appeared to be the best metric for capturing the uncertainty associated with various management responses. Likewise, the projection of catches appeared to be appropriate.

Oregon

- Provide the length composition Pearson residuals when weighting using the McAllister-Ianelli approach.
  Rationale: This will provide a look at the Pearson residuals to determine if they are of reasonable size and will provide a more detailed look at the effects of weighting the compositions.
  Response: The results were presented as requested.
  Conclusions: It was noted that the maximum length composition Pearson residual was reduced from 6.45 (Francis weighting) to 5.12 (MacAllister-Ianelli weighting), but residuals remained relatively high because the sample size was small and bin width was not necessarily ideal for the commercial fishery, although results were better for the recreational fleet data. Higher residuals may also be due to growth error or selectivity. There was only a small effect on recruitment deviates, which might be expected to be most sensitive to the interpretation of length composition data. The same general pattern in recruitment deviates (i.e., they initially decrease and then adjust as information from the data becomes available) is present in both weightings, but the sensitivity run has slightly lower variance. It was concluded that the results seem robust to the choice of alternative weighting.

- Turn on the estimation of early recruitment deviations from the start year of the model to one year before the current defined main period in the base model. Tune the bias adjustment ramp, if possible. Compare the uncertainty intervals of the SSB and depletion to the base model. Also, compare the pattern of estimated recruitment deviations.
  Rationale: To examine how the estimation of these early, uninformed recruitment deviations affect the estimation of uncertainty and the recruitment patterns in the 1970s and see if these early recruitment deviations account for model misspecification.
  Response: The results were presented as requested. The biggest difference is the larger amount of uncertainty in relative stock status when estimating the early years of recruitment.
  Conclusions: The initial recruitment deviations clearly affected the early period biomass and indicated greater uncertainty in the initial level of depletion, increasing the error on stock size. It was argued that the additional parameters and complexity resulted in little benefit when determining current stock status, and was only useful in that it characterized the uncertainty of stock size in the early period when there is little information. It was noted that the model runtime could increase significantly with this approach. Therefore, because the impact on the most recent status was small, it was agreed to add this run as a sensitivity rather than use it as the new reference model.

- Implement a time block in 2004 for the length compositions and allow the model to freely estimate selectivity.

Rationale: Seasonal depth restrictions were implemented in 2004, which may affect compositional data.
Response: There was very little change in the derived outputs and the time series of derived quantities measuring scale, status, and productivity, as well as model uncertainty. In addition, an alternative ORBS abundance index that included winter trip data, which had previously been filtered out was evaluated. It was concluded that the alternative standardized index was very similar to the base model index.
Conclusions: It was agreed that the alternative "all year" index produced minor changes to the abundance index fit and stock status. Overall model log-likelihood was lower for this index, with poorer fit to length-age, but better fits to the index and length data. It was agreed to include the alternative index as another sensitivity.

- Set the last four years of recruitment deviations into a post-main recruitment period (late era) and provide comparisons of SSB, depletion, and recruitment deviation estimates to the pre-STAR base model.
  Rationale: This should not affect the fits to the model or change the historical estimates but will likely have a small effect on longer-term projections
  Response: Comparisons were shown for the last four years with zero recruitment deviation, and slight change that did not change the results of the base model in estimating current stock quantities, but could alter projections. For this reason, the model with zero deviations in the last four years was used in projections.
  Conclusions: It was agreed that this resulted in no significant changes, but forced recruitment deviations to zero. This could slightly affect projections. It was recommended that this be used for projections because it reduced the effect of potential bias from the uniformed last four years of recruitment deviations. It was also agreed to make this change for the reference model.

- Provide the reference points for the run with recruitment deviations estimated from the start of the model. Include confidence intervals.
  Rationale: To examine the full time series of recruitment deviations more fully.
  Response: The requested reference points and confidence intervals were provided.
  Conclusions: Following an earlier request, the small differences in the reference point estimates confirmed that fitting the recruitment deviates to the initial period does not seem to make much difference compared to the reference model. This supports retaining the current reference model. The extended recruitment deviation model should be retained as a sensitivity.

- Provide the model-specific sigmas for the reference model and the model with the extended time series of recruitment deviations.
  Rationale: To determine if sigma changes with the additional recruitment deviations.
  Response: The OFL sigma for the reference model is 0.314. The OFL sigma for the model estimating all recruitment years is 0.312.
  Conclusions: Following an earlier request, it was noted that the OFL sigmas were almost identical, again confirming little net difference in the expected advice from the different models.

- Explore a decision table structure across the log-likelihood of M using the base model. Use the following catch streams: default harvest control rule under a category 1 designation (sigma = 0.5, P* = 0.45), P* = 0.4, and constant catch under an MSY (FMSY of 50% SPR).
  Rationale: Natural mortality is the major axis of uncertainty and this structure appears to be a good one for the decision table since these estimates directly affect estimation of OFLs. The catch streams appeared to be within a reasonable range.
  Response: Projections were provided for the base model using four different catch streams: the harvest control rule predicting an OFL which was reduced based on a P* of 0.45 and a category 2 sigma of 1.0, the harvest control rule predicting an OFL which was reduced based on a P* of 0.40 and a category 2 sigma of 1.0, and constant catches equal to the equilibrium yield using an FSPR = 50% with and without a buffer based on a P* of 0.45 and a category 2 sigma of 1.0. A complete decision table is presented in the post-STAR version of the assessment.
  Conclusions: It was agreed that natural mortality was the most important axis of uncertainty for the decision table. Except for the small adjustment to the four most recent recruitment deviates, the base model was unchanged from the pre-STAR assessment and was used in the projections reflected in the decision table.

Washington

- Provide variance estimates or PSE, if possible, of annual catches from 2002-2020.
  Rationale: Removals are a vital part of the data inputs and vermilion are rarely encountered in WA. Capturing the uncertainty of those removals can help to understand the overall uncertainty in the model.
  Response: The requested catch uncertainty measures are provided.
  Conclusions: There appears to be a combination of regulatory liberalization for Halibut and recruitment contributing to the elevated catch estimates in 2019 rather than sampling error, bias, or artifacts of estimation methods. Thus, there is no support for augmenting or supplanting the values, as they are likely representative. If further liberalization of the Halibut fishery is considered, vermilion rockfish catch may increase as well.

- Provide SB, SB/B0, and estimated recruitment deviation plots for fixed M values (female and male equal) of 0.06, 0.08, 0.10, and 0.12.
  Rationale: Natural mortality is one of the largest sources of uncertainty in the model and when estimating M, the uncertainty is also estimated but is currently an assumed normal distribution based on the inverse of the Hessian. Looking more specifically at this uncertainty with fixed M values may provide insight into the asymmetry of uncertainty that is more realistic.
  Response: Request was completed, and the results were shown.
  Conclusions: Above M of 1.2, the assessment scale inflates unreasonably resulting in uncertainty bounds including unfished levels, the model cannot determine R0 and thus inflates variance to an unrealistic level. While there is assumed symmetric error about the base model over time, there is asymmetry in the results of the terminal year depletion with increasing M, resulting in skew at higher values, while more proximate values are observed at the lower range of M values. Asymptotic uncertainty indicates that there is a lower probability of being more depleted across the major axis of uncertainty M. The reference model captures much of the uncertainty, but not the asymmetric distribution of depletion outcomes and resulting uncertainty. The

asymmetry appears to be across assessments with a single reference model, which does not capture the asymmetry. A Bayesian assessment with asymptotic variances or MLE derived ensemble models would account for some of the asymmetry in an intermodal representation that is not captured by the reference model itself. Ensemble models may provide a better overall reference model.

- Examine length-dependent natural mortality using the Lorenzen M option in SS. Use the age at 50% maturity as the reference age.
  <u>Rationale</u>: There is potential for M to vary with age given the greater potential for natural mortality at smaller size. This request will help determine whether age-varying M has an impact on model parameters and results.
  <u>Response</u>: The Lorenzen M was estimated with an age at 50% maturity at 10 years set as the reference age selected. Age- or length-specific mortality and the invariant form used in the base model results in similar outcomes for spawning biomass and relative depletion.
  <u>Conclusions</u>: By the time cohorts are selected by the gear, they are reaching the minimum of the natural mortality, as small fish are not selected until M is below 0.1, explaining some of the lack of difference in results for spawning output and depletion. While it may be more realistic to use the Lorenzen M, it does not make much difference given the age of first exploitation.

- Implement a time block in 2007 for the length compositions and allow the model to freely estimate selectivity. Explore an additional time block from 2019 to the present.
  <u>Rationale</u>: Seasonal depth restrictions were implemented in 2007 which may affect compositional data. Liberalization of depth restrictions in 2019 may also have affected compositional data and catches.
  <u>Response</u>: Attempts were made to add time blocks to the WA recreational fishery time series, but each of these failed to find a reasonable model. This was determined by unreasonably high ln(R0) values (>17) and significant dome-shaped selectivity, which presumes a good portion of individuals are cryptic right after maturity and presents an undetermined population size. An additional 50 jitter runs (jitter = 0.15 and 0.1) also failed to achieve a reasonable model (Figure R4b). The extension of adding a block in 2019 made no change in behavior and gave similar outrageous results. The two models produced worse AIC values (+2 and +10 AIC units respectively) compared to the base model, so the additional parameters did not improve the overall model fit but produced unrealistic scale estimates.
  <u>Conclusions</u>: Given the lack of improvement to model fit and unreasonable ln(R0) values, it was agreed that time blocking should not be implemented.

- Explore a decision table structure across the log-likelihood of M using the base model. Use the following catch streams: default harvest control rule under a category 2 designation (sigma = 1.0, P* = 0.45), P* = 0.4, and constant catch under an MSY (FMSY of 50% SPR).
  <u>Rationale</u>: Natural mortality is the major axis of uncertainty and this structure appears to be a good one for the decision table since these estimates directly affect estimation of OFLs. The catch streams appeared to be within a reasonable range.
  <u>Response</u>: Projections and tables were provided.

Conclusions: It was agreed that natural mortality was the major axis of uncertainty for the decision table. The decision table columns representing the appropriate M values from the likelihood were determined by fitting a parabola to the likelihood values over M and calculating values that were 0.66 units away from the optimum, corresponding to the 12.5%, 50%, and 87.5% quantiles.

After a multitude of requests and changes to the base models examined during discussions, the base models were selected as the best performing after alterations. For Southern California, two changes to the base model were incorporated 1) implement a time-block in 2017 to represent changes in selectivity for the commercial hook-and-line fishery resulting from regulatory changes, and 2) estimate steepness. For Northern California 1) adding a time block to the CCFRP index in 2017 after the survey was expanded, 2) having the CCFRP length compositions re-weighted to reflect the weighting used in the index, and 3) removal of the last year of the private/rental index (2020) due to sampling constraints during COVID.

Given the level of effort required to implement further changes, and the time available, further alteration of the models to address unresolved issues was just not possible. While the STATs did an excellent job of fulfilling those requests, further change to the model had to be done outside this peer review, as they require further in-depth exploration and in some cases data collection. As such no further improvements are recommended for this review.

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

After careful consideration, this reviewer agreed that these assessments represent the best available information and are useful in providing management advice. All of these assessments were recommended for a full benchmark review during the next assessment process. Of these, only Oregon was recommended by the Panel as a Category 1 stock, with the rest being recommended as a Category 2 stock.

This reviewer generally agrees with most of the Panel's conclusions on Oregon, but is hesitant on listing the stock as Category 1. Given the range of the uncertainty estimated by this model, the uncertainty surrounding the stock structure in this region, the knowledge that all of the other assessments for these stocks in the region were listed as Category 2, it might be more precautionary to list the Oregon assessment as a Category 2 stock. As such a recommendation is made.

Recommendation: Reconsider the Category 1 designation for Oregon. This reviewer did agree with the Panel to set the Category as 1 for Oregon based only on the guidance documents (PFMC, 2020). For practical reasons mentioned above, Oregon might be best served as a Category 2 stock.

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.

A multitude of research recommendations were made during discussions, including:

Overall

- There is a need for a coastwide hook and line surveys to provide indices of abundance and associated biological sampling providing representative data in untrawlable habitats. (High Priority)
- Additional genetic studies like the Saltonstall/Kennedy research mentioned in the California assessments or other additional research to further investigate population structure. (High Priority)
- Increase efforts to provide better resolution of aging error through intralab aging efforts. (High Priority)
- Collection of additional data from within MPAs from CCFRP or ROV surveys will provide representative data across the entire population to complement data collected in areas open to fishing. (High Priority)
- Expanding the California Collaborative Fisheries Research Project. (High Priority)
- ROV surveys in deeper depths than the current surveys. (Low Priority)
- Future research to examine how the data from the WCGBT may be used in assessments of rockfish species that are not commonly encountered by trawl gear. (Low Priority)
- A management strategy evaluation (MSE) focused on the effectiveness of single or combined species assessment models when assessing a complex of species. (Low Priority)
- Additional effort to resolve uncertainties in historical catch reconstructions. (Low Priority)
- Examine whether it is more efficient or accurate to use of numbers of fish vs. biomass as input for projections in the first two years in decision tables. (Low Priority)
- Additional fish tagging experiments may improve estimates of movement, mortality, and growth. (Low Priority)
- Investigate ways to better incorporate recreational discards into assessments, possibly using some of the methods currently used to model commercial discards. (Low Priority)
- Examine how to better account for asymmetric uncertainty through the use of Bayesian frameworks. (Low Priority)

Southern California

- Increase the amount of fishery-dependent age data collected.
- Additional research into methods to standardize the hook-and-line survey index and use the length and age data.

Northern California

- Further studies on larval/juvenile/adult movement via tagging or other methods are warranted to examine connectedness with Southern California.
- Examine the lack of fit in recent years to the PR index.
- Develop a fishery-independent index for this region.

Oregon

- Improve estimates of natural mortality.
- Further, investigate the Stephens-MacCall method for subsetting data used in indices.
- Carry out research to improve the understanding of functional maturity.

- Develop a Bayesian approach to the stock assessment of vermilion rockfish, particularly for stocks where available data are limited.

Washington

- Additional data collection to improve sample size to address the wide confidence bounds.
- Further evaluation of the results of the CARE otolith ageing exchange.

This reviewer would like to prioritize and condense some of the most pressing recommendations (in order of priority) across all of the regions.

Recommendation: Where possible investigate the initiation of fishery-independent indices of abundance. Extension of the NWFSC hook and line survey would be a good place to start. As was seen in some of the regional assessments, fishery-dependent indices are subject to not only harvester behavior, but also management regimes. Having a fishery-independent index could greatly reduce the uncertainty in employing index methods in these assessments. Moreover, it could serve as a platform for other samplings, such as aging, growth, and genetics.

Recommendation: Investigate the impact of COVID-19 effects on fishery-dependent indices and sampling. This has been an odd year given the pandemic. Fishery-dependent sampling from 2020-2021 will likely show some issues as a result of lockdowns, as well as a lack of sampling coverage. To that end, a thorough review of fishery-independent and dependent sampling across assessments coast-wide might be important in using this strange year of data in future assessments.

Recommendation: Continue with calibration of aging through the CARES system. The investigation of an aging error matrix in some of the models was welcome during this review. This reviewer fully supports the continuation of the CARES initiative to get a handle on aging error as well as potential regional differences in aging fish.

Recommendation: Hold a workshop to discuss and formulate best practices dealing with changing spatial management and its effect on fishery-dependent indices. Throughout this review, it was clear that changing spatial management in this region presented some complications for fishery-dependent indices, including changes to selectivity as well as availability. Holding a workshop to discuss and formulate best practices across assessments when management changes affect fishery-dependent indices will be important. Particularly as spatial management measures become a mode widely used tool in fisheries.

Recommendation: Hold a workshop and determine best practices for how to fully utilize hook-based fishery-independent methods survey methods. Clearly, this reviewer's preference is for fishery-independent indices as they can mostly get around some of the spatial management issues and harvester behavior issues mentioned above. Additionally, hook and line surveys are going to be the best tool for these two species, given their habitat preferences. However, hook and line surveys are difficult to standardize and model. There are some interesting issues with hook size, bait usage, saturation, depredation, and many others that can affect selectivity and availably to hook and line surveys. Are they useful as more of a relative index vs. an absolute abundance index? These and other questions are likely to be best answered during a broad workshop incorporating views from not only these two species but other species and assessments in the region.

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

In short, a five-day meeting was held remotely to examine sunset and vermilion rockfish assessment for Southern California, Northern California, Oregon, and Washington as part of the STAR process. The first day centered around the presentations of each of the stock's models, their structure, inputs, and parameterizations. The second through fourth days focused on requests to the STAT, to allow Panel members to explore model behavior, and to test the robustness to uncertainty. The fifth day was mostly for writing the STAR Panel report, with much time focused on follow-up questions and results from the STAT on the axis of uncertainty.

Conclusions and Further Recommendations

This was an educational and very informative review. In general, it was a lot of fun going through all of the different stocks given the wide variety of data sources and methods used. This reviewer found the issue of cryptic species very important to future work which is planned on this subject. A most enjoyable review, even if packed full of work for the week.

Both STATS that worked on these assessments should be commended for their work. Not only were they both thorough but were very amendable to Panel requests throughout the entire process. It cannot be stressed enough that both STATS did a great job in finding and utilizing all of the available data to inform these models. Moreover, the sheer volume of alternate runs and sensitivity analysis were amazing. Both teams did a great job in bringing these two cryptic species from a data-poor to mostly functional assessments worthy of providing management advice.

However, no assessment process is without room for improvement. To that point, a number of recommendations have been made, which this reviewer hopes will aid future work the next time around for these species/stocks assessments. That said, two additional recommendations may help produce a smoother meeting and easier report writing.

Recommendation: Send presentations for day one ahead of time. Presentations on introductory material, model formulations, data, inputs, sensitivities, and initial model behavior should be provided at least a few days prior to the meeting. Again, this is crucial for a remote meeting. Further having this information in one place ahead of time allows the reviewers to see each of the areas side-by-side, to compare and contrast. This would simply make the first couple of days of the meeting more productive, with less time spent on this introductory material.

Recommendation: STAT should relay key findings on the slides when responding to requests. During the request and response process between STATs and the Panel, this reviewer found that when key points and findings were listed on the slides used, it made the report writing phase easier. Often this reviewer, and others, found themselves trying to discern what the STAT was alluding to when writing up the Panel report. Having these findings in written form on the slides presented would bypass any misinterpretations during report writing.

References

Cope, J.M., T.-. Tsou, K. Hinton, C. Niles. 2021. Status of Vermilion rockfish (*Sebastes miniatus*) along the US West - Washington State coast in 2021. Pacific Fisheries Management Council, Portland, Oregon. 97 p.

Cope, J.M., A.D. Whitman. 2021. Status of Vermilion rockfish (*Sebastes miniatus*) along the US West - Oregon coast in 2021. Pacific Fisheries Management Council, Portland, Oregon. 124 p.

Dick, E.J., M.H. Monk, T.L. Rogers, J.C. Field, E.M. Saas. 2021. DRAFT The status of Vermilion Rockfish (*Sebastes miniatus*) and Sunset Rockfish (*Sebastes crocotulus*) in U.S. waters off the coast of California south of Pt. Conception in 2021. Pacific Fisheries Management Council, Portland, Oregon. 255 p.

Monk, M.H., E.J. Dick, J.C. Field, E.M. Saas. 2021. DRAFT The status of Vermilion Rockfish (*Sebastes miniatus*) and Sunset Rockfish (*Sebastes crocotulus*) in U.S. waters off the coast of California north of Pt. Conception in 2021. Pacific Fisheries Management Council, Portland, Oregon. 271 p.

Pacific Fishery Management Council (PFMC). 2020. Terms of reference for the Groundfish and Coastal Pelagic Species Stock Assessments Review Process for 2021-2022. Pacific Fishery Management Council.

APPENDICES

Appendix 1: Bibliography of materials provided for review

Budrick, J. 2016. Evolutionary processes contributing to population structure in the rockfishes of the subgenus genus Rosicola: implications for fishery management, stock assessment and prioritization of future analyses of structure in the genus Sebastes. PhD thesis, University of California, Berkeley.

Hyde, J.R.; Kimbrell, C. A.; Budrick, J. E.; Lynn, E. A.; Vetter, R.D. 2008. Cryptic speciation in the vermilion rockfish (Sebastes miniatus) and the role of bathymetry in the speciation process. Molecular Ecology 17: 1122–1136. doi: 10.1111/j.1365-294X.2007.03653.x.

Hyde, J.R., and Vetter, R.D. 2009. Population genetic structure in the redefined vermilion rockfish (Sebastes miniatus) indicates limited larval dispersal and reveals natural management units. Canadian Journal of Fisheries and Aquatic Sciences 66(9): 1569–1581.doi: 10.1139/F09-104.

Longo, G.C., Lam, L., Basnett, B., Samhouri, J., Hamilton, S., Andrews, K., Williams, G., Goetz, G., McClure, M., and Nichols, K.M., 2020. Strong population differentiation in lingcod (Ophiodon elongatus) is driven by a small portion of the genome. Evolutionary applications, 13(10), pp.2536-2554.

Methot, R. and Wetzel, C. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142 (2013) 86– 99.

Monk, M.H., Dick, E.J., and Pearson, D. 2014. Documentation of a relational database for the California recreational fisheries survey onboard observer sampling program, 1999-2011. NOAA-TM-NMFS-SWFSC-529.

Monk, M., Miller, R., Field, J., Dick, E.J., Wilson-Vandenberg, D., Reilly, P. 2016. Documentation for California Department of Fish and Wildlife's Onboard Sampling of the Rockfish and Lingcod Commercial Passenger Fishing Vessel Industry in Northern and Central California (1987- 1998) as a Relational Database. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-558. doi:10.7289/V5/TM-SWFSC-558.

Pearson, D.E.D., and Erwin, B. 1997. Documentation of California's Commercial Market Sampling Data Entry and Expansion Programs. National Marine Fisheries Service.

Pearson, D.E., Erwin, B., and Key, M. 2008. Reliability of California's groundfish landing estimates from 1969-2006. Tational Oceanic; Atmospheric Administration.

Ralston, S., Pearson, D.E., Field, J.C., and Key, M. 2010. Documentation of the California catch reconstruction project.

Thorson, J.T. and Barnett, L.A., 2017. Comparing estimates of abundance trends and distribution shifts using single-and multispecies models of fishes and biogenic habitat. ICES Journal of Marine Science, 74(5), pp.1311-1321.

Appendix 2: A copy of the CIE Performance Work Statement

Performance Work Statement

External Independent Peer Review by the Center for Independent Experts

Stock Assessment Review (STAR) Panel 2 - Virtual

Lingcod (Northern and Southern stocks)

July 12-16, 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.

Lingcod was last assessed in 2017 in two separate single-stock assessment models, addressing the stock in Washington and Oregon in the north, and the California stock in the south. That assessment estimated relative depletion of the northern stock at 57.9% of unfished biomass. The southern stock depletion was estimated at 32.1%, which falls within the precautionary zone for Pacific Fishery Management Council stocks. Lingcod are large opportunistic top predators in the nearshore demersal ecosystem of the northeast Pacific Ocean and are valued both commercially and recreationally in the U.S. groundfish fishery. They range from Kodiak Island, Alaska to Baja California, Mexico. The historical center of abundance is in the waters off British Columbia and Washington State. Male and female lingcod exhibit different life-histories in that the males guard nests in shallow water for 5-7 weeks in the fall, while the females remain in deeper water; accordingly, the sexes are represented independently in the model. Lingcod are harvested commercially by trawl and longline gear, and recreationally by hook-and-line and spear. In California, the recreational fishery accounts for more than 90% of the landings; in Washington and Oregon the landings are more evenly divided between the recreational and commercial fisheries.

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 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).

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 12-16, 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 **August 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 12-16, 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 2

The specific responsibilities of the STAR panel are to:

8. 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.
9. Discuss the technical merits and deficiencies of the input data and analytical methods during the open review panel meeting.
10. Evaluate model assumptions, estimates, and major sources of uncertainty.
11. Provide constructive suggestions for current improvements if technical deficiencies or major sources of uncertainty are identified.
12. Determine whether the science reviewed is considered to be the best scientific information available.
13. 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.
14. 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.

Participants

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

Stock Assessment Review (STAR) of Vermilion and Sunset Rockfishes

Pacific Fishery Management Council
Via Webinar
All Times are Pacific Daylight Time and Subject to Change During the Course of the Meeting at the Discretion of the STAR Panel Chair
July 26-30, 2021

Monday, July 26, 2021 – 8:30 AM

Early Log-In to Resolve Connection Issues
(8:30 a.m.)
Welcome and Introductions
(8:45 a.m.)
1. Roll Call and Introductions John Budrick, Chair
2. Review Terms of Reference John Budrick
3. Review and Approve Agenda
4. Review Virtual Format Operational Guidelines John DeVore
5. Assign Writing Duties John Budrick

Overview of the Vermilion and Sunset Rockfishes Assessment
(9:15 a.m.)
1. Biology, Fisheries, Data, and Inputs Used E.J. Dick and Melissa Monk

BREAK (10:15 – 10:30 a.m.)
2. Assessment Modeling, Performance, and Current Status of Vermilion and Sunset Rockfishes South of Pt. Conception E.J. Dick
3. STAR Panel Requests to the Stock Assessment Team (STAT-1)

LUNCH BREAK (12:00 – 1:00 p.m.)
4. Assessment Modeling, Performance, and Current Status of Vermilion and Sunset Rockfishes North of Pt. Conception Melissa Monk
5. STAR Panel Requests to the Stock Assessment Team (STAT-2)

BREAK (2:30 – 2:45 p.m.)
6. Assessment Modeling, Performance, and Current Status of Vermilion and Sunset Rockfishes in Oregon Jason Cope
7. STAR Panel Requests to the Stock Assessment Team (STAT-3)

8. Assessment Modeling, Performance, and Current Status of Vermilion and Sunset Rockfishes in Washington Jason Cope
9. STAR Panel Requests to the Stock Assessment Team (STAT-4)

BREAK (4:15 – 4:30 p.m.)
Public Comments
Adjourn for the Day
(After Public Comments)
Tuesday, July 27, 2021 – 8:30 AM
Early Log-In to Resolve Connection Issues
(8:30 a.m.)
Responses to Panel Requests for STAT-1
(8:45 a.m.)
1. Presentation of Modeling Results E.J. Dick
2. Further Discussion of Modeling Results
3. Additional STAR Panel Requests to STAT-1

BREAK (10:00 – 10:15 a.m.)
Responses to Panel Requests for STAT-2
4. Presentation of Modeling Results Melissa Monk
5. Further Discussion of Modeling Results
6. Additional STAR Panel Requests to STAT-2

LUNCH BREAK (12:00 – 1:00 p.m.)
Responses to Panel Requests for STAT-3
7. Presentation of Modeling Results Jason Cope
8. Further Discussion of Modeling Results
9. Additional STAR Panel Requests to STAT-3

BREAK (2:15 – 2:30 p.m.)
Responses to Panel Requests for STAT-4
10. Presentation of Modeling Results Jason Cope
11. Further Discussion of Modeling Results
12. Additional STAR Panel Requests to STAT-4

Public Comments
(3:30 p.m.)
STAR Panel Discussion/Planning (as needed)
(4:00 p.m.)
Adjourn for the Day
(4:30 p.m.)

Wednesday, July 28, 2021 – 8:30 AM

Early Log-In to Resolve Connection Issues
(8:30 a.m.)
Responses to Panel Requests for STAT-1
(8:45 a.m.)
1. Presentation of Modeling Results E.J. Dick
2. Further Discussion of Modeling Results
3. Additional STAR Panel Requests to STAT-1

BREAK (10:00 – 10:15 a.m.)
Responses to Panel Requests for STAT-2
4. Presentation of Modeling Results Melissa Monk
5. Further Discussion of Modeling Results
6. Additional STAR Panel Requests to STAT-2

LUNCH BREAK (12:00 – 1:00 p.m.)
Responses to Panel Requests for STAT-3
7. Presentation of Modeling Results Jason Cope
8. Further Discussion of Modeling Results

9. Additional STAR Panel Requests to STAT-3

BREAK (2:15 – 2:30 p.m.)

Responses to Panel Requests for STAT-4

10. Presentation of Modeling Results Jason Cope
11. Further Discussion of Modeling Results
12. Additional STAR Panel Requests to STAT-4

Public Comments

(3:30 p.m.)

STAR Panel Discussion/Planning (as needed)

(4:00 p.m.)

Adjourn for the Day

(4:30 p.m.)

Thursday, July 29, 2021 – 8:30 AM

Early Log-In to Resolve Connection Issues

(8:30 a.m.)

Responses to Panel Requests for STAT-1

(8:45 a.m.)

1. Presentation of Modeling Results E.J. Dick
2. Further Discussion of Modeling Results
3. Agreement of a Preferred Model Between the STAR Panel and STAT-1
4. STAR Panel Requests for Model Runs for the Decision Table

Responses to Panel Requests for STAT-2

1. Presentation of Modeling Results Melissa Monk
2. Further Discussion of Modeling Results

BREAK (10:00 – 10:15 a.m.)

3. Agreement of a Preferred Model Between the STAR Panel and STAT-2
4. STAR Panel Requests for Model Runs for the Decision Table

LUNCH BREAK (12:00 – 1:00 p.m.)

Responses to Panel Requests for STAT-3

1. Presentation of Modeling Results Jason Cope
2. Further Discussion of Modeling Results
3. Agreement of a Preferred Model Between the STAR Panel and STAT-3
4. STAR Panel Requests for Model Runs for the Decision Table

BREAK (2:15 – 2:30 p.m.)

Responses to Panel Requests for STAT-4

1. Presentation of Modeling Results Jason Cope
2. Further Discussion of Modeling Results
3. Agreement of a Preferred Model Between the STAR Panel and STAT-4

4. STAR Panel Requests for Model Runs for the Decision Table

Public Comments
(3:30 p.m.)
STAR Panel Discussion/Planning (as needed)
(4:00 p.m.)
Adjourn for the Day
(4:30 p.m.)

Friday, July 30, 2021 – 8:30 AM

Early Log-In to Resolve Connection Issues
(8:30 a.m.)
Consideration of Remaining Issues
(8:45 a.m.)
1. Discussion of Proposed Base Models
2. Review Decision Tables for All Assessments

BREAK (10:00 – 10:15 a.m.)

6
3. Review Any Possible Disagreements from GMT, GAP, and PFMC Advisors
4. Identify Research and Data Needs
5. Category Designation and Recommendation for Next Assessment Type

Public Comments

(11:00 a.m.)

LUNCH BREAK (11:30 a.m. – 1:00 p.m.)

Review Draft STAR Panel Report

(1:00 p.m.)

1. Discuss Deadlines for Report Submission
2. Review and Discuss Draft Report

BREAK (2:15 – 2:30 p.m.)

STAR Panel Discussion/Planning (as needed)

(2:30 p.m.)

STAR Panel Adjourns

(4:30 p.m.)