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Proceedings of the Pacific regional peer review on Blackspotted / Rougheye Rockfish (Type I and Type II) stock assessment for British Columbia in 2020

May 26 and 27, 2020
Virtual Meeting

Chairperson: Greg Workman
Editor: Midoli Bresch

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Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting on May 26-27, 2020, held virtually via a video conferencing platform (Zoom). A working paper presenting a stock assessment of two spatially delineated stocks of the Blackspotted / Rougheye Rockfish species complex (REBS) was presented for peer review.

Virtual participation included DFO Science, Groundfish Management Unit (GMU) staff, Policy staff, and external participants from First Nations organizations, the commercial fishing sector, representatives for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), environmental non-governmental organizations, Province of British Columbia (BC), and the National Oceanic and Atmospheric Administration (NOAA).

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report (SAR) providing advice to Fisheries Management to facilitate management of the REBS species complex.

The Science Advisory Report and supporting Research (RES) Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held on May 26-27, 2020 using a video conferencing platform (Zoom). The meeting was arranged for virtual attendance (only) in light of the Covid-19 restrictions. The purpose of the RPR was to review a stock assessment for two spatially delineated stocks of the Blackspotted / Rougheye Rockfish (REBS) species complex.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from DFO Fisheries Management. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations organizations, the commercial fishing sector, representatives for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), environmental non-governmental organizations, Province of British Columbia (BC), and the National Oceanic and Atmospheric Administration (NOAA).

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting (working paper abstract provided in Appendix B):

Starr, P.J. and Haigh, R. 2020. Rougheye/Blackspotted Rockfish (Sebastes aleutianus/melanostictus) stock assessment for British Columbia in 2020. CSAP Working Paper 2015GRF03

The meeting Chair, Greg Workman, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process and the virtual platform for the meeting. The Chair discussed the role of participants, the purpose of the various RPR publications (Science Advisory Report, Proceedings, and Research Document), and the definition and process for achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, working paper, and draft SAR.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference (Appendix A) for the meeting, highlighting the objectives and identifying the Rapporteur. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation regarding social and economic implications.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 29 people participated in the RPR (Appendix D). Midoli Bresch was identified as the Rapporteur for the meeting.

Participants were informed that Zane Zhang (DFO Science) and Paul Spencer (NOAA) had been asked before the meeting to provide detailed written reviews for the working paper, to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report to Fisheries Management to inform fisheries management for the above-noted stocks. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEW

Working Paper:	Blackspotted / Rougheye Rockfish (*Sebastes aleutianus/melanostictus*) stock assessment for British Columbia in 2020. 2015GRF03
Rapporteur:	Midoli Bresch
Presenter(s):	Paul Starr and Rowan Haigh

PRESENTATION OF WORKING PAPER

The authors began with a summary of the life history, depth distribution, and fishery characteristics for the species complex, divided into two stocks defined by an agreed spatial definition specified in the Terms of Reference (TOR). They also summarized the management and conservation history and discussed the extent of genetic work aimed at splitting the REBS species complex into the two species (Blackspotted and Rougheye Rockfish). They discussed their reservations with some of the genetic data, which were almost entirely available from surveys, had limited temporal coverage, and required additional supporting analyses. The approach taken by the authors, which was agreed at a Technical Working Group meeting held in July 2019, was to divide REBS catch and survey data into two spatial areas (north: 5DE plus a proportional split of 5C catch; south: 3CD5AB plus a proportional split of 5C catch), with two fisheries per stock (trawl, and a combined hook and line/trap fishery). Four surveys were used in the assessment, as the remaining surveys, including line surveys, were excluded because of inadequate depth or spatial coverage to be representative of REBS. The passive Sablefish trap survey was also omitted because of uncertainty in its representativeness. The authors pointed out that the West Coast Haida Gwaii (WCHG) synoptic survey was the most important survey for this species complex, given its much higher incidence in this survey compared to the other surveys in the models.

The authors assembled a composite base case model around two axes of uncertainty: natural mortality and the degree to which the catch per unit effort (CPUE) time series was fitted by the model (by altering the amount of process error). A third axis of uncertainty, ageing error, was explored in sensitivity runs. The presenters mentioned an issue with seamount age data, wherein catches from seamounts were excluded from the stock assessment (they are thought to be a separate stock and not part of the main BC stock--there was agreement from other DFO biologists on this point), but seamount age data had been included in the age frequency data used in the model results presented in the draft research document distributed before the RPR. However, corrected results were made available in the presentation at the RPR. The authors indicated that, although they chose nine models to make up the composite base case, they were flexible about which final models to include in the composite base model and were seeking advice from the participants.

There was an inadequate amount of age data available for the REBS south stock, leading to poor Markov Chain Monte Carlo (MCMC) diagnostics and a consequent need to fix the survey selectivity parameters in order to obtain acceptable MCMC diagnostics. In addition, priors for the commercial fishery selectivity parameters were developed from the REBS north model runs.

Results for the REBS north stock tended to be relatively optimistic, reflecting an overall upward trend in the CPUE series. On the other hand, the REBS south stock model results tended to be pessimistic, reflecting an overall downward trend in its CPUE series. The REBS north stock was assessed to be above the DFO precautionary reference points as a composite base case, as were all nine component runs. The REBS south stock composite base case was above the DFO

precautionary reference points; however, several of the component runs were in the Cautious zone. Projections predicted that the stock would decline at current levels of catch.

There was a wide gap in the commercial fishery age frequency data spanning 2007 to 2017, which could not be rectified for the stock assessment, in part due to the shut down of the ageing laboratory because of covid-19 (only 10% of the requested samples had been analyzed before the closure of laboratories in DFO facilities). All models were included in the proposed composite base case for both REBS stocks, but the authors noted that some of the REBS south runs featured poor MCMC diagnostics and could be dropped.

CLARIFICATION QUESTIONS FOLLOWING THE PRESENTATION

- There was a question from a participant about whether data for hook and line events included trap gear. The response was that the Other fishery combined hook and line data with commercial trap catch and age frequency data.
- The next question was about why the Sablefish trap survey was not being used for the assessment, to which the authors replied they hadn't used it because they were uncertain as to what the survey catches represented in terms of the overall stock. It is a passive collection procedure, catches are relatively low, but the authors made it a research recommendation to understand what it demonstrates before using it in future assessments.
- Another participant asked about whether exclusion of seamount data affected the survey data. No, there were no trawl survey tows in the seamount area.
- There was a discussion about biological data from the seamounts. The authors pointed out that while the fishing was done in commercial vessels, the trips were primarily chartered. Because of this, the ageing data should have been marked as research in origin rather than from commercial fishing.
- There was another question about whether the seamount REBS were considered part of the northern stock? One of the participants responded that, for Yelloweye Rockfish, the genetic data showed the seamount fish did not comprise a distinct stock. Further, the prevailing currents indicated that the seamounts were sinks, not source populations for the rest of the BC coast. A participant noted that the movement of Sablefish was mostly one way to the seamounts as well. A participant noted that the catch data go back over a long period, and there was a significant longline catch in the 1980s-90s off the seamounts. He asked whether the authors were able to differentiate that catch? They responded that they can only identify seamounts by a combination of major, minor, and locality areas, so if those three fields are missing they cannot identify where the catch came from. For purposes of the assessment, the biological and commercial data from Bowie Seamount were removed.
- A question arose about the increasing commercial CPUE trend for the REBS north stock and whether it reflected fishing changes or changes in abundance? The authors noted that the CPUE standardization procedure removes depth and latitude effects which corrects for some fishing adjustments. Authors believe CPUE is a reasonable signal for the species.
- Participants brought up delineation of the two species within the complex and stated they wanted sufficient time to talk about the split of the two. Authors say they expect a lot of talk about this in the general discussion.
- It was agreed that the authors would re-create a modified composite base case for the southern stock, excluding results from the MCMC runs that had not converged (runs 4, 7, and 8). They would present the revised results on day 2. These results were accepted by the participants and it was agreed they would be incorporated into the SAR.

PRESENTATION OF WRITTEN REVIEWS

PAUL SPENCER

The main comments and discussion are listed below.

- Concerning the spatial split of the two stocks: the reviewer did some calculations on field identification information from Creamer (2016, Master's thesis), to compare with the genetic percentages identified by the authors of the working paper. The simple analysis showed that technician identifications (IDs) in the field were comparable to splitting them out by areas. Otolith morphology might also be a promising area to consider for these species. The authors response was that IDs in the field were done strictly by DFO science staff, not observers. The commercial observers do not make any attempt to identify to species. DFO also has an otolith morphology experiment in progress. The authors note that they have reservations about the Creamer analysis because the author did not divide the data in half to see how well a model based on the first half would predict the second half. In other words, the author did not attempt to validate the model.
- The reviewer commented about doing sensitivity analyses on the species split and looking at the effect of error in spatial apportionments. The response was that any changes in catch apportionment between the two stocks would not necessarily deal with the misidentification issue (in sensitivity tests), because it wouldn't change the total catch, just the ratio of catches (e.g., the catches were split up by area so catches you take from one you need to add back to the other). The proportions were taken from a range of surveys over six-seven years - a mix of years and surveys. The coverage is also not consistent across years. So to use these data as a proxy for species split is questionable and requires supporting analyses.
- The authors pointed out that it is accepted that genetic differentiation among stocks within the same species gets wiped out if there is even a small amount of genetic exchange between stocks. One of the authors consulted with a geneticist who agreed that with free genetic exchange, it may be hard to maintain two separate species. The hybrids occur all the way through the spatial distribution of the two species, suggesting that we need to be confident that these are really two distinct species. Further genetics analysis is required. A participant commented that they may be currently undergoing speciation, so the genetic distance should increase over time. Another participant said that the Creamer analysis was done before we had much of this data, and we have a lot more now. The hybrids may be less successful than the pure species, therefore over time that would lead to a divergence of the two species. A participant claimed that hybridization is common amongst rockfish species.
- The authors acknowledged that the broad spatial split is an oversimplification, but that was what was agreed upon at the start of the analysis and is reflected in the TOR. It makes sense that there are not these sharp spatial divisions between stocks. Another participant noted that we should look back at why we are considering these as two species if they can be managed adequately as a species complex.
- The reviewer asked why the authors modelled males and females separately, even though the two sexes were very similar in growth rate and age distribution: The authors responded that they always did their age structured models as two sex models, but thought that it would not make that much difference to results. The authors agreed that a single sex model may have been a better choice, given the paucity of age frequency data, and would consider it in future assessments of this species set.

- The reviewer asked whether the authors had explored age-length keys. Authors responded that it could be useful in the survey data, but almost all of the samples were aged anyway. Because the commercial fishery is a year round fishery, there would need to be age-length keys for each season. You would have to match the ages and the lengths quite carefully and these data are not available.
- The reviewer suggested that the authors might try plotting the age distribution bins as bar graphs, and asked why the plus group was so old (80+). The authors responded that they were worried about lowering the plus group too much because estimates of stock status may change, and thought that since these fish were so old they might be criticized for having a lower plus group. They pointed out that zero observations do not have a lot of weight due to the assumed robust normal distribution used to fit the age data. The real issue is the need for better age sampling. A participant asked if they had considered using the Dirichlet distribution. The authors did not consider it for this assessment, as they were constrained by the software they were using. The participant made a further comment about the Dirichlet distribution, which is used in the Hake stock assessment, and mentioned that this approach was worth considering for future stock assessments.
- The reviewer noted that his comment on the ageing error matrix had been addressed by the authors already, in work completed after the original draft had been submitted for review.
- The reviewer asked whether the authors had considered removing the National Marine Fisheries Service (NMFS) triennial survey. The authors did this run in response to the review, but it did not change the outcome because there was little contributed information by this survey and selectivity had been fixed.
- The reviewer was concerned about the potential for hyperstability in the CPUE index and asked if the authors had thought this. The reviewer mentioned ways to check for hyperstability (e.g., by computing how the spatial contribution to the CPUE changed over time). The authors responded that they had not done this type of analysis but, when the CPUE was compared to the West Coast of Haida Gwaii (WCHG) survey, the match was acceptable (presented in Appendix C of the Resdoc). The reviewer did not share the same opinion as the authors about the quality of the match to the CPUE index by the survey series. The authors responded that the first survey point was from a different survey design, and that there were almost ten years between the first and second data points.
- How did the authors account for ageing error in the growth modelling? The authors responded that CVs were calculated from observed lengths and ages, i.e., they were not model-derived. How ageing error was incorporated into the random effects model was uncertain because the Bayesian model adopted was provided by a colleague and relied on Stan (a probabilistic programming language). The authors will review this model more carefully if used in future assessments.
- How did the authors deal with ageing error in the maturity ogives? The maturity ogive in the model is treated as data, used by the model to split out the mature stock females from the total female stock, and applied without error in every year. Maturity remains constant over time, and only affects the spawning stock estimate for the reference points and in the stock recruitment relationship.
- The reviewer asked whether the authors had considered using dome-shaped selectivity because rockfish may move to deeper grounds as they age, pointing out that there is some evidence of this in Alaska. The authors responded that it is prudent to assume no dome-shaped selectivity unless there is good evidence that older fish are not caught by fishing gear, and did not think this was true for these stocks.

- The reviewer asked why the strength of recruitment in 2021 was so much larger than other years. The reviewer suggested that the authors do a retrospective analysis to see how much recruitment estimates have changed over time with the addition of new data. In response, the authors thought that a retrospective analysis in this instance would be relatively non-informative because the commercial ageing data were not available between 2006 and 2018.
- The reviewer had concerns about the age-frequency reweighting and wondered if the authors had performed enough iterations to stabilize the weights. The authors replied that they typically do one or two reweights and assess how much change occurs between reweights, opting to stop once that weights on age composition (based on mean age) stop changing and/or once the standard deviation of normalised residuals (SDNRs) for the composition data converge on unity.
- In response to the question about maturity ogives and the discontinuity at age 11, the authors agreed that in future they could try putting a penalty on deviations from 0 at a younger age to try and get smoother curves. The reviewer offered to provide code for this situation and the authors accepted.

ZANE ZHANG

The main comments and discussion are listed below.

- Concerning the steepness parameter, the reviewer wondered why the authors did not use a prior and try to estimate steepness for the working paper. The authors responded that it became clear from the early runs of the REBS north stock that the stock status was going to be pretty high, and so the steepness parameter would not come into play (usually has an effect when stock status is low). With the limited data available, it was expedient to fix this parameter. Stock status for the REBS south stock was not as high as that in the north, but the authors struggled to get the southern model to work at all without trying to estimate another parameter. The reviewer wanted to know if the authors had a sense of how sensitive the stock projections were to different values of steepness. They responded that it would likely have an effect for the southern complex, but that lots of stock assessments fix the value of steepness. The authors did not have time to do sensitivity analyses on steepness. The reviewer thought 0.7 seemed like a high value, but the authors responded that it is an average estimate (based on previously used priors for rockfish), and that American scientists are using higher values for rockfish currently. This was confirmed by the reviewer from Alaska.
- Regarding the weighting of the MCMC samples for each composite case: for the REBS north stock, the MCMCs had good diagnostics, but the authors agreed that MCMC diagnostics for some of the component runs for the REBS south stock looked poor. The authors noted that they would rather drop them altogether than include them with a lower partial weight. The authors also mentioned that the procedure for weighting various component runs from Bayesian analyses was not well-established.
- In response to the reviewers question about excluding some survey series, the authors responded that there is no reason to believe that one survey is better than the other. The locations of the surveys are different, but they cover the depth distribution of the species adequately, and are thought to be representative of the stock. There is no reason to believe that some are more representative than others. Non-representative surveys had already been excluded.

- The reviewer wondered why the authors did not include formal MCMC diagnostic tests in the working paper. The authors replied that they have done so in the past, but different diagnostic tests yielded inconsistent results. The reviewer agreed that visually assessing the MCMC diagnostics was adequate, but would like more description of the criteria used in the working paper.
- A retrospective analysis was suggested for base cased model results. The authors acknowledged a desire to do so, but that this would require adopting a different model software (e.g., Stock Synthesis).
- There was a comment about recruitment levels, to which the authors replied that recent recruitments (i.e., after 2000) in the REBS north stock were lower than the long-term average (see Figure F.14 in the WP). The authors noted that virgin recruitment and the associated unfished biomass reflect average recruitment over the entire period of model reconstruction.
- The reviewer would like a better description of what the “Soft limit” is (regarding New Zealand metric).
- The reviewer asked if they had looked for autocorrelations within their projections but the authors said the software they used doesn’t allow for auto-correlation in projections. This is a good suggestion for incorporation into future assessments.
- The reviewer suggested that the authors include the value of the Mode of Posterior Distribution (MPD) in important table captions. The authors disagreed that the MPD should be in the tables, stating they are simply a starting point used for the MCMCs. The MCMC posterior statistics are the results used for providing management advice.

GENERAL DISCUSSION

- Another participant prepared some written comments and suggestions on the working paper, which he presented during the meeting (Appendix E). He suggested that the authors include retrospective analysis in future stock assessments. They responded that they are limited by the capabilities of their current modelling software and by time constraints, but they are looking into alternative software to include retrospective analyses in future assessments. Another recommendation was to use a Tweedie GLMM instead of a delta-lognormal GLM. The authors agreed that this model could be used. The participant also brought up the Dirichlet distribution, and noted that he thinks it is available in the Stock Synthesis assessment software.
- A participant asked about whether the authors had explored a higher-order length-fecundity relationship but the answer was no, fecundity was assumed to be proportional to weight (which usually has a cubic relationship to length).
- A participant asked if DFO management requested a harvest rate policy over a constant catch policy, could a CSAS Science Response process be used to prepare advice on Total Allowable Catch (TAC). The authors replied that in order for a harvest rate policy to work, you would need to have an abundance indicator (e.g. a trawl survey) that was trusted. The best approach would be to build a management procedure using that information. The authors had attempted to calculate TACs associated with the harvest rates, but stopped because it would require separate selectivities from two modelled fisheries (to derive vulnerable biomass), requiring an assumption that there is a constant ratio of catches between the two fisheries.

- The chair asked why, when natural mortality was estimated, it was so much higher than expected for such a long lived species. The author responded that this model did not converge, so it wasn't a reliable estimate. It could be due to lack of informative data (e.g, sampled older ages).

SPATIAL SPLIT

- The chair asked whether the participants were willing to accept the justifications for splitting the REBS species complex into spatial stocks, and whether the two resulting stock definitions were acceptable. The chair noted that in regards to a species specific split, the needs are mostly related to Species at Risk (SAR) and COSEWIC, whereas the Marine Stewardship Council (MSC) certification requirements are less definitive. A participant noted that there are parallels between this process and the Yelloweye Rockfish process, which seem to suggest that some spatial considerations are important for management (i.e., the REBS north stock appears to be faring better than the REBS south stock). The authors reiterated that the species-specific distribution is not well established and much more work is required to get the data necessary to do species-specific assessments. The participants agreed that it is important to remove species-specific references in the working paper text and focus on the species complex and how it appears to have different estimates of stock status in the north versus the south.
- A participant asked whether the assessment was robust enough to allow managers to manage the complex for 3CD5AB and another management area for 5CDE. It was pointed out that 5C is not a high catch area and the catch appeared to be more Blackspotted than Rougheye (similar to the northern stock complex). The authors noted that the addition of 5C to 5DE would be inconsequential to the results of the assessment (without having to redo the entire analysis) because of the low catches of REBS in that area, as well as the large uncertainty in both stock assessments, especially for the southern stock assessment results. This arrangement was agreed to by participants as a pragmatic approach for management.
- There was some discussion about the amount of juvenile REBS caught in Queen Charlotte Sound and Hecate Strait (as evident in the relevant synoptic surveys) and whether this was a significant observation. According to survey technicians the best survey for juveniles is the Hecate Strait synoptic trawl survey. It was suggested that these data may be useful for getting a sense of the ecology of juvenile REBS. Juvenile REBS also show up in the Queen Charlotte Sound synoptic survey and possibly in the QC Sound shrimp survey. While the incidence of small REBS is high in the Queen Charlotte Sound synoptic survey, they are too small to contribute much to the overall biomass estimate. A participant pointed out that an analysis of juvenile data could also be useful for the Marine Protected Area (MPA) process, in terms of identifying important juvenile rockfish habitat to include within MPA boundaries.
- The authors emphasized again the need for further work to refine the understanding of the two species / stock complex question, in terms of why the genetic separation persists (is it related to depth, habitat preference, etc.) The stock complex division used in this analysis may need to be re-examined in future stock assessments as new data and analyses become available.

COSEWIC/SARA CONSIDERATIONS

- The chair asked the participants from COSEWIC and the DFO SAR program (SARP) whether they were satisfied with the assessment, in light of the lack of species-specific conclusions and also whether there were further analyses for the authors to undertake.

- The participants from the DFO SARP acknowledged that they are a long way off from being able to deal with the issue on a species-specific basis and that they did not have any criticism of the way the authors have dealt with the species question in the analysis at the present time. The SARA listing in 2009 of two Designatable Units (DUs) - Rougheye Rockfish Type I and II – as Special Concern was based on the 2007 COSEWIC assessment. In accordance with the listing, a Management Plan was developed in 2012 with objectives that focus on monitoring, managing and assessing these DUs so they are maintained at sustainable levels, using, for example, DFO Science surveys, commercial CPUE data, and management tools under the Commercial Groundfish Integrated Program. If new information emerges that suggests a conservation concern for either part of the REBS stock complex, or COSEWIC produces a new assessment of the DUs structure or status, then SARA would address these topics at that time.
- The participant from COSEWIC noted that they might need to re-evaluate DU status but for the purposes of this document, the analysis appears to be the best that can be done at this time. There was some concern about the document saying that REBS south (originally called 'Rougheye Rockfish' in the working paper) is close to the cautious zone, but that interpretation has changed. Now, the document reports that one spatial unit of the complex is closer to the Cautious zone than the other. The resolution of this point is not an issue for DFO, other than the long-term goal to address the data gaps (e.g. species specific catch, habitat considerations). In terms of management and assessment, COSEWIC/SARP are confident that DFO has met its responsibilities.
- An author asked whether the 1.5-generation projection period was acceptable given COSEWIC criteria (projections to 3 generations). COSEWIC responded that they need to rethink that point but suggested that the authors do not need to undertake any further work at this time. The authors pointed out that long projection periods (for long-lived species) remains highly uncertain.

COMMERCIAL FISHERY DATA COLLECTION

- Participants agreed that it will be important to start identifying to species level in the commercial fishery catch if there is ever to be species-specific assessments of the REBS complex.
- A DFO participant noted that when REBS are encountered on the surveys they are always assigned a "species guess" by the DFO technician, but that they don't know how well these guesses line up with genetic information yet. Participants also mentioned recent otolith morphology work in the Pacific Biological Station ageing lab, which could be used in the future to address the species identification question. If the morphology criteria are sufficiently predictive, it may be possible to use this procedure to estimate species composition in earlier survey and commercial fishery catches that have associated otolith collections.
- There was a question raised about the process necessary to obtain information that science needs from commercial sampling to improve future assessments. Is a separate science advice process warranted to review the current commercial sampling program design? There was talk about how the amount of commercial sampling (especially otolith collection) has declined since the 2000s and the authors did not know why this was occurring. DFO Groundfish participants agreed that there should be a review of the level of sampling achieved in each year to determine if these levels were adequate for stock assessment purposes. There was agreement that a review of the DFO Groundfish bio-sampling procedures should be conducted.

- A participant pointed out that while this question was discussed in connection with commercial fishery sampling, it was also relevant to recreational and Food, Social and Ceremonial (FSC) fisheries as well.

REASSESSMENT TIMELINE

- A participant questioned whether the reassessment timeline should be shortened from ten years, given that the REBS south stock was estimated to be near the Cautious Zone. It was recognized that staff availability and resources are often the limiting factor.
- A participant from DFO reminded the review group that there are many ageing samples in the queue for processing, and these would contribute to further analysis before the ten year period is up. Another participant noted that the decision should be based on existing trends and conditions, not the resources available to DFO. The authors reminded the group that because the surveys are not done every year, there would not be much additional data within 5 years for a complete reassessment.

WORKING PAPER RECOMMENDATIONS

- There was some discussion around research recommendation #2 (i.e., to consider the relationship of single-species stock assessments in the context of the overall ecosystem). A participant noted that this recommendation appears in many past assessments but wanted clarification on what the authors intended by the recommendation. The authors responded that stock assessments are often criticized for being single species focused, but it is not clear how this kind of study would be done. Quantitative multi-species models require large amounts of data while the authors barely had enough data to do the analysis in the working paper. This research recommendation appears, essentially as a placeholder for future work.
- Another participant stated that perhaps academia could help take this from just a recommendation to a reality. The chair pointed out that there are several national working groups working on how to incorporate ecological considerations into stock assessments. The participant responded that the literature on resilience is quite extensive and encouraged DFO to continue pursuing this line of inquiry to better understand the relationship to the management of marine resources.

CONCLUSIONS

- The working paper was accepted, with minor revisions, at the conclusion of the regional peer review process and the participants agreed that the TOR objectives had been met.
- It was agreed that the spatial split for the two stocks of the REBS species complex presented by the authors was acceptable for management purposes, and that 5C could be managed as part of either stock area (5DE or 3CD5AB) without much consequence to the stock status in either area.

RECOMMENDATIONS & ADVICE

- Develop procedures to collect biological data from hook and line commercial fisheries.
- For future stock assessments, attempt to clarify the spatial structure of the stock (this will likely depend on advancing genetic testing and methodologies).

- Analyze juvenile REBS data in more detail; captured in various surveys (e.g., Hecate Strait synoptic, Queen Charlotte Sound synoptic, Shellfish trawl).
- To avoid multiple interpretations, the RES and SAR documents should be consistent when referring to the stock complex and the spatial stocks.
- The recommendation for reassessment remains at ten years from now (2031); however, indicators (e.g., survey trends) should be agreed upon which could trigger an assessment earlier if new information warranted concern for the stocks.
- Prioritize work on otolith morphology for species specific identification.

ACKNOWLEDGEMENTS

We appreciate the time contributed to the RPR process by all participants. In particular, we thank the reviewers, Paul Spencer and Zane Zhang for their time and expertise. We also thank Greg Workman as Chair of the meeting and Midoli Bresch as the Rapporteur.

APPENDIX A: TERMS OF REFERENCE

BLACKSPOTTED / ROUGHEYE ROCKFISH (TYPE I AND TYPE II) STOCK ASSESSMENT FOR BRITISH COLUMBIA IN 2020

Regional Peer Review – Pacific Region

May 26-27, 2020

Nanaimo, BC

Chairperson: Greg Workman

Context

The Blackspotted (BSR or Type I) / Rougheye (RER or Type II) Rockfish (Sebastes melanostictus and aleutianus, respectively) species complex (REBS) ranges from northern Japan to southern California at depths of 200 to 800+ m along the shelf break. These two species are among the longest lived Sebastes, with maximum recorded ages of 147 y (Type I) and 125 y (Type II) (based on the areal definitions made below) in British Columbia (BC) waters and 205 y in Southeast Alaska (most likely a Type I specimen), and with a current estimate of natural mortality of M=0.035 (McDermott 1994). The REBS complex is intercepted by trawl nets, hook and line gear, and the Sablefish trap fishery, and is a key species caught in the BC multispecies integrated groundfish fishery. The species complex has been managed as a single population of Rougheye Rockfish, pending advice on species identification methodologies and the implications of various harvest strategies on expected stock status for each species within the complex. Differentiating between these two species is done through genetic sampling because it is not possible to reliably distinguish between these species by visual inspection. Genetic sampling has also determined that these two species hybridize, further confounding the capacity to separate REBS observations in the catch or surveys.

Abundance information for this species in Canadian waters comes from surveys, and the indices are characterized by high relative error and show no trend over time for the combined species complex. The BC commercial fishery has a reported catch of REBS between 690 and 1,340 tonnes annually over the last two decades, with a mean annual catch of 820 t from 2015 to 2019. Survey abundance indices have insufficient species identification information to be able to differentiate between Type I and Type II observations in most years. New methodologies must be developed before stock assessments based on species-specific data can be attempted. Such stock assessments will require developing procedures capable of differentiating historical catches (commercial and survey) by species. This is needed because the large majority of the historical information has been reported as RER but comprises the combined species complex. In the interim, while these methodologies are being developed, each species can be approximately defined by the Pacific Marine Fisheries Commission reporting area, where REBS data from areas 5DE are assumed to be BSR (Type I) and REBS data from areas 3CD5AB are assumed to be RER (Type II). REBS data from area 5C are considered to be in a zone of hybridization (Creamer 2016) and consequently will be omitted from the stock assessment except to proportionately distribute the combined catch among the two species.

A quantitative stock assessment has never been undertaken for either BSR or RER. ‘Blackspotted/Rougheye Rockfish Type I and II’ are listed as Special Concern under Schedule 1 of the Species at Risk Act and assessed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007). An assessment of the species complex has also been identified as a condition of the Marine Stewardship Council certification of the Hake and Halibut fisheries. Fisheries and Oceans Canada (DFO) Fisheries Management has

requested that DFO Science Branch assess BSR and RER relative to reference points that are consistent with DFO's Fishery Decision-Making Framework Incorporating the Precautionary Approach (DFO 2009), and provide advice on the implications of various harvest strategies on projected stock status. The advice arising from this Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR) will be used to inform fisheries management decisions to establish catch levels for each population consistent with the DFO Precautionary Approach. This work may also inform decisions external to DFO, including Marine Stewardship Council certification of the Pacific Hake and Pacific Halibut fisheries.

Objectives

The following working paper will be reviewed and provide the basis for discussion and advice on the specific objectives outlined below:

Starr, P.J. and Haigh, R. 2020. Blackspotted / Rougheye Rockfish (Type I and Type II) stock assessment for British Columbia in 2020. CSAP Working Paper 2015GRF03

The specific objectives of this review are to:

1. Recommend reference points consistent with the DFO Precautionary Approach (PA), including the biological considerations and rationale used to make such a determination. If possible, these should include the provisional DFO limit reference point (LRP) of 0.4BMSY and the upper stock reference (USR) of 0.8BMSY, or, alternatively, historical reference points (e.g., Bmin) if maximum sustainable yield (MSY)-based ones are not feasible. The choice of reference points is often determined by the complexity of the population model, which, in turn, depends on the quality and quantity of the input data.
2. Evaluate the current status of the BSR and RER proxy populations relative to the recommended reference points, or provide rationale why reference points cannot be used.
3. Using probabilistic decision tables, evaluate the consequences of a range of harvest policies on projected biomass (and exploitation rate) relative to the reference points and provide additional stock metrics. If the data are insufficient to quantitatively evaluate BC BSR and/or RER in terms of the selected reference points, summarise what is known about the status of these species, and discuss the implications for harvest advice.
4. Describe sources of uncertainty related to the model (e.g. model parameter estimates, assumptions regarding catch, productivity, carrying capacity and population status), including uncertainty associated with the separation of the available data into component species.
5. Evaluate and provide advice, as time allows, on procedures that may be under development for separating the REBS species complex into component species over time.
6. Recommend an appropriate interval between formal stock assessments, indicators used to characterize stock status in the intervening years, and/or triggers of an earlier than scheduled assessment. Provide a rationale if indicators and triggers cannot be identified.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management)
- Commercial and Recreational Fishing Representatives
- Environmental Non-government Organizations
- First Nations
- Province of BC
- USA Government Agencies (NOAA, Alaska Fish & Game)

References

COSEWIC. 2007. COSEWIC assessment and status report on the Rougheye Rockfish type I and II Sebastes sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 36 pp.

Creamer, J. M. 2016. Using genetic species identification and environmental data to distinguish historical catches of cryptic Blackspotted Rockfish (Sebastes melanostictus) and Rougheye Rockfish (Sebastes aleutianus) in British Columbia. Masters of Resource Management, Simon Fraser University, 40 p.

DFO 2009. A Fishery Decision-Making Framework Incorporating the Precautionary Approach.

McDermott, S. F. 1994. Reproductive biology of rougheye and shortraker rockfish, Sebastes aleutianus and Sebastes borealis (Doctoral dissertation, University of Washington).

APPENDIX B: WORKING PAPER ABSTRACT

The Rougheye/Blackspotted Rockfish (REBS, *Sebastes aleutianus/melanostictus*) species complex is ubiquitous along the British Columbia (BC) coast, with trawl catches taken primarily from the depth range of 135-845 m. Fisheries using trawl gear see highest densities off NW Haida Gwaii, at the mouths of Moresby and Mitchell's Gullies, and off the NW coast of Vancouver Island. Fisheries using hook and line gear catch REBS along the 500 m isobath with the highest densities occurring off NW Haida Gwaii. REBS prefer soft substrata in sloping areas with frequent boulders.

In April 2007, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the REBS complex, comprising a pair of sympatric species, as 'Special Concern'. In 2009, REBS was added to SARA's Schedule 1 as Special Concern. Since then, no changes have been made to the status of the species. At the time of this assessment, the taxonomy was emerging and these species were named Rougheye Rockfish Type I and Type II, where Type I corresponded to Blackspotted Rockfish (BSR) and Type II denoted Rougheye Rockfish (RER). Although the taxonomy separating the two species is clearer now using genetic analyses and various biomarkers, species allocation methodologies to historical data still need to be developed. In this stock assessment, each species was spatially defined by Pacific Marine Fisheries Commission areas, where REBS data from areas 5DE are assumed to be BSR (Type I) and REBS data from areas 3CD5AB are assumed to be RER (Type II). REBS data from area 5C were considered to be in a zone of hybridisation and consequently were omitted from the stock assessment except to proportionately distribute the 5C catch between the two species (~65-70% in favour of BSR). It is recognised that this spatial definition only approximates the true species distribution but was adopted in the absence of a more reliable methodology.

This stock assessment evaluates two stocks along the BC coast, BSR 5DE and RER 3CD5AB, which are harvested by multiple fisheries. The assessment uses an annual catch-at-age model tuned to one fishery-independent trawl survey series for BSR and three surveys for RER, a bottom trawl CPUE series for both, annual estimates of commercial catch since 1935, and age composition data from survey series (spanning 1997-2016) and commercial fisheries (spanning 1978-2018). The model starts from an assumed equilibrium state in 1935. Two fisheries are modelled: one a combined bottom and midwater 'Trawl' fishery and an 'Other' fishery, which combines halibut longline, sablefish trap, salmon troll, rockfish hook and line, etc. The second fishery is a compromise that acknowledges other methods capturing this species while keeping the complexity to a minimum, given the lack of good information from these additional fisheries. For each stock, nine base model runs using a two-sex model were implemented in a Bayesian framework (using the Markov Chain Monte Carlo procedure) under a scenario that fixed natural mortality to three levels (0.035, 0.045, 0.055) using three CPUE process errors (0.1, 0.2759 for BSR or 0.2529 for RER, 0.4) each. Steepness of the stock-recruit function was fixed at 0.7; catchability for the surveys and CPUE, and selectivity for three of the four surveys and the commercial trawl fleet were estimated. For each stock, the respective nine component runs were combined into a composite base case which explored the two major axes of uncertainty in this stock assessment, namely, the parameter M and CPUE process error. Sensitivity analyses were performed to test the effect of alternative model assumptions.

Stock status at the beginning of 2021 for the BSR composite base case lies in the Healthy Zone with a probability of 1, as do all nine component runs. The composite base case population trajectory from 1935 to 2021 and projected biomass to 2096, assuming a constant catch policy of 600 t/y (just above the 5-year average catch of 548 t), indicates that the median stock biomass will remain above the USR for the next 1.5 generations (75 years). The probability envelope around the constant catch policy will extend into the Cautious and Critical zones due

to a much larger cumulative removal than that under a harvest rate policy of 0.1/year. A phase plot of the time-evolution of spawning biomass and exploitation rate in the two modelled fisheries in MSY space suggests that the stock is in the Healthy Zone, with a current position at B_{2021}/B_{MSY} = 2.25 (1.35, 3.36), $u_{2020(trawl)}/u_{MSY}$ = 0.060 (0.014, 0.202), and $u_{2020(other)}/u_{MSY}$ = 0.122 (0.028, 0.430).

Stock status at the beginning of 2021 for the RER composite base case lies in the Healthy Zone with a probability of 0.80, ranging from a low of 0.17 to a high of 1 in the component runs. The composite base case population trajectory from 1935 to 2021 and projected biomass to 2096, assuming a constant catch policy of 300 t/y, indicates that the median stock biomass will eventually crash at the current amount of removals (5-year average catch of 291 t). The fixed harvest rate policy appears to offer a more sustainable catch policy, with median projected biomass remaining above the USR for the next 1.5 generations (75 years). A phase plot of the time-evolution of spawning biomass and exploitation rate in the two modelled fisheries in MSY space suggests that the stock is in the Healthy Zone, with a current position at B_{2021}/B_{MSY} = 1.14 (0.614, 2.60), $u_{2020(trawl)}/u_{MSY}$ = 1.04 (0.190, 2.44), and $u_{2020(other)}/u_{MSY}$ = 0.619 (0.136, 1.68). The Trawl fishery's harvest rate is above that at u_{MSY}.

APPENDIX C: AGENDA

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific

Regional Peer Review Meeting (RPR)

Blackspotted/Rougheye stock assessment for British Columbia in 2020

May 26-27, 2020
Virtual Platform on Zoom

Chair: Greg Workman

DAY 1 – Tuesday, May 26, 2020

Time	Subject	Presenter
0900	Introductions/Overview of virtual platform Review Agenda CSAS Overview and Procedures	Chair
0915	Review Terms of Reference	Chair
0930	Presentation of Working Paper	Authors
1030	***Break***	
1045	Overview Written Reviews	Chair + Reviewers & Authors
12:00	***Lunch Break***	
1300	Identification of Key Issues for Group Discussion	Group
1330	Discussion & Resolution of Technical Issues	RPR Participants
1430	***Break***	
1445	Discussion & Resolution of Results & Conclusions	RPR Participants
1530	Develop Consensus on Paper Acceptability & Agreed-upon Revisions (TOR objectives)	RPR Participants
1600	Adjourn for the Day	

DAY 2 - Wednesday, May 27, 2020

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping Review Status of Day 1 (*As Necessary*)	Chair
0915	Carry forward outstanding issues from Day 1	RPR Participants
1030	***Break***	
1045	*Science Advisory Report (SAR)* Develop consensus on the following for inclusion: • Summary bullets • Sources of Uncertainty • Results & Conclusions • Figures/Tables • Additional advice to Management (as warranted)	RPR Participants
1200	***Lunch Break***	
1300	*Science Advisory Report (SAR) cont'd*	RPR Participants
1430	***Break***	
1445	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (*as necessary)*	Chair
1500	Other Business arising from the review	Chair & Participants
1600	***Adjourn meeting***	

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Bresch	Midoli	DFO Science, Groundfish
Chaves	Lais	Council of the Haida Nation
Christensen	Lisa	DFO Science, Centre for Science Advice Pacific (CSAP)
Cornthwaite	Maria	DFO Science, Fishery + Assessment Data
Finn	Maureen	DFO, Fisheries Management, Groundfish
Frederickson	Nicole	Island Marine Aquatic Working Group (IMAWG)
Frid	Alejandro	Central Coast Indigenous Resource Alliance (CCIRA)
Gardner	Lindsay	DFO, Fisheries Management, Groundfish
Grandin	Chris	DFO Science, Groundfish
Grant	Paul	DFO Science, Species at Risk
Haggarty	Dana	DFO Science, Groundfish
Haigh	Rowan	DFO Science, Groundfish
Keizer	Adam	DFO Fisheries Management, Groundfish
Keppel	Elise	DFO Science, Groundfish
Leaman	Bruce	COSEWIC
Magera	Anna	DFO, Fisheries Management, Species at Risk
Magnan	Al	DFO Science, Centre for Science Advice Pacific (CSAP)
Olsen	Norm	DFO Science, Groundfish Section
Romanin	Kevin	Province of BC
Rusel	Christa	A'Telgay Fisheries Society
Schut	Steve	DFO Science, Spatial Data Unit
Spencer	Paul	NOAA
Sporer	Chris	Pacific Halibut Management Association (PHMA)

Last Name	First Name	Affiliation
Starr	Paul	Canadian Groundfish and Research Conservation Society (CGRCS)
Turris	Bruce	Canadian Groundfish and Research Conservation Society (CGRCS)
Wallace	Scott	David Suzuki Foundation
Workman	Greg	DFO Science, Groundfish
Wyeth	Malcolm	DFO Science, Groundfish
Zhang	Zane	DFO Science, Quantitative Assessment

APPENDIX F: ADDITIONAL NOTES ON WORKING PAPER

Notes – Chris Grandin

1. Retrospectives – Strip away one year of data at a time giving the model run for each previous year showing what the effects are of larger-than-average survey indices or catches on model parameter estimates
    a. Can use hindcasting by projecting retrospectives to see how good your model is in reality at predicting stock status
2. Use Tweedie Generalized Linear Mixed Effects Model – This avoids problems with the 2-model Delta-Lognormal approach:
    a. DeltaGLM adds complexity by needing a fit and reporting on two models
    b. DGLM two models are fit with separate links and the coefficients cannot be combined
    c. DGLM **assumes independence among the two component models which may not be true if locality fishing is happening.** The Tweedie GLMM incorporates the localities
    d. DGLM renders a final index which is dependent on the reference levels that the predictors are set to
3. Thorsen et. al. 2016 - Use Dirichlet-Multinomial parameters in the model
    a. Intrinsic parameter for each fleet/survey in the model
    b. No reweighting steps prior to modelling
    c. Reweighting doesn't have to be done for each sensitivity since the parameters are estimated for each run
    d. Ages with zero observations can be included, with other methods they cannot
    e. Has been simulation tested (hake)