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Proceedings of the Pacific regional peer review on the Evaluation of Management Procedures for the Outside Population of Yelloweye Rockfish Rebuilding Plan

October 29-30, 2019
Nanaimo, British Columbia

Chairperson: Greg Workman
Editor: Midoli Bresch

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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 of October 29-30, 2019 at the Pacific Biological Station in Nanaimo, B.C. A working paper focusing on evaluation of management procedures for the outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) rebuilding plan was presented for peer review.

The discussion focused on the results of a new analysis that showed outside Yelloweye Rockfish populations may not be as depleted as indicated by the previous stock assessment. The major topics discussed included key uncertainties, the need for updated objectives for the stock, policy implications of the results, and future work.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science, Groundfish Management Unit staff, Policy staff; and external participants from First Nations organizations, Committee On the Status of Endangered Wildlife in Canada (COSEWIC), commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to the Groundfish Management Unit (GMU) to inform the rebuilding plan.

The Science Advisory Report and supporting Research 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 October 29-30, 2019 at the Pacific Biological Station in Nanaimo to review an evaluation of management procedures for the outside Yelloweye Rockfish population rebuilding plan.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from the Groundfish Management Unit of Fisheries and Oceans Canada. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting:

> Evaluation of potential rebuilding strategies for Outside Yelloweye Rockfish in British Columbia by Sean P Cox, Beau Doherty, Ashleen J. Benson, Samuel D.N. Johnson, and Dana Haggarty. CSAP Working Paper 2017GRF02

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. 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 around 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 papers, written reviews of working paper, and agenda.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying the Rapporteur for each review. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions to the microphones so they could be heard by those online.

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, 43 people participated in the RPR (Appendix D). Midoli Bresch was identified as the Rapporteur for the meeting.

Participants were informed that Ben Williams and Chris Rooper 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 the Groundfish Management Unit to inform rebuilding planning for the above-noted stock. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEW

Working Paper:	Evaluation of potential rebuilding strategies for Outside Yelloweye Rockfish in British Columbia. 2017GRF02
Rappoteur:	Midoli Bresch
Presenter:	Sean P Cox

PRESENTATION OF WORKING PAPER

All authors were present, except Samuel DN Johnson. An oral presentation was given by Sean P. Cox to summarize the working paper described in the following abstract.

ABSTRACT OF THE WORKING PAPER

This paper aims to provide advice on rebuilding Outside Yelloweye Rockfish (OYE) using a combination of stakeholder-manager-science consultations and closed-loop simulation modelling to test performance of a set of candidate management procedures (MPs) against specific quantitative objectives. The overall approach aims to expose the ecological and fishery consequences of specific analytical (e.g., data collection, assessment methods) and management choices (e.g., harvest control rules, target fishing mortality rates) for Yelloweye rebuilding. The key components of this work are:

1. development of two-stock hierarchical age-structured operating models for OYE that represent a range of hypotheses about natural mortality and exploitation history,
2. testing MPs comprised of monitoring data, assessments, and harvest control rules (HCR) used to implement rebuilding policies, and
3. evaluating performance measures that are used in determining the expected conservation performance of alternative MPs relative to stated rebuilding objectives.

Alternative data scenarios produced a wide range of estimated stock status, as well as biological and management parameters, from which four representative OMs (using a 1960 or 1918 start year and alternative catch scenarios) were selected for simulation testing of the MPs. The four OMs ranged in current biomass from approximately 3,100 to 10,100 t in the North (groundfish management areas 5BCDE) and 2,400 to 5,500 t in the South (groundfish management areas 3CD5A). This range is considerably wider than the statistical uncertainty within any particular OM. No single factor clearly explains the range of biomasses because natural mortality, absolute catch levels, and historical recruitments all affect biomass and recruitment estimates either directly or indirectly. The 1960 start year generally has the higher unfished and current biomass, while the lower bound commercial catch scenario leads to the lower unfished and current biomass. None of the four OMs indicate that either OYE stock area has been fished to less than 20% of the unfished level or below 40% of B_{MSY}, as inferred in previous assessments. Model estimates of spawning biomass depletion range from 34-56% of unfished in the North and 28-48% in the South. These correspond to 119-198% of B_{MSY} in the North and 97-167% in the South.

The candidate MPs evaluated included three different assessment methods:

1. a catch-at-age (CAA) assessment model,
2. a surplus production (SP) assessment model, and
3. an empirical rule (IDX) using survey index trends.

The three assessment methods were used in combination with different harvest control rules or implementation error scenarios to create a set of candidate MPs that were simulation tested for each of the four OMs for North and South areas independently. Performance statistics were evaluated using combined outputs across OMs via a 50%-16.67%-16.67%-16.67% weighting scheme. Simulations of MP performance for setting future OYE total allowable catch (TAC) generally showed robust, or potentially robust, performance to a wide range of OM scenarios. The CAA MPs were tuned via a weighted target fishing mortality rate to provide relatively stable OYE biomass over the projection period and biomass in both the North and South responded accordingly. Management procedures based on SP models or survey index trends (IDX) produced a range of increases and decrease in future OYE biomass. The IDX MPs had dual undesirable properties of biomass decreases and high interannual catch variability. Although the SP models generally led to biomass increases, they did so because of under-estimation biases and often showed erratic patterns in TACs. It is likely that undesirable properties of IDX and SP MPs could be improved via further tuning.

CLARIFICATION QUESTIONS FOLLOWING THE PRESENTATION

- A participant asked that the rationale for weighing of the operating models (OMs) be explained better. The authors responded that it was decided by the technical working group and is not set in stone.
- Another participant wanted to know which data were being simulated in the closed-loops and whether or not the statistical fit to the indices was maintained for generating the data into the future. The authors confirmed that the fits were essentially maintained in simulations so that a good fit would stay good in the future.
- A question was raised about natural mortality, and whether the authors had tried a time varying natural mortality rate to account for potential changes due to climate change. The response was that most of the information shown in the working paper is used as a prior for natural mortality, and the prior had to be tight or the model would estimate unreasonably high values. There is not much information in the data about natural mortality, and there would be even less about time varying natural mortality. In other words, the work is limited by the data available.
- Another question was where the 64 tonne (in the North) threshold for TAC came from. The authors relayed that the value came from industry, who indicated 64t was the minimum TAC that would allow other fisheries to operate (the value was 36t in the South).
- A question was asked about the reasoning behind the North-South split for the two populations. Authors responded that it was mainly to ensure a large enough sample size in each area, and it aligns with the Pacific Halibut Management Association (PHMA) survey areas. It does not align with management scale, which is finer than the North-South split.
- Participant pointed out that data for the two stocks needs to be additive, to support Committee On the Status of Endangered Wildlife in Canada (COSEWIC) assessment for the one Designatable Unit (DU). Need to make sure that it is clear that the work was done on two populations (North and South), but they are components of a single genetic stock, from a biological sense.

PRESENTATION OF WRITTEN REVIEWS

BEN WILLIAMS

Please refer to Appendix C for full written review. The main comments are listed below:

- Provide information on the quality of annual catch (including discard mortality pre-2006), specifically quantify the uncertainty in these estimates
- The effect of changing stock structure should be thoroughly evaluated prior to implementation for a rebuilding plan
- Clearly describe the estimate of generation time
- Investigate the assumptions and model structure for determining maturity at age
- Explore the effect of different age plus groups on model stability
- Explore PHMA survey catch-per-unit effort (CPUE) estimated via a delta model to account for zeroes
- Present both prior and posterior distributions in appendices

AUTHORS RESPONSE TO BEN WILLIAMS

- In response to the question about maturity ogives, the issue may be that at younger ages (<10) there are a few outlier points that maybe should have been removed. A weighted regression with a small sample size may result in overestimating the number of small fish that are mature. This would be relatively straightforward to fix by assuming they are not mature at all, but not sure how much of an effect it would have.
- Simulating the variance on the catch isn't possible. The catch was generated by a DFO catch reconstruction algorithm that doesn't propagate error. Uncertainty in the catch is typically defined qualitatively based on time periods. For example, uncertainty would be high in the distant past, moderate in the 80s and 90s, but in the modern data we have a lot of confidence. The authors tried to deal with this by using an upper and lower bound on catch.
- The calculations for estimating generation time were re-visited yesterday in advance of the meeting but gave very similar results to the recent COSEWIC results. The authors used the mean age of the unfished spawning stock, not Hoenig's method, but they came out pretty close. The authors will include the equation in the final research document.

CHRIS ROOPER

Please refer to Appendix C for the full written review. The main comments are listed below:

- Provide further justification for the North-South split in the stock, as well as the management and research implications for this decision.
- Would like some consideration of the spatial patterns in the different fisheries over time as it may provide insights into the characteristics of commercial catch relative to the survey indices, potential for serial depletion, or whether fishing has become restricted due to TAC reductions
- The reviewer expressed concern over the treatment of International Pacific Halibut Commission (IPHC) survey data, for example, the decision to exclude stations that had caught Yelloweye Rockfish in less than 11 years of the time series. If you remove stations with zeroes, over time you risk removing evidence of local depletions or changes in spatial

structure of the stock. Poor fit to the IPHC index is also of concern and the paper doesn't adequately address the issue. Also interested in why the synoptic trawl survey data were not included in the analysis. The reviewer wondered why there was no attempt to model the indices outside of the CAA model somehow. For example hook competition and habitat changes.

AUTHORS RESPONSE TO CHRIS ROOPER

- Synoptic trawl survey catches are really low so it was excluded to reduce the complexity of the model. For the zeroes in the IPHC data, early sensitivity runs showed the 11 year threshold did not make much difference. At minimum it makes sense to remove all stations that have never caught Yelloweye because the survey was not designed to index rockfish and those stations likely do not contain rockfish habitat.
- Two versions of a hook competition model (one used by the IPHC and one that was weighted by area) were looked at and found to have only a small effect on the surveys, in both North and South.
- The authors will include a map showing spatial effort of fishing, from gfsynopsis report.
- In regard to zeroes in the IPHC index, the authors agreed that localized depletions are a concern, especially for a survey that has been fishing at fixed locations for twenty years and these fish do not move.
- The spatial issues may be more important for the composition data, not the index data, as they seem to be driving the conditioning of the model. The authors did apply the Thorson correction for spatial composition data but took it off the final results because it didn't change anything.

GENERAL DISCUSSION

RECREATIONAL CATCH

- A participant raised a concern about the recreational catch used in the analysis, and whether it was too high. The authors responded that DFO provided a recreational catch reconstruction that was developed for the previous assessment and passed peer review in 2015. The authors tested the sensitivity of the models to recreational catch by using upper and lower catch scenarios, which scaled the model biomass and had an influence on the estimate of F_{MSY} because it has to account for the change in fishing mortality. Another participant noted that it is not necessary to get the recreational data spot on, because they do not drive the management procedure (MP) that will be chosen for decision making.
- There was a question about selectivity for the recreational fishery, and why that was derived from information in Washington state, since the fishery in Puget Sound is very different from the recreational fishery in BC. The authors agreed it is a key uncertainty that was looked at in the operating models but not carried through the simulations and this could be done if requested. The concern about selectivity in the recreational fishery is that there is potential for the fishery to be removing individuals before they are old enough to spawn.
- The participant also wanted to know how the recent changes to regulations in the recreational fishery (non-retention, mandatory descending devices) would be accounted for when evaluating the rebuilding plan. The authors responded by saying some scenarios would have to be proposed that estimated discard mortality, but for this analysis 100% mortality was assumed.

- There was concern expressed that there are biases in the creel surveys due to miss-identification of species, and different methodologies. The authors stated that miss-identification has been identified by the groundfish unit as a problem and some initiatives are underway with partners to develop resources including smart phone apps to help with identification and new ID cards.

FOOD SOCIAL AND CEREMONIAL CATCH

- A participant asked for the treatment of Food Social and Ceremonial (FSC) catch to be explained and the explanation in the paper to be expanded. The authors responded that FSC catch is only included in the projections at 18%, which is taken from the IFMP allocations. A participant brought up that dual fishing trips are included in the Fishery Operations System (FOS) database, and any FSC catch under those trips would be included in the catch data, but that it wouldn't be very much. Either way, it is not double counted in the model because it was not explicitly included but could be clarified in the paper.
- A First Nation representative noted that the main thing to be clear about is why there is a difference between this assessment and the last. Data collected by some Nations show a decline in rockfish and these will have to be reconciled with the recent results.

IPHC SURVEY INDEX

- General concern was expressed about the fit, or lack of fit, to the IPHC survey index. It was suggested the authors try down weighting the age composition data to see if the fit improved.
- It was suggested by one participant that the authors try fitting a senescence natural mortality rate, to try and get a better fit to the plus age group.
- Comment from another participant that the department (DFO) should develop a standardized approach to dealing with the IPHC survey for rockfish assessments.
- Other than a more detailed documentation the committee agreed with the way the IPHC CPUE index was developed and the analysis.

REFERENCE POINTS

- A written review from a participant pointed out that a big issue is not establishing biomass related reference points, but rather the loss of age structure and the age-fecundity relationship adding that specific objectives should be developed to protect these attributes of the stock. The authors agreed that these are important attributes, but the scope of this project was to see if the biomass related objectives could be met with a particular MP. These considerations will also require more data to be collected in the future.
- There was a comment from a participant that there is a need for a process for objectively setting a new biomass target. In terms of data collection it would be useful to get clear guidance on what to collect going forward and whether the department has the capacity to deal with the data if collected.
- A question was asked about how the reference points were calculated. The authors explained that they are B_{MSY} based reference points, and during projections they assumed a Beverton-Holt stock recruitment relationship. They explained the steepness parameter of the stock recruitment relationship, which gives an indication of the productivity of the stock at low population size is difficult to estimate unless you have actually depleted the stock to very low levels. The estimate of steepness is therefore strongly reliant on the prior, which was

taken from the literature on rockfish, because there is very little information in the data about steepness.

ECOSYSTEM CONSIDERATIONS

- Comment from a participant about the importance of including ecosystem considerations, e.g. two different productivity schedules in the North and the South could be due to differences between the two ecosystems. There are also other effects that the fishery is having on the ecosystem, such as bottom impacts. The paper should include a section with some information on environmental effects that might be drivers of the stock. The authors responded that in the case of outside Yelloweye Rockfish there isn't any well documented effects of changes in environments. It doesn't mean that these considerations are not important, it just means we want to approach them from an evidence-based platform, and not provide un-substantiated commentary.
- Another participant mentioned that the management paradigm is not ready to go to an ecosystem based approach, no matter what ecosystem models are out there. The MSE framework is the only existing way to test climate change impacts, as robustness tests. You can propose a set of scenarios and test them. This needs to start making it into TORs, given that it is now the law to consider it (under fish stock provisions).The authors responded that the debate is going to be up for a long time. One thing that is relevant is that Outside Yelloweye are captured in a multispecies fishery, but the second you have a rebuilding problem it collapses to a single species problem. This is a management problem that could be considered here and is more immediate than whether or not temperature affects Yelloweye. Once you start talking about multispecies interactions, the concept of sustained over-fishing pops up and whether you might want to fish some species in an overfished state in order to maintain the broader fishery. It is an ecosystem-type problem which will need to be addressed soon.

ANALYTICAL FRAMEWORK

- Concern was expressed that the range of operating models considered in the analysis may not sufficiently capture the range of uncertainty for the stock. A participant was uncomfortable with the difference between the assessment advice from 2015 and the outcome from this analysis and asked for clarity on what is driving the differences. The authors responded that the main difference is that the operating models are all age structured and the last assessment was a surplus production model. The surplus production model yield curve is symmetrical, so the production rate is a straight line, and when you start fishing down the stock its production goes up linearly. For a CAA model, maturity is a curve, the recruits per spawner goes up in a curve, not a straight line. At high biomass it is flat for a while, then it goes up in a curve. That ends up shifting the most productive biomass and that alone can probably explain the differences in stock status.
- Comment that it would be nice to avoid a conclusion from this meeting being that the last assessment was wrong. The authors response was that they did not say the previous assessment was wrong, just that it did not have a structure to produce an alternative to what it came up with, and some of the assumptions were perhaps unrealistic, and the shape of the production curve. It is also possible to move to a more ensemble approach.
- The authors also noted that if they were to develop an operating model that mimicked the previous assessment there would still be the issue of how to weight that model, which is an open question not well addressed in the literature. There was no guidance in the TOR about

the range of operating models that needed to be included in the scenarios. There was no stipulation that a pessimistic scenario had to be included.

- It was raised that the process needs to keep in mind that industry is being severely curtailed and there is a need to settle on a plan going forward. Commercial representatives did not agree with the last assessment, because the experience on the water did not reflect what the models were saying. The experience on the water better reflects the results of the current analysis, and so the possibility that the stock is already where it should be needs to be considered.
- MPs performed well because the operating models estimated the stock status to be better than in the last assessment. MPs may have performed well because the conditions were not challenging. The law states we need to come up with a status of the stock, relative to the limit reference point (LRP), probably within the next year. If not derived from this process, there will have to be another process soon (in terms of fish stock provisions). Need to be specific about our perception of stock status as a result of this process and relative to current objectives.
- Comment from one participant that the authors appear to have met all the requirements in the TORs. The GMU agrees that the authors have met their obligations under the TORs. It is to be expected that further work would arise from this process, but from a management perspective that work cannot be completed here, e.g. biomass targets that have to be developed in consultation with FN and stakeholders.

BROADER IMPLICATIONS

- Authors pointed out that a major challenge is that the policy is clear on what happens when you go into rebuilding but it is not clear on what to do to come out of it. What does OYE management look like moving forward? Is the stock rebuilding, transitioning, or does normal fishing resume? It was commented that the department needs to have further discussions with First Nations and other stakeholders about what a rebuilt stock looks like, but in terms of the working paper it is a useful framework for evaluating rebuilding plans.
- The idea of a single assessment document with a single assessment TAC is what we are trying to get away from, policy wants one thing, but a robust management approach wants something more like an ensemble approach. Don't over-interpret the results of the MPs. They could be wrong, but what matters is the overall performance. Because COSEWIC needs outputs for the entire Designatable unit (i.e. North and South combined), the authors agreed to provide one, assuming that there was agreement on a method for providing aggregating the models. They also agreed to include a section of the paper that is specifically for COSEWIC.
- There was a comment about the North-South split of the analysis and how this doesn't align with the national view of OYE as a single fish stock. A representative from the Policy branch responded that it is not the end of the world if there are two stocks with two LRPs. Nationally they are open to disaggregating stocks, it is just a decision we need to make moving forward. But would have to make the decision quickly, because it would be awkward if we batched them in as one stock, and then treated them differently in the future. How does that account for the change towards spatial stock assessments, and evolving research? This issue has been raised, and the idea would be that we would have to amend it in the future. Might be more practical to report the coast wide outcome (LRP) in the paper.
- At a national level there are working groups trying to interpret the fish stock provisions and figure out what they mean for science. This is an ongoing conversation and if something

useful comes out of this process then it will certainly get passed on to the working groups. This is a very timely process. Another comment noted that the two processes are not talking to each other very well (legal and science), our hands are tied by the legal process. Science is trying to demonstrate that they have done their due diligence on trying to provide advice in these circumstances

CONCLUSIONS

- The working paper was accepted with minor revisions at the conclusion of the regional peer review process.
- See Appendix E for WP revisions.

RECOMMENDATIONS & ADVICE

- Work to resolve issues with recreational data: fishery selectivity, accounting for shift in regulatory approach, catch reconstruction, and creel survey methods/errors
- Develop more detailed objectives to evaluate MPs against before full implications and consequences of management procedures can be understood.
- This paper provides advice on rebuilding Outside Yelloweye Rockfish (OYE) using closed-loop simulation modelling to test performance of a set of candidate management procedures (MPs) against specific quantitative objectives.
- A management-oriented approach was initially intended to develop rebuilding plans for OYE; however, in identifying and conditioning operating models for OYE, the authors concluded the stock is probably not in need of rebuilding above the LRP.
- All operating models implied that OYE is currently above $0.4B_{MSY}$, coast-wide, even though OYE biomass declined by 49-71% in the North and 57-79% in the South, and 52-73% coast-wide over the past two OYE generations.
- Current objectives for OYE rebuilding emphasize biomass-based objectives over other important aspects such as catch and spatial distribution. Several potential MPs were identified that could increase or stabilize OYE biomass in both North and South areas. For example, the CAA MPs were tuned to achieve a target fishing mortality rate that would provide relatively stable OYE biomass over the short term.
- Any MP that is implemented in the interim should seek to increase or stabilize OYE biomass while fishery objectives are developed further. An interim MP could be selected and implemented from the MPs evaluated through this process to provide harvest advice in the short term.

ACKNOWLEDGEMENTS

The chair thanks the authors (Sean Cox, Ashleen Benson, Beau Doherty, Samuel Johnson, and Dana Haggarty) for delivering the working paper and revisions; Ben Williams and Chris Rooper for providing thoughtful reviews; Midoli Bresch for rapporteuring and developing the proceedings; all of the participants for the time they contributed to the process; and finally, the CSAP office (Ann Mariscak and John Candy) for their assistance in preparation for the meeting and in the production of the final documents.

APPENDIX A: TERMS OF REFERENCE

EVALUATION OF MANAGEMENT PROCEDURES FOR THE OUTSIDE POPULATION OF YELLOWEYE ROCKFISH REBUILDING PLAN

Regional Peer Review – Pacific Region

October 29-30, 2019
Nanaimo, British Columbia

Chairperson: Greg Workman

Context

As part of the Sustainable Fisheries Framework, Fisheries and Oceans Canada (DFO) has developed "*A Fisheries Decision-Making Framework Incorporating the Precautionary Approach*" (DFO 2009), and "*Guidance for the Development of Rebuilding Plans under the Precautionary Approach Framework*" (DFO 2013). These documents outline the departmental policy and guidelines for applying the precautionary approach (PA) to Canadian fisheries. A key component of the PA Policy requires that when a stock has reached or fallen below a limit reference point (LRP), a rebuilding plan must be in place with the aim of having a high probability of the stock growing above the LRP within a reasonable timeframe. As such, through the PA Policy, the requirement for rebuilding plans for depleted stocks has become departmental policy for key harvested stocks managed by DFO. Yelloweye Rockfish, which is managed as two stocks (inside and outside populations), is a target species in the hook and line commercial fisheries, Food Social and Ceremonial (FSC) fisheries, and recreational fisheries.

The outside population of Yelloweye Rockfish was last assessed by DFO in 2015 and reference points were established (Yamanaka et al. 2018). The biomass was estimated to be less than the Limit Reference Point (LRP), necessitating the development of a rebuilding plan. The Yelloweye Rockfish Inside population was also assessed to be below the LRP (Yamanaka et al. 2011). A rebuilding plan for both Yelloweye Rockfish populations was developed and published in Appendix 9 of the Pacific Region Integrated Fishery Management Plan (IFMP) for Groundfish (DFO 2018). Although the rebuilding plan for the Inside population of Yelloweye Rockfish also requires revision, this peer review process will focus on the outside population and lessons learned will be applied to the inside population in a subsequent process.

The DFO guidance document for the development of rebuilding plans (DFO 2013) recommends that rebuilding plans undergo regular (no more than 3 years) performance reviews, in addition to appropriate monitoring and assessment. The outside Yelloweye Rockfish rebuilding plan was based on the 2015 stock assessment and should be reviewed for 2019. While the stock assessment provides valuable short-term, tactical advice, it does not contain all of the information required in a rebuilding plan.

The DFO Fisheries Management Branch has requested that Science Branch develop advice to inform a rebuilding plan consistent with the DFO (2013) guidance document. This advice will include a review and updating of rebuilding objectives for the outside Yelloweye Rockfish population and fisheries, and development of an analytical framework for evaluating candidate management procedures against the rebuilding objectives.

The advice arising from this Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR), will be used to revise the rebuilding plan for the outside Yelloweye Rockfish population. Both Yelloweye populations are listed as Special Concern under Schedule 1 of the *Species at Risk Act* (SARA) and assessed as Special Concern by COSEWIC. The RPR findings

may be also used to inform future COSEWIC reassessments as well as SARA recovery potential assessments, and listing decisions. A SARA Management Plan is currently under development.

Objectives

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

Benson, A., S. Cox, B. Doherty, Haggarty, D.R. Evaluation of Management Procedures for the Outside Population Yelloweye Rockfish Rebuilding Plan. CSAP Working Paper 2017GRF02.

The specific objectives of this paper and review are to:

1. Report on a set of candidate management objectives and corresponding performance metrics for the Outside Yelloweye Rockfish population and fisheries that will support the development of a rebuilding plan under the Sustainable Fisheries Framework policies and inform COSEWIC reassessments as well as recovery potential assessments and listing decisions.
2. Develop and report on Operating Models (OMs) to represent alternative hypotheses for the Outside Yelloweye Rockfish stock and fishery dynamics (e.g., processes determining annual stock biomass, recruitment, fleet-specific fishing mortality).
3. Recommend biological reference points that are scientifically defensible and appropriate given the available data and management needs.
4. Develop closed-loop simulation to evaluate the performance of candidate management procedures (MPs) that are robust to uncertainties in monitoring data, assessment methods, management decisions, and catch limit implementation.
5. Demonstrate the value of information for those assessment models that require catch-at-age series in terms of relative MP performance.
6. Examine, identify, and report on uncertainties in the data and methods.
7. 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 (Ecosystems and Oceans Science, Species at Risk, and Fisheries Management sectors)
- Province of British Columbia
- Academics
- Indigenous organizations
- Industry (commercial fishing industry)

References

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Yamanaka, K. L., McAllister, M.M., Etienne, M. Edwards, A.M., and Haigh, R. 2018. Stock Assessment for the Outside Population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/001. ix + 150 p.

Yamanaka, K. L., McAllister M.K., Olesiuk, P.F., Etienne, M.-P., Obdradovich, S. and Haigh, R. 2012. Stock Assessment for the inside population of yelloweye rockfish (*Sebastes ruberrimus*) in British Columbia, Canada for 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/129. xiv + 131 p.

APPENDIX B: WORKING PAPER REVIEWS

BENJAMIN WILLIAMS, ALASKA DEPARTMENT OF FISH AND GAME

This working clearly outlines rebuilding objectives and methodology for outside yelloweye rockfish in British Columbia. The authors should be commended on the considerable efforts they have put into this rebuilding plan. I've had a limited time for this review but do have some recommendations that may prove beneficial for the report. These recommendations are generally related to the operating models, exploring model assumptions and providing areas that may benefit from further clarification.

Three general assessment methods were explored, the CAA, SP, and IDX, with the SP model most similar to the previous full assessment. However, the OM structure was changed to such a degree (North/South population split) that the SP model presented within is not directly comparable to the previous assessment. Indeed, the assessments in this report all show the population biomass above the rebuilding threshold.

It is not possible to compare the most recent assessment in terms of this rebuilding plan. I recommend that the last assessment framework (e.g., Model 0) be rerun with updated data and considered as a viable candidate model within this rebuilding scenario. This would provide a baseline for review of alternate assessment methods. Additionally, has there been a consideration of a panmictic assessment with an associated TAC apportionment? Yelloweye rockfish is not generally considered to have much movement as adults, however larval drift could provide a measure of continuity in stock structure. There are viable alternatives to separate or hierarchical OMs (e.g., TAC allocation by area), it is unclear whether these have been fully considered.

Catch data, particularly the historical catch data, are likely subject to error and probably bias. This has been addressed to some degree in the alternative operating models by using the catch data as maximum or minimum values. However, the extent of the differences in these models is not presented within the working document. A study to quantify the uncertainty and potential bias would be valuable for understanding estimated stock trends. This would allow for the precision of landings to be directly incorporated into model uncertainty, though as noted in the working paper would increase model run time. With the uncertainty in the catch data and the short (relative to the species life history) time series of age information the estimation of stock status pre-1980s should be viewed with great caution.

Population generation time and the maturity schedule would benefit from clarification. In the working paper introduction 1.5-2.0 generation times are stated as ~57-76 yrs. The pre-COSEWIC review states that a generation time for OYE females using $M = 0.038$ is 42.5-42.7. Therefore, the generation time for simulation should be between 64-85 yrs. This generation time is dependent upon A_{50} maturity estimates of 16.2-16.4 years for females. Further, if one were to use the hierarchical prior on M used within the OMs ($M = 0.0345$) then 1.5-2.0 generation times is ~ 68-92 yr.

As the generation time is dependent upon A_{50} an examination of the maturity schedule used in the working paper is a worthwhile endeavor. Of note is that the schedule used for these assessments has maturity > 0 at age-0 (Figure B.11). There is also a data point at a maturity of 1 for age-0 fish; it may be prudent to QA/QC these data.

Maturity schedules are typically estimated using logistic regression, though the last two assessments (Yamanaka et al. 2011; 2018) utilized a cumulative lognormal density function, though compared it to a logistic function (Yamanaka et al. 2018 - Figure 5) and deemed the cumulative lognormal density function more appropriate (note that this reviewer suspects that

the logistic model was potentially mis-specified). In the pre-COSEWIC background document (Keppel and Olsen 2019) there is reference to using a double normal function to estimate maturity which is much more akin to how selectivity is estimated (Table 1: EQ.1 of working paper). The associated Figure 17 in Keppel and Olsen 2019 shows maturity at negative ages as well as a proportion mature >0 at age-0. Following the origination of this estimation procedure through the referenced Edwards et al. 2017. There are examples of consistent bias with this procedure overestimating the proportion mature for younger ages, so much so that ages < 9 were populated with observed proportions instead of model fits. This same trend was observed in Edwards et al. 2014 and Edwards et al. 2012 which in turn references Stanley et al. 2009. The Stanley et al. 2009 maturity analysis exhibits the overestimation of younger ages which were corrected for. This was deemed acceptable as the basis for the maturity curve was to calculate spawning biomass used in the B-H stock-recruit function (bottom of paragraph page 81) and due to this it "is not necessary for the maturity function to be highly accurate".

Given that the rebuilding plan is built in part on the A_{50} value, the maturity parameter estimates are used as priors for estimating the max intrinsic rate of increase *r*, and the biological reference points are based, in part, upon estimates of SSB which are directly related to the maturity schedule it is worth critically evaluating the maturity schedule estimation procedure.

Exploring the size of the age plus group may be a worthwhile endeavor that could stabilize model behavior. A general guideline used by the NPFMC plan team is that the plus group should be set such that the proportion of ages in the plus group for all years is <10%, the plus group proportion is less than the maximum proportion in the remainder of the age composition data, and minimize age bins with zero samples (Hulson et al. 2015). The PHMA survey has potential as an independent data sources in model fitting, as yelloweye rockfish can be subject to localized depletion it may be beneficial to incorporate a delta-model framework for calculating CPUE, thus including zero capture sets. As a practical matter, it would be helpful to know what modeling framework this assessment was computed in (e.g., ADMB, SS3, SAM) as each software program has its strengths. Last, when priors are applied on parameters, it would be helpful to present both the prior and posterior distributions for comparison to allow for a better understanding of the data.

In summary my suggestions for improvements are

- Provide information on the quality of annual catch (including discard mortality pre-2006), specifically quantify the uncertainty in these estimates
- The effect of changing stock structure should be thoroughly evaluated prior to implementation for a rebuilding plan
- Clearly describe the estimate of generation time
- Investigate the assumptions and model structure for determining maturity at age
- Explore the effect of different age plus groups on model stability
- Explore PHMA survey CPUE estimated via a delta-model
- Present both prior and posterior distributions in appendices

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Yamanaka, K.L., McAllister, M.M., Etienne, M., Edwards, A.M., and Haigh, R. 2018. Stock Assessment for the Outside Population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/001. ix + 150 p.

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CHRIS ROOPER, FISHERIES AND OCEANS CANADA

The CSAP working paper evaluating rebuilding strategies for Outside Yelloweye Rockfish is an excellent piece of work. The authors should be commended on the clarity of purpose, the completeness of the analysis and the documentation of choices/assumptions. I enjoyed reading the working paper and generally have few comments that cannot be easily addressed in minor revisions or further explanation.

Below, I have made some general comments on the stated objectives of the working paper. The objectives were to:

1. Report on a set of candidate management objectives and corresponding performance metrics for the outside Yelloweye Rockfish population and fisheries that will support the development of a rebuilding plan under the Sustainable Fisheries Framework policies and inform COSEWIC reassessments as well as recovery potential assessments and listing decisions.

The working paper adequately states the agreed upon rebuilding objectives and develops and evaluates corresponding performance metrics in the evaluation of management procedures. There is a conflict between the current management objectives (identifying rebuilding plans) and the current stock status (rebuilt). I'm not sure it is within the scope of this paper to address this issue, but technically means this objective is probably not met.

2. Develop Operating Models (OMs) to represent alternative hypotheses for the outside Yelloweye Rockfish population and fishery dynamics (e.g., processes determining annual population biomass, recruitment, fleet-specific fishing mortality).

The working paper developed multiple OM's that represented a wide variety of alternatives for the YE population and its dynamics.

3. Recommend biological reference points that are scientifically defensible and appropriate given the available data and management needs. Page | 2

The working paper does not appear to recommend BRP, in part this is because of the conflict between the status of the stock and the objectives of the analysis (stated in #1 above). Some reconciliation of the two needs to occur and probably new management objectives agreed upon before a BRP can be decided.

4. Develop closed-loop simulations to evaluate the performance of candidate management procedures (MPs) with respect to their robustness to uncertainties in monitoring data, the choice of assessment methods, and catch limit implementation.

The working paper completed multiple closed loop simulations under different scenarios and uncertainties that are presented in detail in the Appendices. This objective has been adequately addressed.

5. Demonstrate the value of information for those assessment models that require catch-at-age series in terms of relative MP performance.

The working paper demonstrates the progress in stock assessment from the previously used surplus production model and the catch at age model in the ability to fit the data better, with robustness and reduction in uncertainty.

6. Examine, identify, and report on uncertainties in the data and methods.

The working paper adequately reports on uncertainties in the data and methods, as well as addressing uncertainties with regards to major assumptions that were made.

7. 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.

I did not see this in the paper, but maybe this is the purview of the CSAP process itself. Based on the evidence provided and the relatively long-life of the species, an appropriate interval might be 4-5 years with triggers of an early assessment being a substantial drop in CPUE in either of the two index series (north and south PHMA surveys).

General comments

As I understand it, the split into stocks is largely justified for management concerns (trends in the two areas are exhibiting slightly different trends, allocation of TAC is an issue) and alternating years of surveys, rather than on biological characteristics or data (many of the parameters are shared between “stocks”). As the authors note, the North-South division is probably still too large for the sort of stock structure that might be observed in the relatively sedentary species. This is a common problem across most rockfish assessments. However, the North-South split has implications for management, in that the production curves are different, doesn’t this split somewhat limit management options if future years see further diverging abundance trends in the stock? There are pretty strong assumptions about shared

selectivity for fisheries between the two regions and no plans for future collection of aging structures from the fisheries. This seems like it could be problematic in the future if the characteristics of the fishery or stock productivity change, especially given the uncertainty around the recreational fishery. In general, it’s a little unclear if the assumption of two stocks has a downside, a bit more discussion might help.

Two key assumptions with regards to defining the scope of the operating model were choosing only models where MSY < 500 t and M < 0.05. Both of these assumptions seem well supported

by other stock assessments for rockfish (in particular the US West Coast has a similar estimate of M) and the catch history of the fishery. One could argue from the catch history that this number is a bit on the high side given the catch history.

There is uncertainty around discards/catch reconstruction. What happens when you increase the fishing mortality? Productivity goes up to compensate I would imagine?

Because it is a rockfish and they are strongly tied to habitat, it would be nice to see some figures of the spatial patterns in the fishery, such as a time series of maps of the spatial patterns in catch shown in Anderson et al. 2019. This might provide some insight into the characteristics of the commercial catch relative to the survey or serial depletion of areas or whether fishing has become restricted due to TAC concerns.

Survey indices:

The survey indices used were appropriate, but I have a couple of concerns and maybe a suggestion about the use of these indices. Especially in light of the relatively poor fit of the OM to the IPHC survey time series in the south. In figure 5, there is a definite declining, but highly variable trend in CPUE in the IPHC survey, while the OM predicts a slight increase in that survey. I'm not sure that the explanation given in the working paper results (section 3.1.1) is adequate to address why this is happening. Is this because of the shared productivity parameters between the two stocks? Or some other issue related to the selectivity or age structure of the southern population? The working paper did not include the time series of catches for the synoptic trawl surveys. These also appear to show a very noisy but declining trend for YE in the south. Was there a reason for not including this data? Would adding this data provide more clarity or a benefit? From a cursory look at the selectivities, the longline surveys select for older fish in general than the three fisheries. This would seem problematic in that the fishery is occurring on age classes that have not been observed in the surveys (in combination with no age data collections from the fisheries to help predict incoming recruitment). It may be that using the synoptic survey data would be helpful in this regard?

1. For the IPHC indices, a subset of the stations determined to be in yelloweye habitat was used where YE were caught for 11 years of the time series. This decreased the CV around the annual index, but it also inflated the index and amplified changes in the index. In addition, the variability in the index is higher during the final 4 years of the time series for both the south and the north. Two things are of potential concern with these trends. From an ecological standpoint, YE could potentially be contracting their use of habitat as the population declines. Choosing only "hotspots" of YE CPUE could mask declines in spatial area occupied and further over-estimate the index
2. Related to that, if the variability increases in the latter part of the survey, it would be interesting to know if that was related to highly variable positive catches or a higher proportion of zero catches in the subset of stations that were chosen for analysis (maybe more likely). If this is the case, showing something like stations occupied by yelloweye over time might be informative and might also indicate whether there were spatial patterns in the decline of fishes.

I understand that neither of these items is likely to have a large effect on the results, but they may provide insights into how cautious one should be when approaching the results.

Given the different types of surveys included (and not included), the differing years sampled and the potential for stock structure on a smaller scale than the current OM, would it be beneficial to try to model the biomass indices rather than including each separately in the OM. The main reason that I might suggest this, is that as the authors point out, there is a lot of uncertainty around those surveys that are not targeted to YE (e.g. are they sampling the correct habitat, is

this a potential reason for the variability from year to year). Secondly, especially with longline gear there is a potential to have inter-specific competition for hooks, so that the CPUE doesn't necessarily reflect abundance. In particular, this might explain some of the IPHC v. PHMC differences in trends. One way to approach this would be to try to combine the different surveys into a single abundance estimate outside of the OM. There are a number of ways to do this in the literature. The advantage as I see it would be to have a more stable and precise abundance index that could be fed into the OM. This may also allow the stock to be combined back into a single unit, but with some more data-driven spatial structure included through the modeling. I would suggest this might be an item for future directions.

Survey CPUE, FISS filled in south with linear regression, resulted in very high index in 2000 (highest in series). Is this why the FISS index does not fit. The survey index used in Yamanaka 2009 was lower than the one used in this assessment/OM. Is this a reason for the increase in biomass? My sense is no (it's an index), but its noticeable. The savings in CV going from 1-11 years is minimal. Why bother, it artificially ups CPUE (think about basin theory here, if YE caught 11 years at a station, indicates prime habitat, but in years of higher abundance they may be spreading to low abundance stations), I'd be tempted to use the full data set. CV is increasing over the last 4 surveys in both areas, what are the stations doing? Are you seeing more zeros or more variable catch? This is also an argument for looking at the spatial distribution of commercial catch.

More Random Specific comments

1. Objectives (numbered steps) could probably use a flow chart for the visually inclined.
2. Spatial patterns in the fishery?
3. Figure B5, B6 legend says "Tresholds"
4. Figures – check for description of error (for example B3 is SE?)

APPENDIX C: AGENDA

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific

Regional Peer Review Meeting (RPR)

Evaluation of Management Procedures for the Outside Population of Yelloweye Rockfish Rebuilding Plan

October 29-30, 2019
Nanaimo. BC

Chair: Greg Workman

DAY 1 – Tuesday, October 29, 2019

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping 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
1445	***Break***	
1500	Discussion & Resolution of Results & Conclusions	RPR Participants
1630	Develop Consensus on Paper Acceptability & Agreed-upon Revisions (TOR objectives)	RPR Participants
1700	Adjourn for the Day	

DAY 2 – Wednesday, October 30, 2019

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
1445	***Break***	
1500	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (*as necessary)*	Chair
1545	Other Business arising from the review	Chair & Participants
1600	***Adjourn meeting***	

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Acheson	Chris	Canadian Sablefish Association
Ahern	Pat	Sport Fishing Advisory Board (SFAB)
Anderson	Sean	DFO Science, Groundfish
Archibald	Devan	Oceana
Banning	Jessica	DFO, Fisheries Management, SARA
Benson	Ashleen	Landmark Fisheries
Bocking	Bob	Maa-nulth Fisheries Committee
Boyes	David	Commercial Industry Caucus - Halibut
Bresch	Midoli	DFO, Science, Groundfish
Candy	John	DFO Science, Centre for Science Advice Pacific
Carruthers	Tom	University of British Columbia
Clarkson	Molly	Council of the Haida Nation
Connors	Brendan	DFO Science, Quantitative Assessment
Cornthwaite	Maria	DFO Science, Groundfish
Cox	Sean	Simon Fraser University
Doherty	Beau	Landmark Fisheries
Edwards	Andrew	DFO Science, Quantitative Assessment
English	Philina	DFO Science, Groundfish
Finn	Maureen	DFO, Groundfish Management
Forrest	Robyn	DFO Science, Quantitative Assessment
Gardner	Lindsay	DFO, Resource Management
Grandin	Chris	DFO Science, Groundfish
Grant	Paul	DFO, Science, SARA
Haggarty	Dana	DFO Science, Groundfish
Haigh	Rowan	DFO Science, Groundfish
Holt	Kendra	DFO Science, Quantitative Assessment
Huynh	Quang	University of British Columbia
Kanno	Roger	DFO Fisheries Management
Keizer	Adam	DFO Fisheries Management, Groundfish
Kelly	Mike	Sport Fishing Advisory Board (SFAB)
Keppel	Elise	DFO Science, Groundfish
Kronlund	Rob	DFO Science
Leaman	Bruce	COSEWIC
Olmstead	Melissa	DFO Science
Romanin	Kevin	Province of BC
Rooper	Chris	DFO Science, Quantitative Assessment
Sporer	Chris	Pacific Halibut Management Association
Starr	Paul	Canadian Groundfish Conservation Society
Tadey	Rob	DFO Fisheries Management, Groundfish
Turris	Bruce	BC Groundfish Conservation Society
Wallace	Scott	David Suzuki Foundation
Williams	Ben	Alaska Department of Fish and Game
Workman	Greg	DFO Science, Groundfish

APPENDIX E: RESEARCH DOCUMENT REVISIONS

The authors agreed to make the following revisions prior to publication of the research document:

- Clarify how CPUE for the IPHC index was calculated and expand on the explanation
- Further clarify treatment of FSC data and how it is included in the models
- Provide further details on the rec data, specifically around treatment of selectivity
- Explore the fit of the age data to the plus group through a senescence M
- Explore scenarios that would be forced to better fit the indices as opposed to the age data
- Put age composition data from the surveys into the working paper
- Add map showing spatial distribution of effort- from gfsynopsis report
- Use stations that had caught OYE in 1 year for IPHC survey index
- Adjust the IPHC index data for years where only 20% of the hooks were sampled (scale these estimates)
- Change text in working paper about development of objectives to say they were developed by DFO
- Expand on and articulate differences in status from a surplus production model and a catch at age model and why that occurs
- Add in catch series figure from the talk into an appendix in the working paper
- Change reference to “stock” if referring to north or south to avoid confusion with biological coastwide stock
- Be explicit about how generation time was calculated