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Proceedings of the Pacific regional peer review on the Recovery Potential Assessment – Fraser River Chinook Salmon (*Oncorhynchus tshawytscha*) – Eleven Designatable Units

July 7-9, 2020, October 1, 2020, and March 11-12, 2021
Virtual Meetings

Chairperson: Mike Bradford
Editors: Grace Young and Justin Barbati

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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 Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meetings on July 7-9, 2020, October 1, 2020 and March 11-12, 2021. A working paper focusing on Elements 12 to 22 of the Recovery Potential Assessment (RPA) of 11 Designatable Units (DU) of Fraser Chinook Salmon was presented for peer review.

The paper was accepted with minor revisions by most participants however, a small minority had concerns with modelling used for Elements 13 and 15; these issues were ultimately resolved. Major concerns are captured in the following proceedings.

In light of the COVID-19 Pandemic, participation was completely web-based. Participants included Fisheries and Oceans Canada (DFO) Science, Fisheries Management, and Ecosystems Management Branch staff; and external participants from First Nations organizations, the fishing sector, academia, and environmental non-governmental organizations.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to inform the Species at Risk (SAR) program and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) on the recovery potential of the identified eleven Designatable Units of Fraser Chinook Salmon.

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

INTRODUCTION

Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meetings were held online on July 7 to 9, 2020, October 1, 2020, and March 11-12, 2021 to review Elements 12-22 of the recovery potential of eleven Designatable Units (DUs) of Fraser Chinook Salmon assessed to be Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Recovery Potential Assessment elements 1-11 were covered in a separate working paper which was reviewed 10-12 October 2019.

The Terms of Reference for the science review (Appendix A) were developed in response to a request for advice from the DFO Species at Risk Program. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, the fishing sector, academia, and environmental non-governmental organizations.

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

Recovery Potential Assessment for 11 Designatable Units of Fraser River Chinook Salmon, *Oncorhynchus tshawytscha*, Part 2: Elements 12 to 22 by Lauren Weir, Daniel Doutaz, Michael Arbeider, Kendra Holt, Brooke Davis, Catarina Wor, Brittany Jenewein, Kaitlyn Dionne, Marc Labelle, Chuck Parken, Richard Bailey, Antonio Velez-Espino and Carrie Holt. CSAS Working Paper 2018SAR07b.

Three separate meetings were held to achieve consensus on all elements with time between required to update and amend the modelling as suggested by participants. All three meetings were Chaired by Mike Bradford. At the end of the first three-day meeting in July, there was some concern on the analysis and modelling work in Elements 13 and 15 that had implications for the allowable harm statement in Element 22. Another meeting was held on October 1, 2020 to compare diagnostics and results from new modelling efforts (see Technical Modeling Meeting below). A third and last meeting was held March 11-12, 2021 to address outstanding concerns regarding the models and results, reach consensus on the allowable harm statement, and prepare summary bullets for the Science Advisory Report (see Appendix C for each meeting agenda). Accordingly proceeding notes have been divided chronologically by meeting dates. In total, 51 people participated in the RPR process (Appendix D). Justin Barbati and Grace Young acted as Rapporteurs for all meetings.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to inform the Species at Risk (SAR) program and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) on the recovery potential of the identified eleven Designatable Units of Fraser Chinook Salmon. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat website.

REVIEW OF WORKING PAPER: INITIAL MEETING (JULY 7-9, 2020)

INTRODUCTION

During the initial meeting, the Chair, Mike Bradford, 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, and draft SARs.

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. Grace Young and Justin Barbati were identified as Rapporteurs for the meeting.

Participants were informed that Michael Folkes and Andrew Rosenberger 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.

REVIEW

Working Paper:	Recovery Potential Assessment for 11 Designatable Units of Chinook Salmon, *Oncorhynchus tshawytscha*, Part 2: Elements 12 to 22. 2018SAR07b
Rapporteur:	Grace Young and Justin Barbati
Presenters:	Lauren Weir and Dan Doutaz

Presentation of Working Paper

Lauren Weir and Dan Doutaz presented an overview of the working paper including a brief summary of the RPA Elements 1-11 an overview map of all populations, and an in-depth description of the analysis undertaken of Elements 12-22 and resulting models used for forward projections for the Harrison DU under different productivity scenarios. They also provided information on data limitations for 10 of the 11 DUs addressed and resulting qualitative assessment of these populations throughout the paper. The working paper abstract is included in Appendix B.

Presentation of Written Reviews

The reviewers provided written reviews in advance and presented a summary at the meeting. Both reviewers strongly commended the author group for this enormous undertaking, while recognizing how the work was affected by limited data and resources. Each reviewer highlighted gaps in the working paper and topics to discuss for the elements covered in Part 2 of the Terms of Reference. A summary of major points identified by the reviewers are provided below.

Andrew Rosenberger

- Overall the report is clear, well written and an excellent effort in the face of major data limitations.
- Recovery is a broader discussion than just abundance metrics and must consider long-term persistence and multi-spawning site DUs. The group should also discuss the terminology of recovery targets (i.e. upper and lower vs survival and recovery) and the temporal scope of targets.
- There should be a discussion in Element 15 on the ten qualitative DUs and how current trends and available evidence play into the ability to achieve recovery targets. Also, whether productivity should be broken down and explored in smaller components (e.g. sensitivity to

habitat restoration) recognizing there are uncertainties in the pathways of effects and magnitude.

- The lack of assessment for Elements 14 and 18 are notable gaps, and should be addressed in some manner. There should be a discussion on the current habitat supply and habitat demand when the species has reached its biologically based recovered targets. This could be demonstrated as a table parsed out by life history stage.
- It was suggested that some additional tables for Elements 16 to 19 that provide more information on the effects of mitigation strategies on productivity and survival could be added. Under Element 19, a table providing qualitative information on the likelihood, magnitude and scope of the inventoried mitigation measures on DUs using a review of current literature could be added. This could also help inform Element 20.
- The reviewer agreed with the allowable harm assessment given the context and recent trends in productivity. There was some commentary on whether an analysis at a finer scale should be included for the stream-type DUs.
- The research list was fairly comprehensive. Some additional activities could include: improving the ability to assess fishing impacts, improving our understanding of limiting factors in both freshwater and early marine rearing with habitat supply considerations and improving our understanding of in-river mortalities. There was a recommendation to include a table in the research needs section to summarize concepts, link them to intended use and how they may relate to future modeling work, and some concepts around the scope and magnitude of change expected from activities.

Michael Folkes

- Despite the great data limitations, the authors presented a well-supported set of qualitative indicators that, by their cumulative weight of evidence, support the general conclusions for all the data-limited DU's considered. The quantitative evaluation of Harrison DU was thorough and the uncertainty was well represented.
- Both the Chinook projection model and VRAP2 (Viability Risk Assessment Procedure) will project population abundances for DU2 (Harrison). However, comparisons to validate similarity of results were not conducted or included.
- More discussion could be included on how the computation of S_{MSY} (spawners at maximum sustainable yield) and the definition of success impacts the outcome of the models, especially for VRAP2.

GENERAL DISCUSSION

The following section summarizes the general discussion that followed the reviewer presentations. Issues have been grouped by either the subject matter or elements rather than presented in the chronological order discussed.

Recovery Targets (Element 12)

The Species at Risk Act (SARA) Policy for Survival and Recovery provides guidance on the interpretation of species survival and recovery that were not used in the original working paper. A fulsome discussion regarding the use of “upper” and “lower” recovery targets in the original working paper identified the need for rewording the targets in a manner that distinguished both the practical biological, as well as policy, implications. This was bolstered by the fact that since some of the recovery targets are so low, framing them as “survival” targets gives a better interpretation of their state. As a result, the terms upper and lower recovery targets were replaced with survival (approximates the objective of the population achieving COSEWIC assessment status of special concern) and recovery (approximates the objective of the population achieving COSEWIC status not at risk).

The habitat model was used to estimate recovery targets for all DUs other than DU2, and it was clarified that the model is a relationship between accessible watershed area and population size based on a meta-analysis of stock-recruit data from approximately 25 sources in the Pacific Northwest. The authors committed to expanding on the habitat model's methods within an appendix so that it may be employed in a standardized manner in future analyses. An accompanying discussion on the uncertainties of the model and the recovery targets chosen will be included.

Reviewers recognized numerous parameters, aside from population abundance, that can be indicative of population health in Chinook salmon. There was extensive discussion on whether the recovery targets should consider factors such as long-term persistence, multi-site spawning DUs, fecundity and size at age. Relying on abundance targets as currently used in the paper does not account for the difference in recruit production between smaller and larger sized spawners. It was noted there are significant data deficiencies so authors were limited to abundance targets and trends concurrently to acknowledge that abundance alone does not signify recovery. Some additional analysis including a size-at-age analysis for DU2 will be included (WP Appendix 6).

To help address the lack of assessment data for establishing recovery targets, a participant inquired whether the authors had considered using data from Nicola River Chinook Salmon (Spring 4_2). However, the Nicola population was deemed to not be a suitable indicator for other spring-run populations. Similarly, the habitat model was not used on DU2 to test for confidence in its predictions of a population (DU2) where detailed data were available. It was noted previous analyses revealed that the habitat model has underestimated abundance targets for other populations, including Harrison.

Achieving recovery will require maintaining distribution and improving individual subpopulation abundance for those DUs where spawning occurs at multiple locations. This was echoed by participants and the authors, however the authors deemed it unfeasible to do any sort of multi-spawning site analysis.

There was a suggestion for the authors to add additional justification for employing long-term average productivity instead of time-varying productivity for the development of recovery targets. The authors explained that the older values are consistent with the Chinook Technical Committee's Chinook Model as well as the Wild Salmon Policy (WSP). The suggestion to have an alternative S_{MSY} target for DU2 based on more recent productivity was not adopted. Adopting this recommendation would be similar to following a shifting baseline approach and, without current guidance on how to consider this, could be taken out of context by readers of the research document, including policy makers and fishery managers. The decision not to adopt this recommendation follows the conclusions of the National Workshop for Technical Expertise in Stock Assessment (DFO, 2012).

Two participants with expertise in modelling expressed their concerns that recovery targets were based on absolute escapement while the only data in existence for many of these DUs is relative or index data. They suggested using relative counts for upper and lower recovery targets, as well as clarifying what values are absolute vs relative. The authors will be adding additional text to ensure that readers understand the targets are in absolute values even though the data used for some analyses are relative. As long as assessment methodologies remain constant, future analysis should be consistent with the analysis here, particularly for the analysis of trends.

Probability of Recovery (Elements 13 & 15)

There were a number of questions from participants regarding the model choices, supporting statistical evidence, and data used for the modelling of DU2. An additional meeting was held on October 1, 2020 to address some of the concerns highlighted below (Technical Modeling Meeting below).

For Elements 13 and 15, the author group committed to generally enhancing the text around productivity assumptions, fisheries assumptions and explicitly identifying uncertainties and potential sources of error in equations and/or figures. It had to be repeated multiple times that, to avoid the effect of shifting baselines, forward projections for DU2 used results from time-varying productivity models. Thus it was assumed that recent low productivity would continue into the future and was considered a precautionary approach.

Meeting participants highlighted three main issues with the modeling of DU2 conducted in Element 13. First, there were some issues with notation in the equations that were rectified.

Second, a participant took issue with the calculation of maturation rates and their inconsistent application; e.g., equation 3 uses the mean maturation rate while equation 7 uses a random variable maturation rate. The author group was amenable to the suggestion to re-evaluate their approach and see if there would be any significant differences if a single method was used. Authors agreed to run new simulations carrying over maturation rates to the back calculation of age-1 recruits. If the results were different, revisions would be made and incorporated into the SAR.

Lastly, not using a log normal bias correction factor in equation 1 was raised by some participants as a bias-inducing omission. The author group cited the Chinook Technical Committee model, VRAP, and a recent management strategy evaluation as not having used bias correction factors but multiple participants were adamant to one being included. During the first day of the meeting the author group agreed to run the model with a log-normal correction factor but noted that if anything it would make the projection more pessimistic and therefore, unlikely to alter conclusions of the paper. Figure 10 and the associated heat maps were updated to incorporate the log-normal correction factor.

With respect to the data poor DUs, the trend of the last three generations indicating a decline rate that exceeds 30% does not meet the requirement of positive population growth needed for recovery. Some inconsistencies in the otherwise persistent downward productivity of these DUs were used to question whether habitat degradation is really the main contributing factor.

It has already been acknowledged that although there are severe data deficiencies for these DUs, and concerns about the status of freshwater habitat, there are also changes in survival in marine habitats that could affect population status. An inability to appropriately quantify changes in marine productivity and dynamics, according to the authors, prevented its inclusion in their analyses. The authors agreed that time-varying marine survival rate would be very helpful to include but that it would take quite some time to incorporate and would likely have high uncertainty and variation. It was suggested that Table 13 could be enhanced to better reflect the changes in productivity that can occur due to habitat changes.

Habitat Supply and Restoration (Elements 14 & 18)

The discussion on habitat supply and potential for restoration was fairly limited in the working paper given the lack of habitat requirement and supply data (specifically quantitative requirements for various life stages) for Fraser River Chinook Salmon. Additionally, spawning population-level assessments would need to be conducted to observe trends in habitat supply within DUs, something that is not adequately conducted at the moment. This was noted by many participants, and the authors agreed to try and capture the habitat features that may be limiting given the threats assessment and some literature. Where applicable, the authors were to incorporate DU-specific comments including coarse information on the feasibility of restoring certain habitats.

Multiple participants noted that there was a lack of consideration of the marine habitat throughout the working paper (e.g., carrying capacity, changes in marine productivity, competition with Asia-derived salmon, and local hatchery releases, etc.), and it was noted that the RPR process lacked experts in marine ecology that could speak to these points. The authors agreed to bolster this section with additional literature that could help describe the relative importance of limitations to the populations in the marine environment.

A research recommendation for this process will be further quantification of habitat requirement and supply, as well as limiting factors that exist or are expected to develop.

Mitigation Measures (Elements 16, 17, 19 & 20)

Scientific support for mitigation measures to help restore at-risk populations is an essential part of an Recovery Potential Assessment (RPA), yet was largely absent and unstructured in the working paper. Particular threats, and their relevant mitigation options, that were highlighted as having a lack of information were: Big Bar landslide, forestry and wildfire management, water use, pollution, agriculture and cumulative impacts. Aside from these above mentioned threats there was recognition that the section in general lacked a substantial evaluation of mitigation options, both in terms of restoring currently affected habitat, as well as reducing effects related to future projects.

To address the concern that Element 16 lacked a structured, methodical approach, the meeting was adjourned so that the author group, Chair and other relevant participants could create a table to be presented in the working paper. The proposed table was well received by participants, especially once comments and feedback were included, as it identifies specific mitigation options available to address threats stemming from various pathways of effect. This was not done on a DU-by-DU basis, but it will be related back to the threats tables in the first paper (Tables 24-55). A threat-by-threat walkthrough of potential mitigations ensued. This table will be included in the working paper.

The expansive marine and freshwater distribution, as well as variations in run timing and habitat use is confounded by the lack of habitat requirement and supply data as well as spawning population-level assessments. As a result, an attempt to list and prioritize mitigation options for each DU, while considering their feasibility, was deemed by the author group to be outside of the resources available for this paper. The author group agreed to incorporate more literature that was as relevant as possible to the DUs in question by focusing on similar species, habitat qualities, threats and geographic proximity.

Some notable mitigation options that were mostly omitted from the working paper included the use of mark-selective fisheries, marine mammal culls, incidental mortality associated with catch and release fisheries, bycatch reduction in the Canadian groundfish fleet and illegal, unregulated and unreported (IUU) fishing enforcement. Authors will address these points in the discussion of mitigation measures but emphasized that these mitigation options, and even the threats that they are meant to minimize, are still a source of scientific uncertainty. Specifically, it was felt there is sufficient evidence on the effects of a pinniped cull on salmon recovery, and therefore, there will be no suggestion to implement one within the paper. After a short discussion on new and emerging research and pinniped culling programs, the authors agreed to disaggregate pinniped predation from the broader category of “invasive and problematic species.”

An emphasis on multi-jurisdictional collaboration will be emphasized in the discussion of Element 16 and the paper’s concluding remarks. Specifically, a new approach to forestry that shifts away from the conventional clearcutting of stabilizing slopes can only take place through very engaged discussions with the Province of British Columbia. An interesting proposal was the idea of reducing log boom storage in the Fraser River which may reduce water quality by the influx of tannic acids into the water. Tools to reduce some of the more significant impacts of dams and water management are readily available but again, will require collaboration with the Province.

Participants from the interior of British Columbia (BC) requested greater recognition of the work that is currently being conducted to enhance DUs 9, 10 and 11 that are severely impacted by the Big Bar landslide. The authors will add to the discussion, noting that hatchery enhancement to mitigate that threat is being undertaken now and will continue to be undertaken for the next few years.

Elements 19 and 20 were not completed for this process due to data deficiencies, insufficient resources and the inter and intra-population life history and habitat diversity. This was questioned by some of the participants as it pertains to the state of knowledge moving into further elements, particularly the discussion of allowable harm. Participants were reminded that Elements 19 and 20 pertain to quantifying the impacts of specific mitigation options on specific DUs, something that is not feasible in this assessment given the above noted issues.

Risk-based assessments and management strategy evaluations were raised as possible techniques that could be used to add some degree of quantification to the proposed measures and it was widely recognized that these should be used in future salmon RPAs. Given that this is not a possibility for the current process, a more thorough literature review will incorporate mitigations that have known outcomes in similar Chinook populations.

Research needs for the mitigation elements echo the same need for increased monitoring of salmon DUs that is identified for all other sections of this document. With strengthened abundance, productivity and habitat data it would be more feasible for future science advice to include more direct, quantitative estimates of benefits from mitigation options.

Allowable Harm Statement (Element 22)

Review of the allowable harm element started with an author-led overview of the draft allowable harm statements for this RPA. Allowable harm is the harm that will not jeopardize recovery or survival. Recovery implies survival so reaching the upper recovery target (recovery) will include the lower recovery target (survival). A member from the Centre for Science Advice Pacific (CSAP) reminded all participants that exemptions and permits are granted only within the confines of allowable harm and emphasized that, as per the Terms of Reference, the RPA is not to allocate harm to various activities.

Discussion of allowable harm started with participants focusing on previously made points that the appropriate analysis required to support the allowable harm statements (which were considered overly pessimistic by a few participants because there have been years in the recent past where DU2 abundance have reached the proposed targets) was not completed. The lead author reminded participants that modelling shows that DU2 is unable to reach the desired percent change in abundance and the 4-year average abundance that exceeds the upper recovery target.

An analysis to evaluate which management strategies would be best suited to recover the populations, and to what extent, was highly desired by the participants. Recognizing that there are substantial data deficiencies and a lack of required resources for this RPA, the concerned participants recommended some sort of risk-based assessment that could use qualitative data. As per previous discussions the authors agreed to bolster previous relevant sections and recommend a risk-based approach for future RPAs. Some participants noted that is should be stated that these allowable harm statements are made in the absence of a tangible, quantifiable and prioritized recovery framework.

Other RPAs were referenced that provided some flexibility around interpreting allowable harm statements (e.g. Sakinaw sockeye) in the context of management measures, while keeping in mind the precarious nature of these population statuses.

The author group, and select participants including participants from the Interior that support minimized allowable harm, had a breakout session to consolidate allowable harm concerns and re-evaluate DU groupings and wording. Authors made new allowable harm recommendations but did not adopt the suggestion to split the non-Harrison DUs into new groups as the statements would end up being redundant. The new statements comply with DFOs Precautionary Approach (DFO 2009) and emphasized that the recommendations are made based on the weight of evidence and may change as the DU status changes based on mitigation measures and/or natural productivity. More general wording was used (removal of terms referring to absolute restrictions and “best chance of survival”) to reflect these uncertainties. DUs above Big Bar are emphasized as needing particular attention until the point when landslide impacts are alleviated, while a suggestion to outline the limited range and population size of DUs 7, 8 and 14 was also accepted.

CONCLUSIONS

There was a general acknowledgement by participants and authors that significant data deficiencies exist for many of these DUs and addressing each element thoroughly was not feasible at this time. Accordingly, there were many recommendations made to set priorities to advance recovery of these DUs in the future. Consensus was reached for many of the elements, however, before the paper could be accepted, further discussion was still required to review the model selection for DU2, examine alternative approaches to population trajectories and correspondingly, the probability of reaching potential recovery targets, and revisit the allowable harm statement. These issues were addressed at the Technical Modeling Meeting (Oct 1, 2020) and Final Meeting (March 11-12, 2021) summarized below.

TECHNICAL MODELING MEETING (OCT 1, 2020)

OVERVIEW

On October 1, 2020 a half-day online meeting was held to present new modelling work for DU2 (LFR-Harrison) addressing outstanding concerns from the July RPR meeting. The meeting began with a review of the goals for the day’s session and a roll call. In the July meeting, participants suggested reviewing the model selection process, and examining alternative approaches for population trajectories (Elements 13) and probability of reaching potential recovery targets (Element 15). Between July and October the authors worked with select participants to prepare new models that included:

- The addition of a log-normal correction factor in forward simulations;
- Consistent back calculation of age-1 recruits; and,

- A comparison of alternative Ricker forward projection models for DU2 including a model with constant (long-term) productivity, a model with auto-correlated deviates and a model with time-varying productivity.

Prior to the meeting, participants received new forward projection modelling based on the three models and two new appendices addressing lines of evidence for temporal variation in productivity and descriptions and comparisons of Ricker models for DU2 (LFR-Harrison). Both of these appendices were subsequently included in the final Working Paper. Following the introductions by the Chair, the lead author presented a brief overview of the results from new modelling efforts.

GENERAL DISCUSSION

Model Selection for DU2 (LFR-Harrison) (Elements 13 & 15)

After conducting a model selection analysis of alternative Stock Recruitment (S-R) model formulations, the authors brought forward the time-varying productivity model as the best choice for reviewing population trajectories (Element 13). There was no statistical basis to choose one model over the other however, the authors agreed that the time-varying productivity model was best supported by the biological lines of evidence provided in Appendix 6 (Temporal Variation in Productivity for DU2) and demonstrated preferred residual patterns. There was also concern from the authors that the alternative models provided an average long-term productivity estimate that might overestimate current conditions.

A small minority of participants objected to the use of a time-varying productivity model. There was concern that the model reflected a declining trend not representative of the historic periodicity in abundance and demographic residuals in as illustrated in the Appendix. The authors and other participants explained that the Ricker residual graphs in the appendix represent the synergistic effect of the different demographic factors and while several factors are considered, there are numerous other factors that exist. There was not enough data for this DU to use a decadal oscillation model and while productivity does change over time, the purpose of this section (as outlined in the RPA guidelines) was to create a model based on current productivity.

One participant suggested that the time-varying model should not be selected because the difference in Akaike Information Criterion (AIC) value between it and simpler models exceeded the typical numeric for model acceptance; the Standard Ricker was most parsimonious. As mentioned in the supporting Appendix 7, the use of AIC in time-varying models can be problematic and while the difference in AIC was comparatively high, it was considered not enough to reject this model given other lines of evidence. The participant expressed their skepticism in using a newer model that has not been simulation tested for Chinook salmon and did not undergo Management Strategy Evaluation (MSE) testing as suggested in the recent Holt and Michielsens (2020) paper. This participant also urged the use of a retrospective analysis prior to accepting this model. Ultimately this was not completed due to the large number of DUs and short timelines faced by the authors. A comment was included in the paper suggesting that future modelling include a retrospective analysis and that fisheries managers should be cautious in assuming a single model is a holistic representation.

Lastly, there was concern that the confidence intervals represented in the time-varying productivity models were too constrained. In the period selected, there was already an example of escapement outside the 95% confidence interval. Authors and several participants agreed that the tight confidence intervals were not unexpected given the low productivity presented.

The majority of participants agreed that the time-varying productivity model was the best choice given the weight of evidence, small residual values and greatest conformance with the Terms of Reference Guidelines to use current rates of population dynamics parameters. This conversation was revisited in the March meeting (see below) and while the time-varying productivity model was ultimately accepted by the group, as noted there was a range of perspectives among participants.

Productivity Parameter Selection (Elements 13 & 15)

The average productivity from the most recent generation available (2010-2013) was used to represent the state of current productivity for forward projections. Some participants argued this dataset does not accurately reflect current conditions and may be too pessimistic. The authors selected this dataset because it was previously agreed upon in the July RPR meeting, was consistent with the most recent Pacific Salmon Treaty agreement and best captured the guidelines within the Terms of Reference to use *"current rates of population dynamics parameters"*. Additional context was added to the paper highlighting the uncertainties around projecting future productivity and suggesting that the model be revisited in the future as more data becomes available.

Harvest Rate Selection for Modelling Probabilities of Achieving Recovery Targets under Different Conditions (Element 15)

Using the three different Ricker stock-recruitment models, the authors developed corresponding heat maps displaying the likelihood of achieving recovery targets under different productivity and exploitation rate scenarios. The assumed current harvest rate in the time-varying productivity model was based on average pre-terminal and terminal rates from the 2009 to 2015 period, for Canadian fisheries only. There was some concern from participants that this time frame was outdated and may not accurately depict *current* harvest rates. The authors chose this period because it represents relatively recent harvest rates and is congruent with methods used in the recent Pacific Salmon Treaty agreement, allowing easier integration with the Species at Risk (SAR) program and Fisheries Management. Also, more recent Coded Wire Tag data was not available at the time. A member of the SAR program clarified that the time period chosen for modelling harvest rates can be a little older, as long as this time frame is clearly reflected in the allowable harm statement. If new data become available, this model can be revisited.

Demographic Factor Timelines (Working Paper Appendix 6)

There was a short discussion on whether the time frames to review supporting information on productivity in Working Paper Appendix 6 should be consistent across all factors considered. In some cases the data ended in 2013 while others, particularly those displaying higher productivity residuals, extended into later years. A suggestion was made to redraft this appendix to include more recent years and compare differences between sexes. The authors noted they used the most up-to date information and were ultimately unable to make changes to the appendix.

CONCLUSION

The meeting focused on a model selection analysis of three Ricker models. It was proposed that the time-varying productivity model be used in the Working Paper, with the attached appendices providing information on the other models. While not all participants agreed with the use of time-varying productivity model choice, participants, especially those in dissent of the modeling approach used, sought clarity as to the extent to which their concerns would be represented in the final Research Document and Science Advisory Report.

FINAL MEETING (MARCH 11-12, 2021)

OVERVIEW

On March 11 and 12 2021, a final online meeting was held to prepare summary bullets for the Fraser Chinook Science Advisory Report (Elements 12-22) and conclude the discussion on recovery targets, population projections and the allowable harm statement (see Appendix C: Agenda). The meeting began with an overview of the *Policy on the Principle of Consensus* (CSAS 2010), purpose of the Science Advisory Report, role of an RPA and review of the previous discussions. In the interest of efficiency, a draft Science Advisory Report was prepared beforehand and provided to participants.

GENERAL DISCUSSION

Recovery Targets (Element 12)

Biological recovery targets in the WP were selected based on both the benchmarks in the WSP and the COSEWIC criteria for status designation. The authors chose a 0.85 S_{MSY} recovery target for DU2 to correspond with the abundance component of the Wild Salmon Policy green status. They also chose a S_{MSY} value of 75,068 consistent with the WSP benchmark and committed to in the bi-laterally agreed-upon Pacific Salmon Treaty as an escapement goal for DU2. During this final meeting, the group wrapped up the conversation on alternative approaches for biological reference points.

On the first day, a couple of participants proposed using a moving target approach with no fixed S_{MSY} and posterior distribution to better reflect changes in recent productivity. This methodology is consistent with recovery target setting for other SARA species (e.g. Bocaccio and Quillback Rockfish). The majority of participants disagreed with this approach and preferred the authors' use of long term benchmarks over a moving target approach. This method is most compatible with the purpose of the RPA, consistent with target setting for other at-risk salmon populations, and easiest to use by fisheries managers.

The group also discussed recovery target setting for the stream-type Chinook populations and clarifying assumptions for the habitat model. More information will be added to the paper clarifying habitat model inputs and corresponding assumptions. In addition, the survival targets for small populations (<1,000; DU 4, 5, 14 and 16) were amended from a previously calculated S_{GEN} to 1,000 spawners. This is consistent with the abundance used in COSEWIC's Criteria D for assessing the status of at risk populations (COSEWIC, 2019). It is also consistent with the approach used for DU 7 and 8.

On the second day of the meeting, the group returned to the discussion of alternative approaches to recovery target setting. One participant supplied two paragraphs of text describing other approaches that could be taken to develop benchmarks. The first approach was to define reference points as estimated quantities that are uncertain. The second, to project associated changes in benchmarks for each alternative scenario considered for future changes in productivity. These alternative approaches were not accepted by the majority however, a short comment was added to the SAR summary bullets identifying this discussion and the participant was offered the opportunity to work with authors to incorporate some text in the Research Document on alternative approaches that could be considered in the future.

Probability of Recovery (Elements 13 & 15)

The lead author began the discussion by providing an overview of the peer review process over the past year to model and address Elements 13 and 15. Her presentation included a review of the outstanding concerns from the July and October meetings, as well as proposed solutions. Major changes to the working paper since the first meeting in July included: modelling updates, recovery target terminology adjustments, removal of VRAP2 methodology in the appendix, inclusion of additional appendices (Temporal Variation in Productivity for DU2 and Ricker Models for DU2) and, contextual updates to the modelling and results sections.

The first discussion revolved around the selection and use of harvest rate data for the DU2 heat maps. There was some concern around using older data (2009-2015 average) given the recent management measures implemented in Canada to conserve salmon stocks. In response, the authors added additional clarification to the SAR describing the delayed acquisition and processing of data, uncertainty regarding the outcome of recent fisheries management measures on exploitation rates, and text on how future management measures may change harvest rates. Furthermore, a table from the Chinook Technical Committee illustrating the most recently available harvest rates in pre-terminal and terminal fisheries in Canada and the United States was added to the Appendix 5 based on a group suggestion. Lastly, there was a recommendation to use actual harvest rates instead of a percentage change to simplify and clarify the y axis of the heat maps. The authors chose percent change because of the difficulty in determining accurate annual harvest rates for fisheries that are not terminal. The authors agreed to provide a translation of harvest rates into exploitation rates.

The group also reviewed the time frame for calculating average productivity from the time-varying productivity model; specifically, the support for choosing a four year period over a longer time frame that might better reflect the cyclical abundance of salmon. Ultimately, the lack of recent data guided the authors' choice. The last available complete brood year is 2013 and incorporating data from the early 2000s would be less compatible with RPA guidelines to reflect "current conditions". To display some of the uncertainties with regards to productivity in current conditions, the authors added an error bar in the heat map demonstrating the range of productivity at zero percent change in Canadian harvest rate.

Lastly, the group discussed ways of refining and improving the utility of the heat maps. The original figures included a productivity change range from -50 to +50% with 10% increments. The authors increased the productivity range to better fit the historic range observed and presented in the Working Paper. Additionally, the authors removed the 10% increments and interpolated the data, thereby smoothing contours of the figure.

There were two other points of conversation under Elements 13 and 15. The group returned to the Viability and Risk Assessment Procedure 2 (VRAP2) analysis. This was originally included in an appendix of the working paper to further examine the potential allowable harm from fisheries for DU2 under current conditions. The model was removed from the WP because there was no bias correction factor. Population projections were now based on joint posterior distribution of parameter estimates from the Bayesian analysis of stock-recruit data.

Under Element 13, there was initially some text that proposed the survival target as a limit reference point with a set percentage management target. This text was later removed because the group agreed that the proposed threshold is a management criterion and not scientific advice.

In the discussion of Element 15, one participant commented on the difficulty projecting time varying project without a hypothesis of future trend. The authors captured this uncertainty by generating a linear trend in productivity where the x axis of the heat maps represented various rates of change over 12 years of the projections. Productivity is incremented annually representing a time varying productivity hypothesis. One participant argued that it is possible to project time varying productivity and hypothesize how time varying productivity will be realized in the future. They reiterated that a reasonable alternative was a 12 year cycle. Other participants argued that the approach taken by the authors was consistent with the approach given by the Terms of Reference and similar to other processes.

By the end of the meeting, the majority of participants accepted the heat map and results with the above-mentioned refinements. This approach was consistent with other processes and the requirements of the Terms of Reference. Simulation testing of the projection model is recommended to provide confidence in its outputs. The SAR and Research Document will include additional text reflecting the limitations and uncertainty in projecting future conditions. If there are changes to productivity or harvest rate in the future, this section can be revisited.

Mitigation Measures (Elements 16, 17, 19 & 20)

The mitigation measure sections of the working paper were developed by participants in the July meeting. This final discussion offered an opportunity to contribute minor revisions and incorporate mitigation measures in the SAR.

On the suggestion of a participant, a table depicting potential mitigation strategies and alternative actions to address threats to Chinook salmon DUs was added to the Science Advisory Report. Additionally, the group agreed to bolster Element 16 by including more discussion on whether specific mitigation measures would benefit stream or ocean type Chinook.

Lastly, a suggestion was made to include further information on mitigation measures to address predation. This was already included in Table 4 of the Science Advisory Report and a similar table was subsequently added to the Research Document. One participant sent the group literature sources on the threat of pinniped predation towards salmon and the efficacy of mitigation measures. There are significant gaps in our understanding of pinniped and Chinook salmon population dynamics, as well as the indirect effects of predator culls and other factors that influence ecosystem functions. No additional mitigation measures were proposed, rather, the research needs included recommendations to further explore these knowledge gaps.

Allowable Harm Statement (Element 22)

After comprehensive discussion of the modelling choices and analysis included in the Research Document, the group returned to the allowable harm statement. It was important to all that the statement convey the many uncertainties and limitations of the data and analysis. There was also extensive discussion on whether the statement should bring attention to specific activities that may impact population recovery (e.g. pinniped predation or climate change). Since the RPA did not explore recovery by activity, participants agreed to keep the statement general. No specific mention of any threats are included in the allowable harm statement and the reader is referred to Part 1 of the RPA and/or a general threat summary included at the beginning of the paper for more information.

Allowable Harm Statement for DU2 (LFR-Harrison)

The allowable harm statement for DU2 was adopted in the afternoon on the second day. During the meeting, the participants refined the text to clarify that all inferences and conclusions are in relation to the base case used for the analyses in Elements 12, 13 and 15. A participant suggested adding a statement on how allowable harm for DU2 might change if productivity increases, as demonstrated by the Element 15 heat maps. Since the purpose of the allowable harm statement is to provide a recommendation using the base case scenario, the group decided against reviewing the impact of changes to productivity. All agreed that this statement should be revisited if there are large changes in productivity.

Allowable Harm Statement for Stream-Type DUs

The group agreed that the allowable harm statement for stream-type DUs should be more restrictive than DU2 reflecting the extensive threats, small population sizes and more severe COSEWIC assessments for many DUs. The additional statement highlighting the effect of the Big Bar landslide for DU 9, 10 and 11 was revisited. A couple participants were apprehensive with its inclusion given the extensive mitigation measures underway. The group ultimately agreed that, despite mitigation efforts, the threat continues and the additional spotlight on the landslide should remain until the risk has been alleviated.

The previous discussion on including specific activities in the allowable harm statement was brought up again when the group reviewed a statement that spoke of widespread freshwater habitat degradation related to insect infestations, wildfire and logging, etc. impeding recovery. Most participants supported keeping this text to showcase the extensive issues impacting and impeding recovery of these populations, however, there were opposing views supporting consistency with the rest of the statement to not highlight specific activities. The group agreed to remove the comment and refer the reader to a summary of threats at the beginning of the document and Part 1 of the RPA.

Lastly, while the allowable harm statements for all DUs are highly restrictive, a member of DFOs SAR salmon team started a discussion on whether some activities (e.g., scientific research and conservation initiatives) could be beneficial, and therefore, permissible. Consistent with the previous conversation, no specific activities were included, however, the authors agreed to refer the reader to Section 73 of *the Species at Risk Act* for activities that may support the population and/or not impact its recovery.

After considerable deliberation, all allowable harm statements were accepted the afternoon of the last meeting day.

Summary Bullets

The final day of the RPR meeting was largely focused on garnering agreement on SAR summary bullets. In the interest of saving time, a draft SAR was prepared beforehand and the Chair used meeting time to lead a fulsome discussion of each included bullet. No commentary was provided for the first two bullets that describe the RPA and populations addressed by the report.

A short definition of recovery and survival targets is included as one of the first summary bullets. One participant recommended linking the recovery target definition to the Green Status abundance target in the WSP. Given the multiple factors considered in the WSP status assessments and number of DUs considered in the paper, the group agreed to keep the summary bullet more general. A more descriptive definition of each target is included in the main body of the Science Advisory Report.

There are several bullets describing key concepts relevant to recovery benchmarks. The group recommended bolstering the bullet on DU2 recovery potential to describe how much productivity or harvest rate would need to change at the base case scenario to achieve recovery targets. The bullet also clarifies base case assumptions with a clear description of brood and catch years.

The bullet on stream-type DU recovery and survival targets was rewritten to reflect that the abundance targets were based on a meta-analysis and there is greater uncertainty in this methodology. A more fulsome description of the methodology used to achieve recovery targets is included in the Research Document.

There was a discussion whether the alternative methods to setting recovery benchmarks and modelling mentioned throughout the Peer Review process should be included in the SAR summary bullet (see General Discussion above). The SAR is intended to reflect the advice stemming from the peer review process so a short sentence was added recognizing the alternative views discussed. A detailed discussion of alternative approaches will be included in the Research Document.

The group discussed whether the allowable harm bullet for stream-type DUs should mention the impacts of the Big Bag landslide. Many participants thought it should be included given the severe impacts on the population. Others argued that significant improvements had occurred since 2019 and if Big Bar was highlighted, additional text should be added to illustrate the significant mitigation measures already in place. This recommendation was accepted and specific mention of Big Bar was included with a short discussion on the mitigation measures underway.

The allowable harm statement is often used by the SAR program to consider whether permits can be issued for activities in contravention of the Act once a species is listed. As such, a participant from this program suggested rephrasing the statement for DU2 to say activities are “not permitted”. This was ultimately discouraged from the group since the term “permit” is akin to management guidance, not scientific advice as per the RPA Terms of Reference.

Following the many discussions on these data limited populations, the group suggested adding two additional bullets to reflect the uncertainties in predicting future conditions. The first bullet speaks to the general challenges in understanding salmon population dynamics moving forward and continuous need to monitor and assess the approach to recovery. The second bullet speaks to the considerable data limitations and resulting difficulties in assessing stream-type DUs. All SAR summary bullets were accepted by participants on the last day of the meeting.

CONCLUSION

After extensive discussion the Working Paper was accepted with revision. A detailed list of suggestions was developed during the meeting to guide the authors in their revision. New text describing different approaches to setting recovery targets and forward projection modelling was provided. The Chair and CSAS Coordinator ended the meeting by providing an anticipated timeline for the distribution of both the draft SAR and draft Research Document. The drafts are provided to participants for editing only, not for changes of content or context. After edits have been collected and incorporated, the documents will be sent for translation before publication.

ACKNOWLEDGEMENTS

We appreciate the time contributed to the RPR process by all participants. In particular, we thank the reviewers, Michael Folkes and Andrew Rosenberger for their time and expertise. We also thank Mike Bradford as Chair of the meeting and Grace Young and Justin Barbati as the Rapporteurs.

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APPENDIX A: TERMS OF REFERENCE

RECOVERY POTENTIAL ASSESSMENT – FRASER RIVER CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) – ELEVEN DESIGNATABLE UNITS

Regional Peer Review – Pacific Region

December 10-12, 2019
Paper #1 – Elements 1-11
Kamloops, British Columbia

July 7-9, 2020, October 1, 2020 and March 11-12, 2021
Paper #2 – Elements 12-22
Virtual Meetings

Chair: Mike Bradford

Context

After the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses an aquatic species as Threatened, Endangered or Extirpated, Fisheries and Oceans Canada (DFO) undertakes a number of actions required to support implementation of the Species at Risk Act (SARA). Many of these actions require scientific information on the current status of the wildlife species, threats to its survival and recovery, and the feasibility of recovery. Formulation of this scientific advice has typically been developed through a Recovery Potential Assessment (RPA) that is conducted shortly after the COSEWIC assessment. This timing allows for consideration of peer-reviewed scientific analyses into SARA processes including recovery planning.

The following eleven populations of Fraser River Chinook Salmon (Oncorhynchus tshawytscha) were designated as Endangered or Threatened by COSEWIC in 2018 based on population declines (COSEWIC 2018).

1. DU 2, Lower Fraser Ocean Fall population (**Threatened**): While the calculation of decline rates is complicated by hatchery releases from 1981 to 2004, this fall run of Chinook spawning in the Lower Fraser has declined steadily in abundance. The abundance data over all years was thought to best represent natural spawner abundance. Declines in marine and freshwater habitat quality, harvest and ecosystem modification in the lower Fraser estuary, are threats facing this population.
2. DU 4, Lower Fraser Stream Summer (Upper Pitt) population (**Endangered**): This summer run Chinook stock spawning in the Pitt River in the Lower Fraser watershed has declined and is now at its lowest recorded abundance. Declines in freshwater and marine habitat quality and harvest are continuing threats to this population.
3. DU 5, Lower Fraser Stream Summer population (**Endangered**): This summer run Chinook spawning in the Lillooet and Harrison rivers in the Lower Fraser watershed has declined to very low levels. Declines in freshwater and marine habitat quality and harvest are threats facing this population.
4. DU 7, Middle Fraser Stream Spring population (**Endangered**): This population of spring run Chinook spawning in the Nahatlatch and Anderson watersheds has declined to very low levels. Declines in freshwater and marine habitat quality and harvest are continuing threats to this population.

5. DU 8, Middle Fraser Stream Fall population (**Endangered**): This population of fall run Chinook spawning in the Seton and Anderson watersheds along the middle Fraser River has declined to very low levels, and the decline is anticipated to continue. Declines in freshwater and marine habitat quality and harvest are continuing threats to this population.
6. DU 9, Middle Fraser Stream Spring population (MFR+GStr) (**Endangered**): This spring run of Chinook spawning in multiple middle Fraser River tributaries has declined in abundance. Declines in marine and freshwater habitat quality, harvest and pollution from mining activities are threats to this population.
7. DU 10, Middle Fraser Stream Summer population (**Threatened**): This summer run of Chinook spawning in multiple middle Fraser River tributaries has declined in abundance. Declines in marine and freshwater habitat quality are threats to this population.
8. DU 11, Upper Fraser Stream Spring population (**Endangered**): This spring run of Chinook spawning in the Salmon and Rausch rivers of the upper Fraser watershed has declined in abundance. Declines in marine and freshwater habitat quality and harvest are threats facing this population. Anticipated changes to North Pacific weather systems that affect groundwater availability, will impact spawning sites and overwinter survival
9. DU 14, South Thompson Stream Summer 1.2 population (**Endangered**): This summer run of Chinook spawning in the South Thompson River has steeply declined in abundance to a very low level. Declines in marine and freshwater habitat quality and harvest are threats to this population.
10. DU 16, North Thompson Stream Spring population (**Endangered**): This spring run of Chinook spawning in the North Thompson River has steeply declined in abundance to a low level. Declines in marine and freshwater habitat quality and harvest are threats to this population. Anticipated changes to North Pacific weather systems that affect groundwater availability, will impact spawning sites and overwinter survival.
11. DU 17, North Thompson Stream Summer population (**Endangered**): This summer run of Chinook spawning in the North Thompson River has steeply declined in abundance. Declines in marine and freshwater habitat quality and harvest are threats facing this population.

DFO Science has been asked to undertake a Recovery Potential Assessment (RPA), for these 11 populations based upon the national RPA Guidance. The advice in the RPA may be used to inform both scientific and socio-economic aspects of the listing decision, development of a recovery strategy and action plan, and to support decision making with regards to the issuance of permits or agreements, and the formulation of exemptions and related conditions, as per sections 73, 74, 75, 77, 78 and 83(4) of the Species at Risk Act (SARA 2002). The advice in the RPA may also be used to prepare for the reporting requirements of SARA section 55. The advice generated via this process will update and/or consolidate any existing advice regarding these populations of Fraser River Chinook Salmon.

Typically, when an RPA is undertaken, all 22 different elements are compiled into one working paper for review to inform not only a listing decision under SARA, but subsequent recovery planning. For Fraser River Chinook Salmon there will be two separate working papers, presented and reviewed at different times. The two working papers are as follows:

- Working paper #1: Fraser River Chinook Salmon – Elements 1-11.
- Working paper #2: Fraser River Chinook Salmon– Elements 12-22.

Objectives

- To provide up-to-date information, and associated uncertainties, to address the following elements:

Biology, Abundance, Distribution and Life History Parameters

Element 1: Summarize the biology of Fraser River Chinook Salmon (11 populations).

Element 2: Evaluate the recent species trajectory for abundance, distribution and number of populations.

Element 3: Estimate the current or recent life-history parameters for the 11 populations of Fraser River Chinook Salmon.

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Fraser River Chinook Salmon populations need for successful completion of all life-history stages. Describe the function(s), feature(s), and attribute(s) of the habitat, and quantify by how much the biological function(s) that specific habitat feature(s) provides varies with the state or amount of habitat, including carrying capacity limits, if any.

Element 5: Provide information on the spatial extent of the areas for Fraser River Chinook Salmon distribution (11 populations) that are likely to have these habitat properties.

Element 6: Quantify the presence and extent of spatial configuration constraints, if any, such as connectivity, barriers to access, etc.

Element 7: Evaluate to what extent the concept of residence applies to the species, and if so, describe the species' residence.

Threats and Limiting Factors to the Survival and Recovery of Fraser River Chinook Salmon (11 populations)

Element 8: Assess and prioritize the threats to the survival and recovery of the 11 populations of Fraser River Chinook Salmon.

Element 9: Identify the activities most likely to threaten (i.e., damage or destroy) the habitat properties identified in Elements 4-5 and provide information on the extent and consequences of these activities.

Element 10: Assess any natural factors that will limit the survival and recovery of the 11 populations of Fraser River Chinook Salmon.

Element 11: Discuss the potential ecological impacts of the threats identified in Element 8 to the target species and other co-occurring species. List the possible benefits and disadvantages to the target species and other co-occurring species that may occur if the threats are abated. Identify existing monitoring efforts for the target species and other co-occurring species associated with each of the threats, and identify any knowledge gaps.

Recovery Targets

Element 12: Propose candidate abundance and distribution target(s) for recovery.

Element 13: Project expected population trajectories over a scientifically reasonable time frame (minimum of 10 years), and trajectories over time to the potential recovery target(s), given current Fraser River Chinook Salmon population dynamics parameters.

Element 14: Provide advice on the degree to which supply of suitable habitat meets the demands of the species both at present and when the species reaches the potential recovery target(s) identified in Element 12.

Element 15: Assess the probability that the potential recovery target(s) can be achieved under current rates of population dynamics parameters, and how that probability would vary with different mortality (especially lower) and productivity (especially higher) parameters.

Scenarios for Mitigation of Threats and Alternatives to Activities

Element 16: Develop an inventory of feasible mitigation measures and reasonable alternatives to the activities that are threats to the species and its habitat (as identified in Elements 8 and 10).

Element 17: Develop an inventory of activities that could increase the productivity or survivorship parameters (as identified in Elements 3 and 15).

Element 18: If current habitat supply may be insufficient to achieve recovery targets (see Element 14), provide advice on the feasibility of restoring the habitat to higher values. Advice must be provided in the context of all available options for achieving abundance and distribution targets.

Element 19: Estimate the reduction in mortality rate expected by each of the mitigation measures or alternatives in Element 16 and the increase in productivity or survivorship associated with each measure in Element 17.

Element 20: Project expected population trajectory (and uncertainties) over a scientifically reasonable time frame and to the time of reaching recovery targets, given mortality rates and productivities associated with the specific measures identified for exploration in Element 19. Include those that provide as high a probability of survivorship and recovery as possible for biologically realistic parameter values.

Element 21: Recommend parameter values for population productivity and starting mortality rates and, where necessary, specialized features of population models that would be required to allow exploration of additional scenarios as part of the assessment of economic, social, and cultural impacts in support of the listing process.

Allowable Harm Assessment

Element 22: Evaluate maximum human-induced mortality and habitat destruction that the species can sustain without jeopardizing its survival or recovery.

Expected Publications

- 2 Science Advisory Reports
- 2 Proceedings
- 2 Research Documents (working papers 1 and 2)

Expected Participants

- Fisheries and Oceans Canada (Ecosystems and Oceans Science, and Ecosystems and Fisheries Management sectors)
- Province of BC
- Academia
- First Nations

- Industry
- Environmental non-governmental organizations

References

COSEWIC 2019. COSEWIC assessment and status report on the Chinook Salmon *Oncorhynchus tshawytscha*, Designatable Units in Southern British Columbia (Part One – Designatable Units with no or low levels of artificial releases in the last 12 years), in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxxi + 283 pp.

APPENDIX B: ABSTRACT OF WORKING PAPER

Eleven Designatable Units (DUs) of Chinook Salmon (*Oncorhynchus tshawytscha*), within the Fraser River were assessed as Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2018, and are currently under consideration for addition to Schedule 1 of the *Species at Risk Act* (SARA). The first part of the Recovery Potential Assessment (RPA) (Elements 1-11) provided DU descriptions, status updates and an assessment of the threats and factors limiting recovery. This second half provides potential recovery targets, a discussion of mitigation measures, population projections and a recommendation of allowable harm. Survival and recovery targets for each DU were suggested based on Wild Salmon Policy (WSP) benchmarks, with additional requirements about observed percent change in spawners. Two different projection models were used to assess likely future trajectories and the chances of meeting these targets, however, results are only available for DU2 (LFR-Harrison). Despite efforts to produce the required input parameters for the stream-type DUs, significant uncertainties and a considerable lack of data prevented quantitative assessment, and hence these DUs were assessed qualitatively. Results for DU2 (LFR-Harrison) indicate that reaching the survival target under recent conditions is about as likely as it is not likely (48% chance), while meeting the recovery goal is unlikely (16% chance). The risks imposed by climate change and continued anthropogenic development add additional uncertainty that was only described qualitatively. Based on the quantitative assessment for DU2 (LFR-Harrison) and the qualitative assessment for the remaining DUs, it is recommended that human-induced mortality and other sources of harm identified in the threats assessment should be significantly reduced and in some cases prevented to provide the best chance for these populations to recover.

APPENDIX C: AGENDAS

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific

Regional Peer Review Meeting (RPR)

Recover Potential Assessment for 11 Fraser River Chinook Salmon DUs Part 2: Elements 12-22

Virtual Meetings
Chair: Mike Bradford

AGENDA – INITIAL MEETING JULY 7-9 2020

DAY 1 – Tuesday, July 7, 2020

Time	Subject	Presenter
09:00	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chair
09:15	Review Terms of Reference and the RPA process	Chair
09:30	Presentation of Working Paper (Overview)	Authors
10:30	***Break***	
10:45	Written Reviews and Authors Response	Chair + Reviewers & Authors
12:00	***Lunch Break***	
13:00	Completion of discussion of written reviews Discussion & Resolution of Issues: Elements 12-15, recovery targets and projections	Reviewers and authors RPR Participants
14:30	***Break***	
14:45	Consensus on conclusions: Elements 12-15, recovery targets and projections	RPR Participants
16:00	**Adjourn for the Day**	

DAY 2 - Wednesday, July 8, 2020

Time	Subject	Presenter
09:00	Review Status of Day 1 (*As Necessary*)	Chair
09:15	Discussion & Resolution of Issues: Elements 16-20, mitigation options	RPR Participants
10:30	***Break***	
10:45	Discussion and consensus on mitigation, con't	RPR Participants
12:00	***Lunch Break***	
13:00	Discussion and consensus on mitigation Discussion on Element 22, allowable harm	RPR Participants
14:45	***Break***	
15:00	Consensus on the acceptability of the working paper	Chair & Participants

Time	Subject	Presenter
15:30	Introduction of the Science Advisory Report --Preliminary list of conclusions (bullets)	
16:00	***Adjourn for the day***	

DAY 3 - Thursday, July 9, 2020

Time	Subject	Presenter
09:00	*Science Advisory Report (SAR)* Develop consensus on the following for inclusion: • Results & Conclusions • Sources of Uncertainty Additional advice to Management (as warranted)	Chair & Participants
10:30	***Break***	
10:45	SAR Finalization	RPR Participants
11:30	• SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (as necessary) • Other Business arising from the review	Chair
12:00	***Adjourn Meeting if completed***	
13:00	***Additional time, if needed.***	

AGENDA – TECHNICAL MODELING MEETING OCTOBER 1, 2020

No agenda was provided to participants. This was an opportunity for the peer review group to discuss new modelling efforts from the authors, including:

- Use of a log-normal correction factor in forward simulations;
- Changes to the handling of maturation rates so that the rates used in the back calculation of age-1 recruits are saved and used to determine spawners for that cohort; and,
- A comparison of results and diagnostics of alternative models for the dynamics of DU2 including (1) Ricker model with constant (long-term) productivity and random deviates, (2) Ricker model with auto correlated deviates, (3) Ricker model with time-varying productivity.

AGENDA – FINAL MEETING MARCH 11-12, 2021

- Introduction
- Review of CSAS procedures and process, introductions.
- Review progress to date; Elements for which consensus has been reached.
- Review revised DU2 data analysis and projections (Elements 13 and 15); develop advice
- Review revised allowable harm statement (Element 22)
- Make decision on the status of the Working Paper, and revisions if appropriate.
- Review of summary bullets in SAR
- Next steps in the procedure, timelines etc.

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Arbeider	Michael	DFO Stock Assessment
Barbati	Justin	DFO Species at Risk Act Program
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Bonney	Giselle	DFO Species at Risk Act Program
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Walsh	Michelle	Secwepemc Fisheries Commission
Weir	Lauren	DFO Stock Assessment
Welch	Paul	DFO Salmonid Enhancement Program
Wor	Catarina	DFO Science
Young	Grace	DFO Species at Risk Act Program
Young	Jeffery	David Suzuki Foundation/Marine Conservation Caucus