Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2022/011

Pacific Region

Proceedings of the Pacific regional peer review on Recovery Potential Assessment – Fraser River Sockeye Salmon (*Oncorhynchus nerka*) – Ten Designatable Units

March 16–18, 2021
Virtual Meeting

Chairperson: Ben Davis
Editor: Jill Campbell

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Nanaimo, BC V9T 6N7

March 2022

Canada

Foreword

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

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1701-1280
ISBN 978-0-660-42088-2 Cat. No. Fs70-4/2022-011E-PDF

Correct citation for this publication:

DFO. 2022. Proceedings of the Pacific regional peer review on Recovery Potential Assessment – Fraser River Sockeye Salmon (*Oncorhynchus nerka*) – Ten Designatable Units; March 16–18, 2021. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2022/011.

Aussi disponible en français :

*MPO. 2022. Compte rendu de l'examen par les pairs de la région du Pacifique sur l'Évaluation du potentiel de rétablissement : Saumon rouge du fleuve Fraser (*Oncorhynchus nerka*) – Dix unités désignables; du 16 au 18 mars 2021. Secr. can. des avis. sci. du MPO. Compte rendu 2022/011.*

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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 (RPR) meeting held on March 16-18, 2021 via the online meeting platform Zoom. The working paper focusing on the recovery potential assessment of nine designatable units of Fraser River Sockeye Salmon, Terms of Reference (ToR) Elements 1-11, 14, 16-18, was presented for peer review.

Due to the COVID-19 pandemic, in person gatherings have been restricted and a virtual format for this meeting was adopted. Web-based participation included Fisheries and Oceans Canada (DFO) Science, Species at Risk Program (SARP), and Fisheries Management Sectors staff, and external representatives from First Nations, Province of British Columbia (BC), industry, 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 decision makers in DFO's Ecosystem Management Branch, Species at Risk Program, and Committed on the Status of Endangered Wildlife in Canada (COSEWIC) to inform *Species at Risk Act* (SARA) recovery planning.

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 virtually on March 16-18, 2021 via the online meeting platform Zoom to review the recovery potential assessment (RPA) for nine Designatable Units (DU) of Fraser River Sockeye Salmon (FRS) via Terms of Reference (ToR) Elements 1-11, 14, 16-18.

The ToR for the science review (Appendix A) was developed in response to a request for advice from DFO's Species at Risk Program. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from DFO Science, the Species at Risk Office, and Fisheries Management staff, and external representatives from First Nations, Province of BC, the fishing industry, environmental non-governmental organizations, and academia.

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

> D. Doutaz, A-M. Huang, S. Decker, and T. Vivian. Recovery Potential Assessment for 9 Designatable Units of Fraser River Sockeye Salmon, *Oncorhynchus nerka*. CSAS Working Paper 2 [2015SAR09b]

The meeting Chair, Ben Davis, 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 fully participate in the discussion and to contribute 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 and working paper.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying Jill Campbell as the Rapporteur for the review. The Chair then reviewed the procedural rules and process for exchange, reminding participants that the meeting was a science review and not a consultation.

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, 44 people participated in the RPR (Appendix D).

Participants were informed that David Patterson and Jason Hwang had been asked before the meeting to provide 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 (SAR) to DFO's Species at Risk Program to inform recovery planning of nine Fraser Sockeye DUs currently listed as Threatened or Endangered under COSEWIC. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEW

Working Paper: D. Doutaz, A-M. Huang, S. Decker, and T. Vivian. Recovery Potential Assessment for 9 Designatable Units of Fraser River Sockeye Salmon, *Oncorhynchus nerka*. CSAS Working Paper 2 [2015SAR09b]

Rapporteur: Jill Campbell

Presenter: Dan Doutaz

PRESENTATION OF WORKING PAPER AND REVEIWS

DFO Biologist Dan Doutaz presented the working paper. The models from Huang et al (2021) have been updated to include information on the 2014-2016 brood years and three sections in the working paper were updated to include these additional years of data. The updated sections were: abundance plots (Section 2.2.2), DU-specific freshwater habitat distribution maps (Section 3.2.1), and modeled threat tables (Section 7).

This proceeding document outlines the discussions for each Element. Questions and comments raised by the reviewers and participants are captured under the appropriate Element.

GENERAL DISCUSSION

ELEMENT 1

- A participant noticed an out of date statement on Page 1. The statement indicates the Fraser River (FR) supports the largest Sockeye population and cites a paper from 1989. The authors will update this statement to reflect that Bristol Bay now supports the largest Sockeye population and they will update the citation.
- A participant suggested a summary table be added to include biology and habitat parameters such as: run timing (in and out), freshwater smolt survival, run sizes, spawn timing, ocean/river/lake type, cyclical run pattern (yes/no), and age composition information.
- In response to a reviewer comment, the authors will change DU24 Widgeon-RT from river-type to ocean-type since this DU spends less than one year in fresh water.
- Data from the Mission Downstream program might be considered for inclusion.

ELEMENT 2

- In response to a participant comment regarding Page 8 Section 2.2.1, the authors will clarify the date range of the available georeferenced spawner data. The participant noted that spatially referenced spawning extent data has been collected since the 1950's and not only since 2001 as the authors suggest.
- Participants indicated that the type and precision of surveys change with fish abundance. The authors will consider including text in the paper to indicate this.
- A participant suggested the authors include a table to summarize the abundance plots. Information in this table could include: spawner abundance as calculated over the short term, long term, and trajectory values. This table should be organized by DU.
- A participant suggested the authors add text indicating the data sets used to generate the abundance plots for each DU. This information could help the reader better understand instances where the total mortality line falls above the Exploitation Rate (ER) line in the

Total Mortality and ER plots. The authors indicated the technical report that accompanies the RPA research document (Pestal et al. In Press; sent out to participants with meeting invite) outlines the data gaps. The differences in Total Mortality and ER may be due to different estimates of en-route mortality. The ERs are calculated using Pacific Salmon Commission data sources and do not include run size adjustments, which may contribute to the discrepancy between Total Mortality and ER in the plots. Another participant indicated that since the run-size adjustment component definitions have changed through time, this would alter historical Total Mortality and ER estimates.

Table 2

- A participant was concerned about how the data quality, as listed in Table 2, was determined. The authors indicated they followed the same data quality assessment techniques as other literature as indicated in the working paper.
- A participant was unclear if the Sample Sites column was meant to be exhaustive or only provides examples of the sample sites used for each DU. The authors will consider changing the column name, perhaps to ‘Survey Sites’, ‘Primary Sites’, or ‘Spawning Sites’, as appropriate.
- A participant suggested adding in DU alias names, as the DU names have changed over time.
- A participant suggested the authors add information on the proportion of the spawning habitat that is monitored, how often those areas are monitored, if there are any gaps in monitoring effort, and if there are any changes to the number of streams monitored.
- A participant noted that sonar work has been conducted in DU22 Taseko-ES, which could be added to the table.

ELEMENT 3

- In response to a reviewer comment, the authors will move the Productivity plots and Total Mortality and ER plots from Element 2 into Element 3. They will also expand the text in this section to address these plots.
- In response to reviewer comments, the authors will include more context in the body of the paper to explain the length-at-age and fecundity-at-age tables.
- The authors acknowledge more work is required in this section to make it clear there are declining trends in length-at-age and fecundity-at-age over time and to highlight the variability within and between DUs.
- The authors will add time series information to the table captions.
- To make the tables more useful, the authors will alter the tables to track length-at-age and fecundity-at-age through time. The authors will also add standard deviations to enable comparisons between DUs and information on the size-fecundity relationship for each DU, as length is a driving factor for fecundity.
- A participant questioned the use of proxy populations in the fecundity table as little evidence was provided to support the link between populations. The authors could add more clarifying text to the paper.

- A participant noted that in the fecundity-at-age table, DU10 Harrison (U/S)-L only had data on the length-fecundity relationship. The authors indicated that this is how the data were recorded for this DU and they were not able to extract the fecundity-at-age information.
- A participant suggested the length-at-age table also include females vs males and even vs odd years.
- Many participants were concerned that the length-at-age information is based on standard length instead of fork length or post-orbital-hypural length. The authors indicated this length was used to include historic data.
- Based on a participant comment, the authors will add text to discuss DU-specific trends in return ages.
- A participant suggested including information or maps indicating how the extent of spawning area has changed over time, especially with respect to spawner density for each DU. Another participant indicated that since effort and habitats have changed over time that it might be difficult to compare how those spawning areas or spawner densities have changed. At minimum, the authors can add text describing the available data. If this suggested work will not be too involved, the authors could add this information to the paper.

ELEMENT 4

- In response to a participant request, the authors will include a summary table on the various life history requirements. Suggested information includes: DU-specific nursery habitat information, duration of migration, optimal migration temperatures and flows, and how temperature and flow has changed over time. The authors indicated additions to this section were lengthy and it may be difficult to achieve them all given the timeline to revise the working paper.
- In response to a participant comment, the authors will add text to indicate how the temperature exposure threat has changed over time.
- It was suggested by a participant that the authors add text indicating the importance of lake habitat, temperature, and oxygen for fry and juvenile fish.
- In response to a participant comment, the authors can consider adding DU-specific eutrophication risks.
- It was widely recommended that the Shortreed et al. (2001) study evaluating natal stream habitat be updated. Much of this assessment relies on that information and these systems have changed over the past twenty years.
- A participant has updated literature on ocean rearing (Section 3.1.4) they will provide to the authors. Their group has conducted a 3-year telemetry study to better understand run timing and it was suggested that this information should be reported in this paper.
- At the suggestion of a participant, the authors can add text between Sections 3.1.4 and 3.1.5 on adult migratory routes from the feeding grounds to the Fraser River (FR). Information on routes taken, diversion rate, and pressure/threats encountered can be added.
- A participant suggested a table on nursery habitat metrics be added. Information on freshwater carrying capacity could be added, either here or under the habitat supply section. The authors should explicitly indicate for which DUs freshwater habitat is not considered to be limiting.

- Participants suggested the authors add text indicating smolts go directly through the estuary to the ocean, with the exception of Widgeon.

ELEMENT 5

- The authors will include the update maps they presented here into the Research Document. These maps could also be updated to include information on where spawning occurs, nursery sites, and sampling sites.
- The authors will also add a map showing the migration corridor along the FR, indicating the location of Hells Gate and the Big Bar landslide.

ELEMENT 6

- At the suggestion of a reviewer, the authors will add text about the impact of the Terzaghi Dam.
- A participant indicated they have done extensive work looking at the efficacy of the fishway and flow regime at the Seton Dam. They found current management actions to be appropriate and fish are able to migrate successfully, however there is latent mortality above these fishways. This participant will send information to the authors to update the paper.
- Due to some confusion by participants, the authors will clarify the wording around how Early and Late Stuart DU's are affected by waters temperatures due to the Kenney Dam cold water releases.

ELEMENT 7

- Many participants requested text be added on straying and residualization. The authors indicated that the definition of residence is well defined in other literature and those topics do not belong in this section.
- Text regarding straying could be included under Element 8, Section 4.1.8.3 Invasive & Other Problematic Species & Genes. This text could include information on straying due to the Big Bar landslide, high escapement years, and drought/high temperature years, as well as text on how straying might be a benefit for specific DUs, depending on the perspective.
- Information on residualization could be included in the life history section, Element 1.

ELEMENT 8

- In response to a participant comment, the authors will add text to define threat risk, possibly in Table 5.
- During the subsequent discussions on each threat area, some impact or risk levels were changed. The authors will ensure all changes made to the tables are reflected in Table 36.

Each threat section was presented by the authors, however, discussion only occurred on the sections listed below.

4.1.1.2 Commercial & Industrial Areas

- The threat risk was originally listed as 'Negligible' for all DU's. Participants suggested this ranking be changed to 'Unknown' since there are not sufficient data to suggest the impact would be 'Negligible'. The text will be updated to reflect this change.

4.1.2.3 Marine & Freshwater Aquaculture

- In response to reviewer and participant comments, the authors will add text indicating that the DU10 Harrison (U/S)-L Weaver spawning channel does not have direct competition with hatchery fish since the channel is highly controlled to reduce competition.
- A participant noted that the impacts of shifting food sources, warmer temperatures, and increased competition with hatchery fish might compound. The authors responded that each of these threats are dispersed throughout this Element and they are uncertain if there is evidence to demonstrate how these threats compound.

4.1.4.1 Roads & Railroads

- There was significant discussion on how culverts are monitored and maintained in BC. Participants indicated there is a technical working group comprised of members from DFO and the Province of BC. However, it appears that more information would be helpful in understanding the impact of culverts on fish passage and to understand if remediation work is helping fish passage.
- A participant noted that the spawning and nursery area in DU17 Seaton-L are paralleled by railways and roads. Any upgrades to these would directly impact this population. The footprint of the railway has constricted the river channel and there is no riparian zone along that side of the channel. The participant thought this should be considered in the threats calculator. The authors will add text to this effect and look into the threat risk for this DU.
- A participant shared knowledge on the impact of an abandoned rail line that parallels the spawning ground of DU20 Takla-Trem-EStu. Many bridges have been failing, rail grade has been washing into streams, and this line crosses almost every tributary along the west side of the watershed. The Takla First Nation has been doing stream crossing remediation. The authors will add this information to the paper.
- A participant indicated that culverts affect some DUs more than others. By conducting an RPA on aggregated DUs, the stock-by-stock nuances are missed.

4.1.4.3 Shipping Lanes

- Based on a participant comment, the authors will add text indicating DU24 Widgeon-RT encounter log booms during the entirety of their freshwater rearing time.

4.1.5.2 Fishing & Harvesting Aquatic Resources

- A participant suggested more text be added regarding the fishery on the Early Stuart DU. They indicated that there is a directed fishery on this DU but that the amount is heavily restricted. There is also a terminal First Nations fishery, however the Nations have voluntarily ceased harvest following the Big Bar landslide.
- A participant suggested a table or figure be added showing the trends in ER from the 1980s to current day. The highest ERs have been on Adam's DU dominant years and therefore, reporting the average ER does not provide the full picture. The authors agreed to generate this table/figure. The authors noted that the threats rating should not be based on historic impacts/threats, but on current and anticipated impacts/threats, and they anticipate fishing impacts to decline. The authors will also add text indicating that the impacts for strong dominant years and off-years are not equal. The authors will also ensure there is text indicating that there has not been commercial or recreational fishing on non-dominant lines

since 2011, however, there has been directed Food, Social and Ceremonial (FSC) on non-dominant lines.

- Participants were concerned about the impact of bycatch by international fleets. Participants noted that the US Alaska fishery is known to catch FRS as bycatch, but that it can take up to 2 years for them to report that information to DFO. Stock identification data are provided for U.S. District 104 (S.E. Alaska catches) and D104 catch of Fraser River sockeye, and managed by the Pacific Salmon Commission (PSC) Secretariat. There may be other US fisheries not in Alaska that are catching FRS as bycatch or unreported catch that DFO does not have data on. The authors will add more text to capture the uncertainty of the impact of these and other international (Asian/Russian) fisheries.
- A participant indicated that the risk category range for these DUs included many layers of uncertainty and mortality risks, including uncertainties on fishing induced mortality for some Canadian and US fisheries (especially from Pink Salmon directed fisheries), the extent of the Alaska fishery not being included in allowable catch estimates, cycle lines directing harvest levels, implementation uncertainty, and small DUs co-migrating with larger DUs. These risk category ranges reflect these uncertainties and the inter-annual variability associated with them. The participant thought these ranges were appropriate.
- A participant expressed concern that the threat risk for DU20 Takla-Trem-EStu was too low considering only 89 fish were observed in 2019, and only 23 fish were observed in 2020. Any impact to this DU could be huge. The authors will leave the ranking as it is but add additional text to indicate this concern.
- Many participants were concerned about the threat of illegal/unauthorized fishing. A participant indicated that enforcement needs to be greatly increased, especially since illegal fishing tends to occur overnight. The impact of illegal/unreported catch could have a disproportionate impact during low run years or on low abundance DUs. The authors will add more text indicating the uncertainties and threats of illegal fishing.
- A participant noted that the spatial extent of the fishery should contribute to the threat impact rating. If a stock passes through Big Bar, but has also encountered fishing pressure below Big Bar, their ER and the impact to the population could be higher than if that stock only faced terminal fishing pressure. A reviewer indicated that any mortality between where we fish and where the fish spawn has to be non-additive and therefore we need to be careful about where we decide to fish. They explained that the ER is a minimum estimate since it is only based on reported catch. If there is a baseline of unreported catch, then as FRS abundance declines illegal/unreported fishing will have more of an impact on the populations. Another participant suggested including information on all fisheries even if there are not mechanisms for quantifying them all in both time and space. The authors will include text highlighting the impact of the cumulative sources of mortality.

4.1.7.2 Dams & Water Management

- A participant noted that there has been discussion of building a cold-water release system at the Seton Dam which could reduce the threat risk for DU17 Seaton-L. The authors will add text to indicate future changes to temperature and discharge rate may reduce the threat risk for this DU.
- A participant was concerned the ‘Negligible’ threat risk might not be accurate given the high mortality rates (15%) other salmon species exhibit when passing through water pumps and that this might be relevant for DU24 Widgeon-RT. They mentioned there has been some citizen science projects in the lower FR to quantify mortality at certain sites. The authors

indicated these data were not included in this paper, only academic sources were considered. The authors also indicated that they didn't think the fry/smolts from this DU would migrate back and forth through the pumps and boxes since they reside in the lower FR where flood control is of less concern. The threat level for DU24 Widgeon-RT will be changed from 'Negligible' to 'Unknown'.

- A participant indicated that the flow control device at McKinley Lake, which affects a portion of DU16 Quesnel-S, was originally intended to enhance flows for Sockeye, but in recent years has been used for flood control, which has resulted in pulses of water being released. The authors will add text to include this information, however, the overall threat rating for this DU will not change as this flow control device is only impacting the fish in McKinley Lake/Horsefly River.

4.1.8.1 Invasive Non-Native/Alien Species

- A participant indicated that whirling disease should be mentioned in the text as a potential future threat. It has been identified in Alberta. There are monitoring programs in B.C. but this disease has not yet been detected.
- Some participants indicated that the threat of zebra mussels as a competitor for food in freshwater systems should be included as a higher risk.
- Some participants indicated European Green Crab may be impacting eelgrass habitat used by DU24 Widgeon-RT. The authors will consider including discussion on this in the paper.
- The impact of the abundant goldfish population in the Quesnel system is of growing concern. A participant indicated that the goldfish do not appear to be impacting Sockeye currently, but that this could change in the future. Also of growing concern is the Smallmouth Bass population in the Beaver Valley system.

4.1.8.2 Problematic Native Species

- A participant indicated the text in the last paragraph on page 83 was contradictory. The text states that all FRS DUs are impacted similarly from pinnipeds and net-pen aquaculture, that DU24 Widgeon-RT is impacted less, and that certain DUs take different migratory routes. The authors will clarify this text.
- Many participants agreed that low population DUs may be disproportionately impacted by predation, particularly by bears and by river otter and bull trout on DU14 North Barriere-ES. The authors will add text to discuss this disproportionate impact.

4.1.9.3 Agricultural & Forestry Effluents

- A participant noted that agricultural nutrients may become aerosolized and lead to eutrophication in some systems. The authors acknowledged that this is emerging research and will add text to include this, however, the overall threat risk level would not be affected.
- A participant was concerned that the risk and causal certainty are the same for each DU in this section. The authors replied that there is not enough DU-specific information on the impacts of pollution, but that all FRS migrate through the lower FR where the majority of the pollution is thought to occur. They will add text clarifying how the risk level was determined and to highlight the data uncertainties.

- A participant noted that near Prince George, pulp and paper mill and mine effluent is much warmer than the freshwater, possibly resulting in thermal shock, especially during the spring freshet and smolt out migration.

4.1.10.1 Avalanches & Landslides

- In response to a participant comment, the authors will ensure the text states the uncertainties surrounding the effectiveness of the efforts at Big Bar and that the impact of this threat should decline over time, especially considering the installation of a fish ladder.

4.1.11.1 Habitat Shifting & Alteration

- In response to a participant comment, the authors will add text to clarify that increased oceanic temperatures might have a positive impact on Sockeye from a bioenergetics perspective, however, changes to food webs might have a negative impact.

4.1.11.2 Drought

- In response to a participant comment, the authors will add text to clarify that DU21 Takla-Trem-S rating included the effect of drought limiting access to spawning streams.

4.1.11.3 Temperature Extremes

- A participant noted that both early and late run DUs are experiencing similar temperature differentials when compared to historic temperatures, considering early run DUs are migrating earlier and earlier. Another participant added that the cumulative impacts of moderate temperatures over a longer duration may be just as harmful as higher temperatures over a short duration. The authors will add text to expand on this but did not think the threat ratings needed to be changed.

ELEMENT 14

- The habitat available to DU24 Widgeon-RT was discussed. It is thought that since this population has sustained itself with under 1000 individuals for so long that this population is unlikely to exceed those numbers and 'recover' under the definition of COSEWIC. Therefore, in terms of reaching recovery targets for this DU, habitat is not a limiting factor. However, protecting this habitat is of high importance. The authors will clarify that for other DUs there is currently enough habitat to support higher abundances, but that is not the case with this DU. Participants noted that we are assuming their suitable habitat has not changed, but that assumption is based on old data. They would like more explicit information on which habitat features may have changed, such as temperature or water flow.
- In response to a participant comment, the authors will consider adding text regarding high seas competition.

ELEMENT 16

- A participant noted that hatchery fish are considered both a threat and a mitigation measure. Another participant indicated that generally only the negative impacts of enhancement are discussed in the paper, but there are positive impacts as well, especially with respect to channel enhancement. The authors indicated they may need to reorganize this section to take those concerns into account.

- A participant indicated that protecting cold water refugia should be a key management priority, as these areas are especially important for spawner migration. Another participant mentioned a program in the US to develop a cold water refugia strategy. The authors indicated this was not something considered in the working group and will include these concepts in the paper as future mitigation options. As well, additional water management efforts at the Kenny Dam could be considered to provide cold water habitats.
- Many participants expressed concern that this paper relies too heavily on the Shortreed et al. 2001 paper and that this information should not be relied upon for recommending management activities (Table 40). Participants indicated that the Cultus Lake Lab may have additional information on lake fertilization and that additional data on recent upgrades exists for the DU10 Harrison (U/S)-L Weaver Creek, DU16 Quesnel-S Horsefly River, and DU20 Takla-Trem-EStu.
- Many participants wished to see the management activities in Table 40 prioritized. The authors indicated there is uncertainty surrounding the effectiveness of the management activities listed, differences in DU-specific vs overall FRS priority actions, and the authors are unable to consider the social or economic implications of management activities. A participant indicated that this is an ongoing RPA process issue and that authors do not have a framework for prioritizing management activities, yet this is precisely what management requires.
- A participant noted that the text implied that the DU24 Widgeon-RT population might increase given mitigation efforts, however this population is unlikely to exceed 1000 individuals.
- In response to a participant comment, the authors will change the wording from ‘reduce harvest’ to ‘reduce fishing related mortality’ in Table 40.

ELEMENT 17

- In response to previous discussions, the authors will add text to indicate that DU24 Widgeon-RT naturally has a small population and is not likely to see increased productivity.

ELEMENT 22

- There was some discussion on how the three generation timeline was decided upon. The authors indicated the RPA guidelines provided this timeframe, as does COSEWIC. The participant suggested looking at longer timeframes, such as 20 years, but the authors indicated that over longer trajectories the populations still appear to be in decline and that using longer timeframes would introduce more uncertainty and wider confidence intervals.
- There was discussion on how DUs were categorized into the allowable harm statements and whether the modeling results or the threats assessment results should be relied upon more heavily. The authors developed the following flowchart:

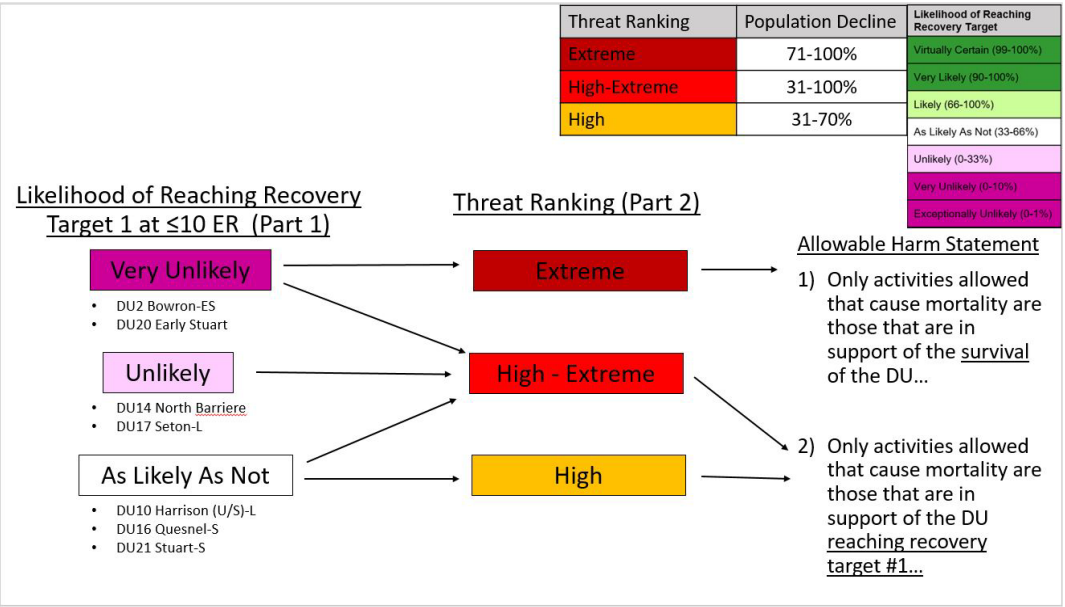

Figure 1: Flow chart used to establish FRS Designatable Unit allowable harm statements.

- A separate allowable harm statement was crafted for DU24 Widgeon-RT since it is not expected to see increases in productivity or recover out of a Threatened status. This population is naturally at low levels and is susceptible to harm even if steps are taken to minimize mortality. As such, meeting participants recommend that the only activities allowed that cause mortality are those that are in support of the persistence of the DU, and all sources of anthropogenic harm should be limited to the maximum extent possible.
- There was concern among authors and participants that the DU-specific allowable harm statements in the working paper would not be included in the Science Advisory Report (SAR), which could result in the downplaying of threats. Meeting participants decided to include the allowable harm statements and the associated DUs in the SAR.
- Participants suggested a sentence be added to the paper indicating that the allowable harm statements address both direct and indirect impacts of human-induced mortality and habitat destruction.

CONCLUSIONS SECTION

- An author noted that the updated modeling indicated that the special concern DUs (DU7 Francois-Fraser-S, DU9 Harrison (D/S)-L, DU11 Kamloops-ES, DU12 Lillooet-Harrison-L, and DU13 Nahatlatch-ES) are now also showing declines and are unlikely to reach recovery target #1. The author will add text to this effect in the conclusion.

CONCLUSIONS

- The participants agreed the TOR objectives were met and the working paper was accepted with the suggested revisions.

ACKNOWLEDGEMENTS

We appreciate the time contributed to the RPR process by all participants. In particular, we thank the reviewers, Jason Hwang and David Patterson for their time and expertise. We also thank Ben Davis as Chair of the meeting and Jill Campbell as the Rapporteur.

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APPENDIX A: TERMS OF REFERENCE

RECOVERY POTENTIAL ASSESSMENT – FRASER RIVER SOCKEYE SALMON (*ONCORHYNCHUS NERKA*) – TEN DESIGNATABLE UNITS

Regional Peer Review – Pacific Region

October 7-11, 2019
Working Paper #1 – Cultus Lake – 22 Elements
Working Paper #3 - 9 populations - Elements 12, 13, 15, 19-22
Richmond, British Columbia

Chairperson: Gilles Olivier

March 16-18, 2021
Working Paper #2 – 9 populations – Elements 1-11, 14, 16-18
Virtual meeting

Chair: Ben Davis

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 ten populations of Fraser River Sockeye Salmon (*Oncorhynchus nerka*) were designated as Endangered or Threatened by COSEWIC in 2017 based on population declines (COSEWIC 2017).

1. Cultus Lake population (Endangered): This population was first designated by COSEWIC as Endangered in an emergency assessment in October 2002. Status was re-examined and confirmed in May 2003 and November 2017. Cultus Lake is one of the most heavily utilized lakes in BC and it has been developed for recreational, residential and agricultural purposes. The lake's water quality has been degraded as a result of seepage from septic systems, agricultural runoff and domestic use of fertilizers as well as by an introduced Eurasian water-milfoil (*Myriophyllum sp*.). The spawning population has declined steadily since 1950 and the current population size remains very small.
2. Bowron – early summer (ES) population (Endangered): The number of mature individuals in this population has been declining since the mid-1950s and there has been a large decline in the past 3 generations.
3. Harrison - upstream (U/S) population (Endangered): The number of mature individuals increased from a low level in 1960 to a peak in 1980. Since then, the numbers have fluctuated in a downward direction to reach an historical minimum in the most recent period.
4. Quesnel - summer (S) population (Endangered): The population has declined consistently since 2000.

5. Seton – late (L) population (Endangered): The number of mature individuals in this population was relatively high and stable from the mid- 1970s to the late-1990s. Since then the numbers have declined considerably to very low abundance and are close to a historical minimum.
6. Takla-Trembleur- Early Stuart (EStu) population (Endangered): The number of mature individuals has been declining steadily for over 20 years despite reductions in fishing mortality. Productivity is currently very low.
7. Takla-Trembleur-Stuart – summer (S) population (Endangered): The number of mature individuals has been declining steadily for three generations yet removals by fishing remained high.
8. Taseko - early summer (ES) population (Endangered): The number of mature individuals was relatively high in the late 1990s. Since then the numbers have declined considerably and are close to a historical minimum.
9. North Barriere – early summer (ES) population (Threatened): Since 1980, there has been a continuous decline to a low number today.
10. Widgeon (River-Type) population (Threatened): The number of mature individuals was relatively stable from 1950 to 1990, and then declined considerably to a minimum in 2000. Over the past 3 generations the number of fish has returned to pre-1990 abundances. However, the small population size makes them vulnerable to stochastic events and increasing threats.

DFO Science has been asked to undertake a Recovery Potential Assessment (RPA), for these 10 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 Sockeye 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 Sockeye Salmon there will be three separate working papers, presented and reviewed together. The three working papers are as follows:

- Working Paper#1: Fraser River Sockeye Salmon (Cultus Lake population) – 22 elements.
- Working paper #2: Fraser River Sockeye Salmon (9 populations: excluding Cultus-L population) – Elements 1-11, 14, 16-18.
- Working paper #3: Fraser River Sockeye Salmon (9 populations: excluding Cultus-L population) – Elements 12, 13, 15, 19-22.

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 Sockeye Salmon (10 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 10 populations of Fraser River Sockeye Salmon.

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Fraser River Sockeye 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 Sockeye Salmon distribution (10 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 Sockeye Salmon (10 populations)

Element 8: Assess and prioritize the threats to the survival and recovery of the 10 populations of Fraser River Sockeye 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 10 populations of Fraser River Sockeye 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 Sockeye 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

- 3 CSAS Science Advisory Reports
- 2 CSAS Proceedings
- 3 CSAS Research Documents

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. 2017. COSEWIC Assessment and Status Report on the Sockeye Salmon (*Oncorhynchus nerka*) 24 Designatable Units in the Fraser River Drainage Basin in Canada 2017. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 179 pp.

APPENDIX B: ABSTRACT OF WORKING PAPER

Nine Fraser River Sockeye Salmon Designatable Units (DUs) were assessed as Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; 2017), and are currently under consideration for addition to Schedule 1 of the Species at Risk Act (SARA). This document is the second of two parts for the Recovery Potential Assessment (RPA) for these DUs. The first part of the RPA involved quantitative analysis of abundance data and generation of recovery targets, and estimating the probability of achieving these recovery targets under a range of modelled productivities and exploitation rates. This second part of the RPA provides an overview of biology and habitat requirements, an assessment of threats and factors potentially limiting recovery, an inventory of potential mitigation activities to increase survival and/or productivity, and a final discussion surrounding allowable harm. The major threats impacting these DUs were assessed in a multi-day workshop with a range of subject-matter experts, and were identified to be climate change, geological events, natural systems modifications, fishing, pollution, and hatchery competition. All nine DUs are faced with a unique and complex suite of threats and limiting factors depending on their geographic location, yet all DUs range from a High to Extreme level of threat risk. Based on the threats assessment, over the next three generations it is expected that there will be a population level decline of 31-70% (High Risk) for: DU10 Harrison (U/S)-L, DU16 Quesnel-S, DU21 Takla-Trembleur-S, and DU24 Widgeon-RT; a population level decline of 31-100% (High-Extreme Risk) for: DU2 Bowron-ES, DU14 North Barriere-ES, DU17 Seton-L, DU22 Taseko-ES; and population level decline of 71% to 100% (Extreme Risk) for DU20 Takla-Trembleur-EStu. Alleviating the numerous and complex threats to these DUs will be difficult, especially as many of the threats are exacerbated by climate change. It will be critical to ensure that efforts are appropriately coordinated through effective governance to successfully mitigate the cumulative impacts of these diverse threats. Given the information presented in this RPA (Part 1 & 2), it is apparent that all sources of anthropogenic harm should be minimized to give these stocks a chance to rebuild. It is our recommendation that the only activities allowed that cause mortality are those that are in support of the recovery, and in some cases survival of the DUs (i.e. DU20 Takla-Trembleur-EStu, DU2 Bowron-ES), and all sources of anthropogenic harm should be reduced to the maximum extent possible.

APPENDIX C: AGENDA

Recovery Potential Assessment (RPA) for 9 Designatable Units of Fraser River Sockeye Salmon, *Oncorhynchus nerka*

March 16-18, 2021

Virtual meeting

Chair: Ben Davis

DAY 1 – Tuesday, March 16, 2021

Time	Subject	Presenter
0900	Introductions Review Agenda & Administrative Details CSAS Overview and Procedures	Chair
0920	Review Terms of Reference and presentation on the RPA process	Chair
0940	Presentation of the Working Paper "Recovery Potential Assessment (RPA) for 9 Designatable Units of Fraser River Sockeye Salmon, *Oncorhynchus nerka*"	Authors
1030	***Break***	
1045	Written Reviews and Authors Response	Chair + Reviewers & Authors
12:00	***Lunch Break***	
1300	Discussion & Resolution of Issues: Elements 1-7	RPR Participants
1445	***Break***	
1500	Consensus on conclusions: Elements 1-7	RPR Participants
1545	Introduction of Threat Components (Elements 8-11) and Threat Assessment Process	Authors
1600	**Adjourn for the Day**	

DAY 2 - Wednesday, March 17,2021

Time	Subject	Presenter
0900	Introduction to the Day Review Outcomes from Day 1 (*As Necessary*)	Chair
0920	Continuation and Conclusion of Threat Components: Elements 8-11	RPR Participants
1030	***Break***	
1045	Introduction and Discussion of Elements 14, 16-18	RPR Participants
1200	***Lunch Break***	
13:00	Continuation, conclusion, and consensus on discussion of Elements 14, 16-18	RPR Participants
1430	***Break***	
1445	Consensus on the acceptability of the working paper	RPR Participants
1500	Introduction of the Science Advisory Report (SAR) Preliminary List of Summary Bullets	Chair
1600	***Adjourn for the day***	

DAY 3 - Thursday, March 18, 2021

Time	Subject	Presenter
0830	Introduction to the Day Summary of Day 2	Chair
0845	Overview of Conclusions for Element 22 “Allowable Harm Assessment” (Drawn from earlier RPA meeting)	Chair
0900	Science Advisory Report (SAR) Develop consensus on the following: • SAR Summary Bullets • Sources of Uncertainty • Results and Conclusions • Additional Advice (as warrented)	RPR Participants
1030	***Break***	

Time	Subject	Presenter
1045	Next Steps – Chair to provide overview • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (as necessary) • Other Business arising from the review	Chair
1200	***Lunch Break***	
1300	Additional time to conclude discussions (as needed)	RPR Participants
1600	***Adjournment of the Recovery Potential Assessment Meeting***	Chair

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Ashton	Chris	Commercial Salmon Advisory Board
Barbati	Justin	DFO Species at Risk Program
Benner	Keri	DFO Fish & Fish Habitat Protection Program
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Bussanich	Richard	Okanagan Nation Alliance
Campbell	Jill	DFO Centre for Science Advice Pacific
Caron	Chantelle	DFO Species at Risk Program
Cone	Tracy	DFO Stock Assessment
Curtis	Shamus	Upper Fraser Fisheries Conservation Alliance
Davies	Trevor	Province of BC
Davis	Brooke	DFO Stock Assessment
Davis	Ben	Retired DFO Scientist
Decker	Scott	DFO Stock Assessment
Doutaz	Daniel	DFO Stock Assessment
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