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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 (Elements 1-11)

December 10-12, 2019
Kamloops, British Columbia

Chairperson: Mike Bradford
Editors: Tanya Vivian and John Bylenga

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Canada

Foreword

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

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting on December 10-12, 2019 at the Coast Kamloops Hotel & Conference Centre in Kamloops, B.C.

In 2018, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed 11 DUs of Fraser River Chinook Salmon as Threatened or Endangered. They are currently under consideration for addition to Schedule 1 of the *Species at Risk Act* (SARA). This first part of the Recovery Potential Assessment (RPA) considers RPA elements 1-11 and includes descriptions and status updates for the populations, an overview of the biology and habitat requirements, and an assessment of threats and factors limiting recovery. A working paper focusing on these elements was presented for peer review at the meeting.

The conclusions and advice resulting from this RPA will be provided in the form of a Science Advisory Report (SAR) providing advice to inform the SARA listing decision. If listed, the scientific advice in the working paper and SAR will be needed to fulfill the development of a recovery strategy and to support decision-making regarding permit allocations under SARA.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science and Fisheries and Aquatic Management Sectors staff; and external participants from the Cowichan Tribes, Nuu-chah-nulth Tribal Council, Okanagan Nation Alliance, Scw'exmx Tribal Council, Secwepemc Fisheries Commission, David Suzuki Foundation, Fraser River Aboriginal Fisheries Secretariat, Fraser Salmon Management Council, Island Marine Aquatic Working Group, Marine Conservation Caucus, Pacific Salmon Foundation, Raincoast Conservation Foundation, Upper Fraser Fisheries Conservation Alliance, Area F Salmon Troll, Sport Fishery Advisory Board, Triton Environmental, and the University of British Columbia.

This proceedings report summarizes the relevant discussions from the peer-review meeting and presents revisions to be made to the associated research documents. The Proceedings, 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 December 10-12, 2019 at the Coast Kamloops Hotel & Conference Centre in Kamloops, B.C. to review elements 1-11 of the Recover Potential Assessment (RPA) for 11 Designatable Units (DUs) of Fraser River Chinook Salmon that were assessed as Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

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

> Recovery Potential Assessment for 11 Designatable Units of Fraser River Chinook Salmon, *Oncorhynchus tshawytscha*, Part 1: Elements 1 to 11 by Daniel Doutaz, Lauren Weir, Michael Arbeider, Doug Braun, Brittany Jenewein, Karen Rickards, Marc Labelle, Shamus Curtis, Paul Mozin, Charlotte Whitney, Chuck Parken, Richard Bailey. CSAS Working Paper 2018SAR07

The meeting 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 (TOR), working paper, formal reviews of working paper, and agenda.

The Chair reviewed the TOR (Appendix A) and the Agenda (Appendix B) for the meeting, highlighting the objectives and identified the Rapporteurs. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions to the microphones so they could be heard by those online.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 55 people participated in the RPR (Appendix C). Tanya Vivian and John Bylenga were identified as the Rapporteurs for the meeting.

Participants were informed that Bill Rublee and Gayle Brown had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting (Appendix D). Participants were provided with copies of the written reviews.

These proceedings summarize the discussions from the meeting and presents recommended revisions to be made to the associated working paper. The SAR and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations and academia.

REVIEW

Working Paper:	Recovery Potential Assessment for 11 Designatable Units of Fraser River Chinook Salmon, *Oncorhynchus tshawytscha*, Part 1: Elements 1 to 11. 2018SAR07
Rapporteurs:	Tanya Vivian & John Bylenga
Presenter(s):	Daniel Doutaz & Lauren Weir

PRESENTATION OF WRITTEN REVIEWS

- The reviewers, Gayle Brown and Bill Rublee (M. Bradford provided in Bill's absence) each presented a review of the working paper (Appendix D). Each reviewer highlighted any gaps in the working paper to be considered during the discussion for each subsequently presented section by the authors.

DISCUSSION

- It was noted that the 2019 escapement data were not available. It was recommended to be added if it was possible, as it is especially important to highlight the impacts of the Big Bar Slide to DUs that spawn upstream of the slide.
- There was enquiry as to what extent the authors were bound by the conclusions of the Threats Calculator from the Threats Assessment Workshop. For example, if further information came following the workshop, were the authors still bound to those conclusions? It was clarified that augmentation was acceptable provided it was supported.
- It was suggested that reference to geographic area in the text would be beneficial to help orient the reader. This was not followed up by the authors nor discussed later.
- A reviewer suggested that it could be beneficial to provide a more detailed description of each DU's trendline. This was not followed up by the authors as such discussions are available in COSEWIC reports.
- A review asked whether the list provided in Table 4 of the RPA was a comprehensive list of spawning sites or contained only a select few and, if it was a select few, what was the rationale for choosing those sites? This was not followed up by the authors nor discussed later.
- A considerable amount of work has taken place since Healy's (1991) review of Chinook Salmon biology which was referenced in the RPA. It was suggested that the authors investigate more recent works.
- Consequences of increasing hatchery contribution to wild populations of concern was not addressed and should be included (i.e. greater fishing pressures, etc.). Additionally, increasing hatchery contributions to Chilliwack may result in impacts to the endangered Summer 5_2 due to potential blending of timing groups. Previous complications at Puntledge River were provided as an example. It should be included as a recommendation in the RPA discussion that research be conducted to confirm the genetic integrity of the Chilliwack Summer 5_2 and breeding protocols established to ensure no mixing. This point was not discussed further as the Chilliwack summer population is not part of this review.
- There are many knowledge gaps that need to be identified and importance highlighted throughout the document where applicable. This was critical as the threats assessments

may have been better informed with fewer gaps. The recommendation was to include a list of key knowledge gaps and desired studies. For example:

  - the lack of specific studies of cattle impacts within the Fraser River watershed;
  - exploitation rates for all DUs, other than Harrison, are unknown;
  - lack of analysis assessing whether fishery management actions have achieved objectives; and
  - freshwater habitat usage by juvenile Chinook Salmon throughout the Fraser River.

- There has been omission of available studies regarding pollution risks to the Harrison (DU 2) population. It was suggested to consult Washington Department of Fish & Wildlife (WDFW) for input regarding Puget Sound studies, University of British Columbia studies on the prevalence coal dust around Roberts Bank, and Canadian government researchers regarding impact of coal dust on juvenile Chinook Salmon.
- A summary table of threats in this RPA was suggested and will be prepared for the SAR.
- The exclusion of bears in the threat assessment discussion of natural predators was identified and consequently agreed upon to be added.
- Quality plots for DU5 did not include Chilliwack River data and the reasoning is not included nor explicitly stated.
- Issues specific to each DU, including key biological factors, were not addressed in the document and could be highlighted. For example: energy requirements for the migration of upper Fraser DUs, those DUs consisting of single spawning sites that are at low abundance, water extraction, and impact of the Big Bar slide.
- It was questioned if Part 1 of the RPA should advise specific actions required for recovery. The response was that it is understood to be in Part 2 of the RPA, but it is important to include a linkage between the two documents.
- A reviewer suggested inclusion of a table summarizing the threats that are the likely drivers of productivity decline. An author responded they were hesitant due to the lack of causal data to draw such conclusions (correlations vs. causations).
- Unless otherwise noted, the authors agreed to changes suggested in the written reviews and would further discuss the critiques in the general threats discussion.

GENERAL DISCUSSION

ELEMENTS 1-7

There was a general interest in the Threats Workshop and how it was conducted. The workshop organizer explained that it was a new process, but gathered a group of experts, including those with threat-specific knowledge. A moderator from COSEWIC was a participant in the workshop. The group discussed each threat in the threats calculator and assigned a ranking. A participant questioned if the authors were able to change the results if new information was obtained. The organizer indicated that the results could be changed if there was evidence in support. It was suggested that a paragraph be added to outline the process and values of the Threats Workshop.

The group felt there was value to highlight in the document that these are results for Fraser River-specific DUs. The authors agreed to this suggestion.

A participant asked for an explanation why Anderson Creek was not evaluated in the Nahatlatch DU, particularly because it is in contrast to the COSEWIC analysis that included the creek. An author responded that it was not included because spawning Chinook Salmon do not utilize Anderson Creek due to restricted access, thus it should not be included. However, they agreed to include text in the document explaining this rationale.

It was identified that there was another indicator (to allow estimation of survival and exploitation rates) being created for the upper Fraser and participants were wondering when these data would be ready. The expert indicated the Chilko River population is being developed as an indicator but it will be a number of years before sufficient data will be available.

There was concern among the group that the current RPA analyses only contained population data up to 2015. The authors agreed that the additional three years of assessment data could change the outcome but it is not likely. In addition, some participants worried that if COSEWIC is only looking at a three generation trend that eventually the rate of change would flatten out with past higher populations no longer being considered. The authors assured that the while the process does evaluate the trend over the last three generations, it also evaluates the trend with all available data (all generations).

A participant asked the group if there was value to evaluate cycle year trends instead of total population trends, as it may show a steeper decline. The authors responded that the analysis was conducted in this way to align with the COSEWIC process. Additionally, an expert identified that data are not available to break out by cohorts or cycle years, and with complex age structure it further complicates the ability to produce that type of estimate.

In discussing the issue of residence, the group asked for clarification on why redds were the only life history component identified. The issue was that only redds meet the specific COSEWIC definition of a residence and perhaps a more general guideline is needed. It was also suggested that the definition is more suited towards terrestrial animals. Another participant asked if residences get special consideration in the recovery planning process. The authors responded that in SARA, if a species is listed, residences are immediately protected against damage and destruction. Additionally, in a SARA listing, critical habitat is also protected and could encompass other habitats used throughout the life history.

Participants asked if fecundity, length at age, and sex ratio were changing over time in these DUs. An expert said these data would be available for populations such as Harrison, Chilko, and Nechako, but for the remainder data are not available. This is because most DUs are surveyed by helicopter and no physical samples are obtained. Another expert also commented that even when samples are obtained there are inherent biases towards size and sex that could invalidate any trends observed. Furthermore, sampling at stations such as Albion (a test fishery in the lower Fraser River) are too early in the migration, and do not account for migration stress; therefore, may not characterize trends in the spawning population.

In relation to the discussion on trends changing over time, a participant asked about age at maturity in the ocean. An expert responded that there are model-based estimates for fish being caught that are sexually mature, but they are not population specific. Another expert added that shelf resident salmon are vulnerable to harvesting throughout their life while offshore populations are primarily targeted once they return to the shelf as mature fish. However, there is a large knowledge gap as to what fisheries that salmon residing in offshore areas are vulnerable to.

THREATS AND LIMITING FACTORS

In general discussion about threats and limiting factors, it was highlighted that the DFO guidance defines threat as having caused, or may cause damage. This section reflects what may happen in the future (three generations) rather than how we got to the current situation. The working paper has some discussion about the impacts of threats that have already occurred, but the focus of this review and the science advice is on the effects of threats going forward.

Further clarification on how the Pacific Salmon Explorer tool contributed to the Threats Workshop was requested. In the workshop, separate working screens were used: one projecting the Threats Calculator and the other the Salmon Explorer with data specific to the threat for the DU being discussed. This allowed workshop participants to stay focused on the specific threat and not the overarching impacts that came along with it.

A participant also enquired about the affiliation of participants in the Threats Workshop. The organizer of the workshop discussed how there were representatives from a variety of groups such as First Nations, the Pacific Salmon Foundation, and different sectors of DFO. Provincial staff were invited but did not attend. Altogether, the organizer summarized that there was a good representation of diversity with a broad basis for input and discussion.

Consensus from the group was that the threats tables in the RPA were difficult to follow as the DUs were in a different order from table to table. The authors noted that this was due to the tables being ordered by threat with the highest ranking at the top. Collectively, it was decided that the tables would be ordered the same each time, and if a DU was not identified as being affected it would be listed as unranked.

Housing & Urban Areas

A participant asked why the risk is low with the extensive housing pressures, specifically in the lower Vancouver mainland. To clarify, the authors responded that this threat is only about the impact of the footprint of any new developments thus, the likelihood is low due to permits and regulations not allowing development on rivers. The low threat ranking is mainly considering the impacts of future houseboat developments. Houseboat threat was predicted to increase due to the possibility that the number of these homes may increase due to inflated land prices and increasing demand for real estate.

It was then asked why the Harrison population (DU 2) was considered low as it is in the lower Vancouver mainland. In response, it was identified that the Harrison Chinook Salmon are direct migrants, and it was hypothesized that the short residence in fresh water mostly excludes them from this impact. Additionally, it was presumed that the spawning areas on the Harrison River would be unlikely to have any future development.

Another participant asked where hydrological impacts from new developments are addressed and the authors responded that they are considered in the Natural Systems Modifications section.

Commercial & Industrial Areas

A participant asked if potential impacts of Roberts Bank, Airport expansion, and George Massey Tunnel replacement were considered. The authors responded that they were, and the participant questioned if the risk was undervalued at low due to factors such as the Roberts Bank expansion changing water circulation, potentially being a barrier to migration, and destruction of eelgrass beds. Furthermore, different participants asked if log booms, light pollution, and shipping lanes were considered in this section. In response, it was identified that

the threat being considered is only the footprint of these impacts and the other threats were addressed in other sections.

Because of the aforementioned impacts, a participant asked why DU 2 (Harrison) is ranked the same as upstream DUs and whether it should be changed from low to medium. The authors stated that they wanted to keep these rankings in perspective, suggesting that the ranking at 1-10% decline was reasonable considering the ability to mitigate these threats; such as the replacement of eelgrass beds; but ultimately had no response about the potential migration impacts. Additionally, DU 2 has the same ranking as other upstream DUs because they all occupy habitat in the lower Fraser River. Another participant added that DFO was reviewing the Roberts Bank proposal but still recommended the threat being kept as low. Collectively it was decided to not change the threat ranking provided text is added in the document describing the potential impacts of the development.

Tourism & Recreation

It was highlighted that this section specifically addressed the impacts of footprints from future developments. The group was satisfied with the ranking and no objections or changes were proposed.

Annual & Perennial Non-Timber Crops

The group was satisfied with the ranking and no revisions were proposed.

Livestock Farming & Ranching

The authors identified that this section deals with the physical trampling of fish by livestock as animals have been observed in some streams. Impacts, such as sedimentation and destruction of habitat or riparian area, are addressed in the pollution and alteration of catchment surface sections respectively.

A participant brought up an organization in Alberta, called Cows and Fish, suggesting that, while this program is specific to trout, it is a tool that could provide guidance for similar issues in British Columbia (BC). A Threats Workshop member identified that they had heard of it, but identified issues such as concerns that fencing would exclude cattle from large expanses of range. Secondly, this would incur considerable cost and the BC government pays for fencing with limited resources to do so. A local area expert indicated that when targeted riparian exclusion fencing is built, it is rarely maintained due to lack of ownership and is subject to damage due to flooding and washouts.

Marine & Freshwater Aquaculture

A participant suggested including a recent analysis comparing fall Chinook hatchery production and survival of Harrison Chinook which was included in discussions at the Threats Workshop. The analysis included two models; density-dependent smolt production and average smolt production focusing on the lower Fraser region. Harrison River and Chilliwack River Chinook Salmon abundance followed similar patterns except when Harrison Chinook populations declined, Chilliwack populations stayed stable. Additional hatchery releases were suggested for inclusion in the analysis, such as Capilano and South Thompson populations. The analyst commented that further inclusion may find more competition among these populations and inclusion is expected to further support the findings. In the case of the South Thompson population, there is no temporal overlap of habitat usage between it and the Harrison population. It was then suggested that an explanation that these other locations were not included in the original analysis should be provided. The analyst also wanted to clarify that

Harrison juvenile survival doesn't correlate to adult returns - a change in survival rate is different from change in abundance; high abundance can result from both high and low survival. Release strategies, including size at release and timing, were questioned. Harrison juveniles released from Chehalis hatchery are aimed to mimic wild size and timing. Additionally, the facilities have the same rearing conditions (raceways, etc.) with the exception of the warmer water at Chilliwack hatchery. A participant commented that long-term mortality issues of unknown origin unique to Chehalis hatchery may contribute to the reduced productivity at Harrison. The analyst commented that the analysis did not investigate causation of the decline.

US Puget Sound hatchery releases are expected to increase in the future, and the addition of one million hatchery releases from the Chilliwack River hatchery was mentioned. Participants expressed concerns about this increase and subsequent rise in competition in the Salish Sea particularly affecting DU 2. This level of competition may not be experienced by any of the other DUs.

As a result, the causal certainty high ranking for DU 2 was questioned and more investigation was desired. An author responded that the high ranking was a result of the abundant information available, but was comfortable with changing the ranking to medium if consensus was reached. It was decided to change the ranking from high to medium for causal certainty for DU 2.

Mining & Quarrying

It was queried if gravel removal between Hope and the Harrison River confluence was occurring. It is currently happening, but mostly in dry areas when water levels are low. The threat calculated for this risk (medium-low) was primarily due to the importance of ephemeral habitats for juvenile Chinook as the associated shallow water and modest flow is their preferred habitat. These gravel bars are also important for upper Fraser populations as they use them extensively as well. The group was satisfied with the ranking and no revisions were suggested.

Roads & Railroads

The authors were questioned if encroachment or riprapping is considered and why it was assessed as unknown risk. While it was indicated that encroachment and riprapping are included elsewhere, the unknown risk ranking was due to the potential impact being positive. Specifically, old culverts which have surpassed their lifespan may be replaced with bridges because of new, more strict regulations. Furthermore, the Threats Workshop group decided it was safer to categorize a risk as unknown if the direction, positive or negative, is unclear. The group was satisfied with the ranking.

Utility & Service Lines

It was identified that this threat had a higher risk than roads and railroads because there is likely no positive impact to a new pipeline crossing. However, most large crossings may be directionally drilled which would minimize the risk. It is important to note that directional drilling is not likely on smaller systems. It was concluded that the document should contain text on the relative impact of the type of pipeline crossing. The group was satisfied with the ranking and no changes were requested.

Shipping Lanes

A participant inquired why there was no mention of the presence or impact of log booms in the Harrison River. It was identified that this category is primarily about the grounding effects of log booms and that other impacts, such as illumination and bark accumulation, are addressed in the

pollution section. However, it was concluded that the authors would provide additional content in the text.

Logging & Wood Harvest

Participants wondered if this section considered leftover logging debris ending up in streams, or temperature changes from the direct removal of riparian habitat. The authors indicated that excess debris is included in the pollution section and temperature changes were addressed in the total modification section. The threat considered here is the physical removal of riparian vegetation in salvage logging situations. As DUs 9 and 17 have large areas of salvage logging, and are small watersheds they would be more easily impacted. The group was satisfied with the ranking.

Recreational Activities

Participants asked for clarity on threat ranking for high impact on DUs 2 & 4 (Upper Pitt). It was primarily due to increasing jet boating activity in these systems but was thought to be more limited for DU 2. Furthermore, the threat was thought to be for juveniles being sucked into jet pumps or stranding due to wake rather than the actual impact on redds. Another asked if the issue of noise on egg development was considered and if high periods of jet boat use would overlap when the eggs were sensitive to acoustic shock. In response, the authors stated that the threat was not considered and, if it were, it would have to be accounted for in a different section. It was also confirmed that there is high jet boat activity during the sensitive period (hunting and fishing). Due to uncertainty around this impact, it was suggested to change the impact for DUs 2 & 4 to medium. The authors suggested that due to the suspected narrow extent of impact for DU 2 it should remain as is. It was than agreed by the group to change DU 4 to medium-high.

Work & Other Activities

The group was satisfied with the ranking and no objections or changes were posed.

Fire & Fire Suppression

It was clarified that fire retardants were to be addressed in the pollution section. The group was satisfied with the ranking.

Fishing & Harvesting Aquatic Resources

Following the authors' presentation of this threat's classification, it was immediately questioned if the assigned ranking of low-medium was sufficient given the identified uncertainties around exploitation rates. It was suggested to change the ranking to low-high to reflect this level of uncertainty. The subsequent discussion focused on DU 2 because it is the only DU included in this report with sufficient information available to inform the ranking process. It is clear that DUs without coded wire tag (CWT) information are still declining and there is uncertainty in optimal sustainable exploitation rates (ER) for these DUs. Data for DU 2 indicates that current exploitation rates are higher than can be sustained.

It was clarified that both the Canadian and US exploitation rates were considered with the expectation that the US rate would remain stable. Higher exploitation rates may contribute to population decline and must be considered for this RPA. The Canadian and US relative contributions to total exploitation rates should be addressed in the document.

An expert expressed concern that changing the ranking to include high was attributing exploitation with a much higher contribution to the population decline than is warranted by the currently available data. There is expectation that management actions in the future will result in an overall lower ER and ER does not equate to rate of population decline.

Recent stock-recruit analysis for DU 2 found that the maximum sustainable harvest is 16%. This rate was questioned if it truly equates to zero risk to the population and can this information be applied to other DUs. The analysis included the most recent available data for a complete cohort and does not reflect the most recent declines in spawner abundance. It was suggested that a summary of this analysis be included in the report as an appendix to support this target at 16% ER. Currently, there is no obligation to manage fisheries to the maximum sustainable harvest which leaves considerable uncertainty for the future. Some participants argued that if the ER stayed within 10% of the 16% target that the low-medium ranking should stand especially because we have some control over these rates. Others were not confident that this was a realistic expectation. There was recognition that changing stock-recruit relationships may result in a change of the maximum sustainable harvest rate.

Some of the uncertainty with respect to exploitation rates stems from the knowledge that escapement targets for DU 2 have not been met in seven out of the last ten years and exploitation rates were also exceeded. It was noted that there was a discrepancy in the DU 2 exploitation table that needs correction; reported that 11 of 24 years did not meet escapement goals, but it should say 13.

Adding to the uncertainty for the future, including DU 2 in fisheries management plans adds another layer of complexity. Their unique life history subjects them to fisheries at all life stages and they are impacted by many fisheries.

Causal certainty for DUs other than DU 2 was ranked medium. This caused some concern in the group due to the lack of information for all DUs other than DU 2. The author explained that there is certainty that fisheries will occur, but the level of impact is unknown. The medium ranking was inferred from DU 2 information.

An area expert expressed concern about the threat ranking for DUs 16 (North Thompson Spring 5_2) and 17 due to their low abundance and productivity. Additionally, they felt that other DUs (e.g., 7, Nahatlatch; 8, Portage; 14, Bessette) with low abundances should also be ranked with a greater threat because the risk is even greater as a result of abundance being so low. In response, it was stated that due to an absence of DU-specific data, it isn't possible to determine if the impact is greater than low, especially as there is no fishing when these DUs are migrating through the lower Fraser River. The expert responded that there is catch and release fishing and the associated mortality must be accounted for unless all fishing is closed. Furthermore, in the absence of data, this uncertainty should be captured by ranking these DUs low-high.

A participant explained that there are knowledge gaps and a need for an assessment of cumulative effects of all threats on the productivity of these DUs. Specifically, it is known that fishing has effects on population demographics such as age and size at maturity. An expert identified that this assessment does not encompass this and it should be addressed in the final summary that there are cumulative effects at play.

In discussion about the new Pacific Salmon Treaty, agreement on the exploitation rate of DU 2, an expert suggested keeping the upper limit of the threat ranking as medium. However, other participants expressed concern for other DUs based on three separate components. First, there is no current data available identifying a sustainable exploitation rate. Second, past harvest rates are associated with negative trends in most DUs. Last, exploitation rates are not tied to

productivity and are not obligated to change if productivity is declining. Therefore, it was suggested that to encompass these factors the ranking should be expanded to low-high.

After considerable debate, no consensus was reached. All agreed to change the ranking for DU 2 to low-high provided commentary is added to recognize the lack of consensus and that future modelling work to come for Part 2 of this RPA would provide more resolution to this issue. All other DUs are ranked based on DU 2 information and were also changed accordingly.

Dams & Water Management

The authors stated that DU 9 includes Bridge-Seton hydroelectric system but is only one part of the DU's total distribution. The primary reason for DUs 9 & 14 threat ranking was the result of intensive groundwater extraction. It was considered an extreme threat for DU 14 as the area is increasing in population and has already been designated as a drought risk by the province. There is little regulation of groundwater extraction. The group was satisfied with the threat ranking.

Other Ecosystems Modifications

It was recognized that DU 9 has been greatly impacted by fires recently with no signs of this changing in the future. The group was satisfied with the ranking and no objections or changes were posed.

Invasive Non-Native/Alien Species

A participant asked if *Didymo* is an issue in these waters. It was identified that it is prevalent everywhere but not at a phase of mass reproduction where it carpets the entire benthic community. It should also be categorized as a problematic native species. Another participant recommended that an area expert be consulted on their studies of *Didymo* outbreaks occurring in areas of low nutrients. Therefore they may be able to give a directed view on what is possible for interior streams. The group concluded that *Didymo* impacts should be considered as a knowledge gap. Other potential invasive species were also addressed, specifically Smallmouth and Largemouth Bass and Zebra Mussels. Finally, a participant asked why the extent of risk for the Harrison River population was listed as restricted while other lower Vancouver mainland DUs were listed as extensive. The authors addressed that the workshop participants felt that the short freshwater life history of Harrison chinook salmon reduced this risk of exposure to freshwater invasive species compared to the others.

Problematic Native Species

The authors clarified that they considered both juvenile and adult life stages in this part of the assessment. A participant asked whether predation effects of bears were accounted for here and if there are particular DUs where bears would be a likely impact. It was noted that bears may have an impact on smaller systems but are not likely an issue on larger rivers. The same participant asked about seal impacts, in particular on juveniles in the Harrison River. A Threats Workshop participant responded that due to the small size of the emergent fry, it would be unlikely that seals would target those individuals. Additionally, this threat accounts for native species population levels that are out of balance, the general predators category is evaluated in Element 10.

Introduced Genetic Material

Participants asked for clarity on this threat for the Harrison River population (DU 2), specifically on how red flesh fish are seemingly appearing in higher proportions in recent years. An area

expert identified that this could be simply due to genetic drift, but they have observed spawners with Coded Wire Tags (CWTs) from other populations in the Harrison River. Another reviewer made an observation that when the red flesh fish were subject to genetic stock identification, they were identified as belonging to the Harrison population. It was also clarified that Chilliwack and Harrison populations may have slightly different gene frequencies but genetically are considered the same. A participant questioned that if this threat should be elevated in risk but the consensus was that although the risk is known to occur, we are unsure if the effects are positive or negative. Secondly, it was also concluded that this may not be a cause for alarm as this is how the species colonizes over time.

In relation to this, a participant identified that the Chilliwack Summer population was supplemented with non-native introductions, a fact which was unknown to the participants in the Threats Workshop. Furthermore, there is a native spring run that spawns above Chilliwack Lake and the risk to this populations should be considered. The authors stated that the spring population is not assessed in this RPA. Another reviewer recommended that if the Chilliwack Summers were populated from transplants that this should be identified in the text. The group concluded that text would be added to clarify the origin of the population and rank it accordingly. Additionally the authors agreed to add text about the percent contribution of hatchery fish to the Harrison each year.

Another reviewer asked if dispersal of Chinook Salmon into other tributaries due to the Big Bar Slide had been considered, specifically because this was observed to be occurring in the Bridge River. An author indicated that it should be included in this threat section and they will add text to discuss straying due to Big Bar.

A participant expressed concern about whether hatchery fish were spawning in Bessette Creek, and therefore this should be considered a potential threat. An area expert indicated that in the past there may have been some mixing, but brood collection now is highly selective. It is also unlikely due to the separate timing of the Middle Shuswap River and Bessette populations. The authors stated that they would add text to address this.

It was recognized by the group that there may not be genetic introgression for populations receiving hatchery fish, but it is known that there are survival differences between natural and hatchery-origin fish. Because of this, a participant suggested creating a table that would display percent hatchery-origin fish spawning in each DU. However, an area expert responded that due to a lack of intensive sampling in most of the DUs, it would not be possible to come up with reliable estimates. Thus it was proposed to create a table displaying the DUs that do receive hatchery fish with a note that most of the ones considered in this RPA receive no enhancement other than straying.

A participant asked if enhancement due to the Big Bar Slide was likely. In response it was identified that there are discussions on enhancement possibilities. However, due to lack of hatchery space there would be definite constraints; suggesting that either using private hatcheries, building new ones, or changing hatchery focus (i.e. reducing CWT indicator programs) would need to occur. It was concluded that the authors would add a section to address this.

Pollution

The discussion on pollution included the threat analysis of Household Sewage & Urban Waste, Industrial & Military Effluents, Agriculture & Forestry Effluents, Garbage & Solid Waste, and Airborne Pollution.

Among the group it was discussed why DU 2 was given the same threat ranking as all the other DUs. It was felt that due to its life history, it should be facing this threat for more prolonged periods, specifically its long residence in Puget Sound. The authors indicated that they discussed this but the expert contacted in the Threats Workshop did not feel it was at a higher risk than the other DUs. Reasons given were that they all transit the lower Fraser, face DU specific local pollutants, and encounter different pollutants, such as high mercury levels in the open ocean. Despite this, some participants still felt it was reasonable to believe that Puget Sound residents would face greater concentrations of pollutants and questioned whether the expert had evidence that this was not the case or if they were just speculating. Ultimately the Threats Workshop participants were not sure if this was speculative and it was recommended that text be added to address this as a knowledge gap and that fish of all life stages should be considered in this. Additionally, a participant identified research done by WDFW in Puget Sound that recognized Harrison and Chilliwack populations as having high concentrations of pollutants that should be referenced.

Another participant enquired about the effects of light pollution and questioned if it was possible that there is increased predation occurring because of this. A paper that discussed this was identified as a possible reference and it was concluded to add text addressing this threat.

It was concluded to keep the threat risk the same but with the added text addressing the uncertainty.

Avalanches & Landslides

It was asked why DU 2 was given a rank of medium considering the low probability of occurrence, and if the threat was considered to be in the tributaries. A contributor to the Coho RPA agreed and stated they gave the risk of slides an unlikely ranking for that assessment. The authors addressed that the threat was from the Meager Creek slide which resulted in heavy siltation of the Harrison River for over two years. It was suggested and agreed upon to add text about this including the likelihood of these events becoming more frequent with extended freeze thaw periods associated with climate change.

Fishways were suggested as a threat as they are not monitored and maintained and have an inherent risk of becoming dysfunctional; specifically in reference to what has recently occurred at the Bonaparte River. There was no further discussion on this.

A participant asked if there was an assumption that Big Bar would be resolved embedded in the table. A Threat Workshop participant responded that Big Bar is considered to be a multi-year impact, but they also concluded that there was a high risk of slope failure throughout the Fraser Canyon that could result in similar impacts.

Habitat Shifting & Alteration

Several participants asked if dust trail impacts and ecosystem alteration (i.e. Roberts Bank) were addressed in this threat. The authors clarified that this threat is considering weather and climate changes that alter habitat. Furthermore, Roberts Bank was addressed in Ecosystem Modifications and the overall threat was ranked as low-medium. The group was satisfied with the ranking and no objections or changes were posed.

Droughts

A possible threat resulting from droughts was identified from an Oregon Department of Fish and Wildlife (ODFW) study. Due to drought, adult chinook Chinook Salmon were observed holding in higher densities in lower parts of rivers and this has resulted in crowding and parasite transfer

leading to pre-spawn mortalities. This was brought up as another effect to consider as a result of climate change.

Concern from the group that many DU's threat rankings were unknown. It was felt that droughts have already had effects in certain DUs that they should have been ranked with more certainty. The authors responded that the effect on population decline was unknown. Additionally, it is difficult to tease apart habitat shifting, drought, and temperature effects as they are interconnected. It was suggested that recent water level could be evaluated but the authors were still not sure if they would be able to re-categorize the threat from that information.

Temperature Extremes

Discussion focused around temperature extremes that adult Chinook Salmon face during migratory periods. An expert responded that temperatures over 21ºC result in stress and it is thought that Chinook Salmon may have a greater tolerance to the high temperatures than other salmon species. High temperature is a secondary stressor with low levels of dissolved oxygen in the water. The group also suggested higher temperatures will promote pre-spawn mortalities through crowding, increased disease transmission, and parasite prevalence.

In response to the observation that Chinook Salmon experience extreme temperatures in the Nicola River, a participant wondered if studies had been conducted regarding spawn success and high water temperatures. An area expert explained that they were not sure if any have been done but they are currently mapping aquifers and their thermal influence.

Another participant identified a paper that discussed Chinook Salmon migratory temperature thresholds and suggested that the lower Fraser has reached these temperatures in recent years. However, there is uncertainty about the prevalence of cool water refugia along the Fraser River.

Separate participants enquired whether this category included temperature extremes in the ocean and if there was reference to migratory conditions elsewhere in the RPA. The authors responded that these threats were not double counted and the marine environment was considered in habitat shifting.

Storms and Flooding

Participants wondered if the recent flooding in the Bonaparte and Chilcotin systems, and its relation to fires, was considered here. The authors responded that it was, but overall hydrology changes are captured in the ecosystems modifications section. Due to this, participants felt like the compounding impacts from these threats may be undervalued by the calculator but the authors responded that it is all captured in the roll up. The group was satisfied with the ranking and no objections or changes were posed.

CONCLUSIONS

The working paper reviewed at the meeting was accepted with revisions as detailed above and in the summarized Recommendations & Advice section below. Each of the threats rankings were reviewed and discussed. In some cases the ranking was agreed upon to be changed, but the majority were accepted as presented. Fishing & Harvesting Aquatic Resources elicited considerable discussion and debate. In the end, no consensus was reached. It was agreed to change the ranking for DU 2 to low-high provided commentary is added to recognize the lack of consensus and that future modelling work for Part 2 of this RPA would provide more resolution to this issue. All other DUs are ranked based on DU 2 information and were also changed accordingly.

RECOMMENDATIONS & ADVICE

There were many recommendations put forth by participants. The authors were in agreement to the following changes:

RECOMMENDATIONS BY REVIEWERS

- 2019 data should be included, however, they may not be available in time for the revisions of the working paper.
- Include reference to geographic area within the text to help orient the reader.
- Include more detailed description of each DU's trendline.
- Clarify if the list of DUs presented in Table 4 is comprehensive or only a select few.
- Investigate and include more recent works than Healey's paper for reference.
- Include discussion on the consequences of increasing hatchery production to wild populations of concern.
- Include a suggestion of further research be conducted to confirm genetic integrity of Chilliwack 5_2 and breeding protocols established limit mixing of populations.
- Identify and highlight importance of various knowledge gaps throughout the document:
    - No studies on impacts of cattle in the Fraser River watershed
    - Exploitation rates for all DUs, other than Harrison, are unknown
    - Analysis assessing if fisheries management actions achieve objectives
    - Freshwater habitat usage by juvenile Chinook Salmon throughout the Fraser River
- Include a summary table of all the findings.
- Available studies regarding pollution risks DU 2 have been omitted and should be included.
- Bears should be included in the discussion of natural predators.
- Quality plots for DU 5 did not include Chilliwack, but the reasoning was not included and should be.
- Advice for specific actions required for recovery is to be in Part 2 of this RPA, but it is important to include a linkage between the two documents in Part 1.
- Issues specific to each DU should be included in the document.

GENERAL DISCUSSION

- A paragraph outlining the process and values of the Threats Workshop.
- Highlight in the document that the DUs being discussed are in the Fraser River.
- Include text in the document explaining why Anderson Creek is not included in the discussion.

THREATS AND LIMITING FACTORS

- If a threat category is not listed in these proceedings, there were no suggested changes.
- Threats tables should have the DUs in the same order for all tables and if a DU was not affected by that threat, would be noted as 'unranked'.

Commercial & Industrial Areas

- Include discussion of the potential impacts of the Roberts Bank proposed development. Marine & Freshwater Aquaculture.
- Change the causal certainty ranking for DU 2 from ‘high’ to ‘medium’.

Shipping Lanes

- Include discussion on the grounding effects of log booms.

Recreational Activities

- Change the threat ranking for DU4 to ‘medium-high’.

Fishing & Harvesting Aquatic Resources

- Canadian and US relative contributions to total exploitation rates be discussed.
- Include in an appendix that shows a summary of the recent stock-recruit analysis of Harrison resulted in the maximum sustainable yield of 16%.
- Correction required on the exploitation rate table for DU 2; should say 13 of 24 years did not meet escapement targets instead of 11 as stated.
- Identify a knowledge gap in the assessment of cumulative effects of all threats on productivity; specifically, it is known that fishing has effects on population demographics such as age and size at maturity.
- Acknowledge that no consensus was reached on the ranking for this category; the ranking will be changed to low-high provided commentary is added to recognize the lack of consensus and that future modelling work for Part 2 of this RPA would provide more resolution.

Invasive Non-Native / Alien Species

- The impacts of *Didymo* should be identified as a knowledge gap.

Introduced Genetic Material

- Identify in the text that Chilliwack Summers have been populated from transplants, clarify their origin, and assess the risk accordingly.
- Add text about the percent contribution of hatchery fish to Harrison annually.
- Straying in response to the Big Bar slide should be added.
- Include discussion about the timing of the Middle Shuswap and Bessette populations, selective broodstock collection reducing the potential for mixing in Bessette.
- Include a table displaying all of the DUs what are currently being enhanced and a note stating that most DUs in this RPA receive no enhancement other than straying.
- Add a section to address the Big Bar slide and potential future plans for additional enhancement outside the current suite.

Pollution

- Identify pollution and the effects as a knowledge gap and that further work is needed on all life stages of fish.
- Research has been done by WDFW in Puget Sound that should be referenced here; it recognized Chilliwack and Harrison populations as having high concentrations of pollutants.
- Another paper discussing the effects of light pollution, questioning if it may contribute to predation should be referenced.

Avalanches & Landslides

- Add text describing how Meager Creek slide influenced the ranking of DU 2 and address how these events may increase in frequency with extended freeze-thaw periods.

Droughts

- Reinvestigate recent water level tables.

ACKNOWLEDGEMENTS

We thank all participants of this RPA process for their advice and contributions.

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

Chairperson: Mike Bradford

February 25-27, 2020
Paper #2 – Elements 12-22
Nanaimo, British Columbia

Chairperson: To be determined

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 complied 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.

Objective

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

- Science Advisory Reports
- Proceedings
- Research Documents

Expected Participation

- 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: AGENDA

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 1: Elements 1-11

December 10-12, 2019

Coast Hotel, Kamloops
Chair: Mike Bradford

DAY 1 – Tuesday, December 10

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chair
0915	Review Terms of Reference and the RPA process	Chair
0930	Presentation of Working Paper (Overview)	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
1630	Description of the threats assessment process	Authors
1700	**Adjourn for the Day**	

DAY 2 – Wednesday, December 11

Time	Subject	Presenter
0900	Introductions Review Agenda Review Status of Day 1 (*As Necessary*)	Chair
0930	Discussion and consensus on threats	RPR Participants
1030	***Break***	
1045	Discussion and consensus on threats, con't	RPR Participants
1200	***Lunch Break***	
13:00	Discussion and consensus on threats and limiting factors	RPR Participants
1445	***Break***	
1600	Consensus on the acceptability of the working paper	
1630	Introduction of the Science Advisory Report • Preliminary list of conclusions (bullets)	Chair & Participants
1700	***Adjourn for the day***	

DAY 3 – Thursday, December 12

Time	Subject	Presenter
0830	*Science Advisory Report (SAR)* • Develop consensus on the following for inclusion: • Sources of Uncertainty • Results & Conclusions • Additional advice to Management (as warranted)	Chair and Participants
1030	***Break***	
1145	Next Steps – Chair to review • SAR review/approval process and timelines • Research Document & Proceedings timelines • Other follow-up or commitments (as necessary) • Other Business arising from the review	RPR Participants
1200	***Adjourn Meeting***	

APPENDIX C: PARTICIPANTS

Last Name	First Name	Affiliation
Arbeider	Michael	DFO Stock Assessment
Bailey	Richard	DFO Stock Assessment
Benner	Keri	DFO Fish and Fish Habitat Protection Program
Bonney	Giselle	DFO SARA Program
Bradford	Mike	DFO Science
Braun	Doug	DFO Science
Brown	Gayle	DFO Science
Bylenga	John	DFO Stock Assessment
Candy	John	DFO Centre for Science Advice Pacific
Caron	Chantelle	DFO SARA Program
Churchland	Carolyn	DFO Salmonid Enhancement Program
Crowley	Sabrina	Nuu-chah-nulth Tribal Council
Curtis	Shamus	Upper Fraser Fisheries Conservation Alliance
Davidson	Katie	DFO Stock Assessment
Decker	Scott	DFO Stock Assessment
Desy	Travis	DFO Stock Assessment
Dionne	Kaitlyn	DFO Stock Assessment
Doutaz	Dan	DFO Stock Assessment
Frederickson	Nicole	Island Marine Aquatic Working Group (IMAWG)
Grant	Paul	DFO Science
Grout	Jeff	DFO Resource Management
Huang	Ann-Marie	DFO Science
Jenewein	Brittany	DFO Resource Management
Labelle	Marc	Okanagan Nation Alliance
Laliberte	Bernette	Cowichan Tribes
Lofthouse	Doug	DFO Salmonid Enhancement Program
MacConnachie	Sean	DFO Science
MacKay	David	Area F Salmon Troll
Magnan	Al	DFO Centre for Science Advice Pacific
Mahoney	Jason	DFO Salmonid Enhancement Program
Maynard	Jeremy	Sport Fishing Advisory Board
McDuffee	Misty	Raincoast Conservation Foundation/Marine Conservation Caucus
McGreer	Madeleine	FRAFS
Milligan	Laurie	Sport Fishing Advisory Board
Mozin	Paul	Scw'exmx Tribal Council (Nicola)
Parken	Chuck	DFO Stock Assessment
Paulson	Lawrence	Area F Salmon Troll
Potyrala	Mark	DFO Fish and Fish Habitat Protection Program
Rickards	Karen	DFO Resource Management
Ritchie	Lynda	DFO Stock Assessment

Last Name	First Name	Affiliation
Rosenberger	Andy	Marine Conservation Caucus
Rublee	Bill	Contractor, Triton Environmental
Ryan	Teresa	University of British Columbia
Scroggie	Jamie	DFO Resource Management
Staley	Mike	Fraser Salmon Management Council
Thomson	Madeline	DFO SARA Program
Thorpe	Suzanne	DFO Fish and Fish Habitat Protection Program
Trouton	Nicole	DFO Stock Assessment
Vivian	Tanya	DFO Stock Assessment
Walsh	Michelle	Secwepmec Fisheries Commission
Weir	Lauren	DFO Stock Assessment
Welch	Paul	DFO Salmonid Enhancement Program
Whitehouse	Timber	DFO Stock Assessment
Whitney	Charlotte	Pacific Salmon Foundation
Young	Jeffery	David Suzuki Foundation/Marine Conservation Caucus

APPENDIX D: WORKING PAPER REVIEWS

BILL RUBLEE, TRITON ENVIRONMENTAL

The working paper correctly reflects the outcome of the workshop and inputs from the group. The paper is clear in its purpose to identify threats to Fraser River Chinook Designatable Units and risks of declines in these DUs. The background information is good and well presented. The methods are adequate to identify the different threats that can affect each of the DUs and the data on escapement decline is extremely clear. However, the data required to clearly quantify the risk associated to the different DUs may not be sufficient. There is a need to further understand constraints during the freshwater rearing period of Fraser Chinook. On that note and based on my experience working on Chinook studies throughout the Fraser River drainage, I am of the opinion that we need to revisit our understanding of Chinook freshwater rearing and distribution particularly throughout the Fraser River for stream-type Chinook. The plasticity of the freshwater rearing of these animals is clearly presented and that in general juvenile Chinook undertake three recognizable strategies for rearing a stated on page 30 of the paper. However, there are definitely data gaps relating to the dynamics of juvenile Chinook distribution and particularly the importance of the Fraser River for rearing, and as a result, a possible underestimation of threats in the mainstem Fraser to the majority of Fraser River Chinook populations. Based on available information colonization of Fraser River habitats appears to initiate predominantly 60-90 days after emergence for some of the natal tributaries. This appears to coincide with the decline in the hydrograph. There is some genetic data available that indicates Nechako and Stuart fry are distributed throughout the length of the Fraser River over time and are a major component of the Chinook assemblage in the Fraser River below Chilliwack. Presumably this seeding results from ongoing recruitment and passive distribution through downstream and underutilized habitats. The Nechako and Stuart appear to be the earlier colonizers, while Fraser River population upstream of the Nechako Stuart confluence appear to recruit later and are found in lower numbers below the Nechako Stuart Confluence. Habitat use by juveniles within the Fraser appears to be weighted to transient hydraulic habitat such and scalloped bars and point bar shears. Fish presence during the day appears to be high, unlike data from clear water systems where juvenile Chinook are generally unavailable during the day but are present at night. The protection afforded by the turbid water in the Fraser River enable fish to maintain similar habitats day or night. It is not clear whether juvenile Chinook rearing in turbid water occasionally require clear water refuge, but it seems that it may not be necessary. The criteria for turbidity < 25 NTU does not seem to be realistic and may lead to a misinterpretation of useable habitat. It is my opinion that we are undervaluing the use of Fraser River habitat and therefore the risk to Chinook that rear for extended periods of time in the Fraser. I bring this forward as a significant gap in our understanding that needs to be addressed. There is likely additional information and experts who could provide some insight on this. I also believe it is feasible to design a system wide program soliciting the support of First Nations along the Fraser that could provide a significant amount of data to define temporal and spatial juvenile Chinook distribution. Although freshwater life history might not be the primary driver to the decline of Fraser River Chinook it is however an area where we may have an opportunity to increase productivity to at a minimum offset reduced productivity extrinsic to the Fraser watershed. It is also something that can unite many groups to take action and provide some political momentum to tackle the larger and more difficult threats.

The threats identification done in the workshop was quite subjective and the more data to prove out the rating the better to remove any doubt that the threat is real.

In its present form threats have been identified and associated risks and possible declines in DUs the next stem providing recommendations and advice to decision makers. I believe the

document provides enough shock value to make decision makers take notice. There is clearly one piece of advice that arises from the paper and that is there needs to be immediate action on the Fraser River blockage or we are at imminent and immediate risk of failure for Fraser Chinook that spawn upstream of this obstruction.

There are a large number of threats as identified in the paper and it would be helpful to identify which threats are likely drivers for production decline, and identify gaps in knowledge to be able to recommend appropriate action. Would it be worth as a next step to do and assessment on trends of the identified threats over the past 15 years relative to the decline of Chinook stocks over the last three cycles? If a threat has not increased, it may not be as significant a threat and might not be a priority for action moving forward. The table below provides a bit of a framework to start. It could also include a column for data gaps and recommended studies/actions. It might be overly simplistic because of the interaction of many of these threats but I put it forward as a suggestion.

Table 1. Suggested framework for threat trends

Threat	Trends over the 3 cycles?	Likely to have contributed to Fraser Chinook decline?	Expected to increase?	Will Threat increase?
Housing and Urban Areas				
Commercial and Industrial Areas				
Tourism and Recreation				
Annual and Perennial Non-Timber Crops				
Livestock Farming and Ranching				
Marina and Freshwater Aquiculture				
Mining and Quarrying				
Roads and Railroads				
Utility and Service Lines				
Shipping Lanes				
Logging and Wood Harvest				
Fish Harvesting Aquatic Resources				
Work and Other Activities				
Fire and Fire suppression				
Dams and Water management				
Other Ecosystems modifications				
Invasive Non-Native and Alien Species				
Problematic Native Species				
Introduced Genetic Material				
Household Sewage and Urban Water				
Industrial and Military Effluents				
Agriculture and Forestry Effluents				
Garbage and Solid Waste				
Air Borne Pollution				
Avalanches and Landslides				
Habitat Shifting and Alteration				
Droughts				
Temperature Extremes				
Storms and Flooding				

GAYLE BROWN, FISHERIES AND OCEANS CANADA

General Comments on the Research Document

The authors were charged with a massive task – to assemble and make use of essentially all available information and data for 11 Designatable Units of Fraser River Chinook Salmon. The objective was to establish the current status of the 11 DUs and to set the stage for the quantitative recovery potential assessment. All components of each RPA Element from 1 -11 relevant to the 11 DUs have been given thorough treatment and I commend the authors for the piece of work which I believe will serve as an important reference document for many years. It should also be used as the model for future Chinook Salmon RPAs.

A brief summary of my main observations is as follows:

1. The document addresses all required or relevant components of each of the 11 RPA elements.
2. All sections contain relevant information and references to scientific literature or subject matter experts although treatment of some topics is more comprehensive than others. The second part of my review will highlight some areas where additional significant information can be included, building on material provided by the authors with the intent of helping to focus recovery efforts.
3. The analysis and presentation of results for Element 2 on recent trends in abundance is a solid treatment, they clearly support outcomes from the overall threat assessments and they provide a cornerstone for the research document. Despite data issues and limitations, they support and strengthen the COSEWIC assessment and convey the accurate take-home message that the inclusion of additional years of more recent data offers no view that abundance trends have reversed. They provide strong rationale that conservation measures are justified and additional actions focused on recovery of all 11 DUs will be required.
4. How the overall level of threat was derived as an outcome of the ‘threats workshop’ and the COSEWIC Threats Calculator is described clearly in section 4.1.12 containing the final summary for the document. The categorization of either High-to-Extreme (6 DUs) or Extreme (5 DUs) for the 11 DUs seems justified. Additional information that could be included in a few areas of the document will be identified but in reality, the document contains sufficient information in its current state to support the assessment of threats. While increasing abundance trends can’t be ruled out in the future, the investigative efforts by the authors has not revealed rationale for an expectation of reversal of the observed declining trends in the near future.
5. The research document, as submitted, is generally well-written and considerable effort has gone into its preparation. For such a lengthy document, I appreciated this as a reviewer but some editorial work is yet required. Some of the editorial issues no doubt reflect the large number of contributors to the document and the unintentional use of different styles. Examples are the lack of a single approach for referencing common names of species and for referencing multi-author citations in the text. The authors indicated in the document that the reference list is a work in progress and for that reason I did not attempt to match citations given in the text with those given in section 6 containing the references. This work needs to be done and accuracy of citations checked as there is at least one in which the publication year is incorrect – Foote and Brown 2011 (this is the ‘internet’ publication year but the actual publication year is 1998). I will provide the authors with a printed copy with my editorial suggestions but won’t deal with editorial issues further in this review.

Comments on Specific Sections of the Research Document

Many questions came to mind while going through the material in the document but I will focus mainly on select sections of the document where given my area of expertise, there is reason to expect that some action can be taken to either improve understanding or reduce the impact.

Section 2 Element 1: The authors provide information for Chinook Salmon that applies throughout their range generally and for the Fraser River DUs specifically, but it's sometimes unclear which geographic area is being referenced in the text. Please review each section and clarify as necessary.

Section 2.2.2 provides a good treatment of trends in abundance and figures and tables provide information in clear and easily digestible format. I recommend that the authors consider some expansion of text for each DU to more fully use the abundance data to go beyond a description of trend lines. For example, a summary could be provided like the following for DU 2: "magnitude of downward trend is not as high for DU 2 as for some of the other DUs but the spawner abundance has been estimated at well under the spawner abundance estimated at Smsy for more years in the past 3 generations than at any other time since standardized Mark-Recapture estimates started in the 1980's."

Table 4 - A list of known spawning streams for each DU, with the CU number for additional reference (p 10): It's unclear whether the list of sites for each DU is intended to be all known sites associated with the DU or a selected set. If the former, the list for the multi-site DUs needs checking as it doesn't seem complete. If the latter, what is the basis for the sites that are listed?

Section 3, Element 4 (Ocean rearing habitat) and Element 5 (Marine Distribution): The information provided on marine distribution for the Fraser stocks is important because it relates directly to understanding of the effect of changes in climate and other limiting factors in the ocean environment and to fisheries impacting the DUs. The authors rely on publications by Healey to summarize information generally known about ocean distribution of ocean- and stream-type stocks but more information has accumulated in the decades since Healey's publication that expands understanding of the diversity of ocean distribution patterns now known to occur in stocks under each of the two broad categories. I strongly recommend that the authors take the following steps:

1. Incorporate more recent information through reviewing annual publications by the Pacific Salmon Commission's Chinook Technical Committee (CTC) in which the percentage of tagged fish estimated in the fishery catches in a broad region of the ocean from southeast Alaska to California are summarized in 'mortality distribution tables' by calendar year and regional fisheries for a suite of coded-wire tag indicator stocks. This list of stocks provides an updated view of the ocean distribution of various life history patterns across a broad region of the Pacific coastal range of Chinook Salmon and more specifically, for stocks from the Fraser River
2. Incorporate CWT recovery information that exists for more Fraser DUs than are included in the annual work by the CTC. Several years ago Mary Thiess and I produced summaries for all Fraser Chinook CUs with CWT recovery data and this effort revealed distribution information existed for most CUs. The approach could be repeated to include any recent information and graphs generated for inclusion in the report. This information will show that even within the larger groupings of DUs based on DFO's management units, there is diversity in the pattern of occurrence in the ocean. These summaries also provide information on occurrence in fisheries outside of the geographic area covered by the Pacific

Salmon Treaty and in fisheries in which Chinook Salmon are caught as by-catch in commercial fisheries targeting other fish.

3. Incorporate information on occurrence of Fraser River stocks in recently published U.S. studies or reports on high seas fisheries and fisheries occurring in region of the Alaskan Aleutian Islands and the Bering Sea. Reference to such studies underscores the point that most Chinook Salmon stocks range over great distances in the ocean and are thereby impacted by many factors. Frequently, the magnitude of impact in any single 'fishery' is relatively small but the number of such fisheries with 'small' can sum to a greater amount that is more difficult to treat as trivial.

Incorporation of the above information will resolve a few cases in the document where the authors make a statement about a Fraser Chinook DU based on the earlier Healey publications concerning ocean- or stream-type Chinook and then contradict it in a subsequent statement using more recent information. I'm willing to assist the authors with the above work and can provide access to scripts written in R, information on data acquisition and references, etc.

Finally, on another note, the authors state that updated maps will be provided for the final document. The COSEWIC map for DU 2 included the Harrison Lake as part of the geographic region encompassing the DU. Neither the adults or juveniles are known to use Harrison Lake as habitat and therefore, it's unclear why Harrison Lake is included. What will the updated map include? What should it include? Have the authors identified any examples where the updated DU maps will differ from the COSEWIC maps?

Section 4, subsection 4.1.2 on Agriculture and Aquaculture (Hatchery Fish): This section could be considerably longer but is sufficiently comprehensive for the purpose of the report. There is one topic that should be included and that is the consequence to wild Chinook stocks when occurring in fisheries prosecuted to take advantage of hatchery Chinook production. This is the state of the world for Chinook Salmon, however, the consequences require greater consideration when the hatchery production is of the same stock as a natural stock of conservation concern and fishing effort may increase in response to the hatchery fish abundance. Information presented in this paper describes how this situation exists and is likely to increase in the future for DU 2 due to the current and planned production increases from Chilliwack River Hatchery. The authors should include discussion of the general topic and more specifically, for DU 2 and any others where the same situation exists.

The authors have excluded the Chilliwack River Summer stock from the trend analysis for DU 5 (Lower Fraser River Stream Summer), and the basis for this I believe is that the returning spawners likely originate from the hatchery releases. This approach has a sound basis for assessment of status but different thinking is needed when considering the recovery potential for a DU. The introduction of Harrison River (white) fall Chinook into the Chilliwack River, when historical information indicates that fall Chinook did not previously occur in the river system, and the continued high hatchery production and large annual spawning return, creates a possible situation where unintentional interbreeding of the native summer 'red' Chinook could be occurring in both the hatchery and river areas. There is a known example of unintentional genetic mixing among two distinct run-timing groups in a B.C. hatchery, i.e., mixing of summer and fall Chinook in the Puntledge River. When the situation was recognized from CWT recoveries of releases of each group, steps were taken to use genetic analysis of potential parental spawners to ensure that unintentional interbreeding ceased and this effort is annually ongoing. Since the Chilliwack River summer run and the hatchery is a potential source of genetic diversity for DU5 and the Chilliwack River Hatchery could serve as the location for recovery efforts, a recommendation should be included in this report identifying that research be

carried out to confirm the genetic integrity of the Chilliwack River summer run and that breeding protocols are established to avoid mixing with the introduced fall Chinook.

Finally, a recommendation for inclusion in this document should be considered that all enhancement activities occurring within the DUs in this RPA be reviewed and that objectives and appropriate protocols be developed to ensure that activities are aligned with recovery of the DUs.

Section 4, 4.1.2.2 Livestock farming and ranching: It is surprising that there have been no studies quantifying the extent of contact (or impact) by cattle on stream banks and stream beds in Fraser River areas where they could affect Chinook Salmon production. Is this not a gap that should be identified and advice given in this document that studies or monitoring take place?

Section 4, subsection 4.1.5.2 on Fishing & Harvesting Aquatic Resources: This section on fishing effects is well-laid out and includes considerable useful information. It contains comprehensive description of how fishery planning by DFO has included specific management objectives for the Fraser Chinook management units in the annual fishery planning and has devised management actions to achieve the objectives. Aside from reference to the recent CSAS technical review of stream-type Fraser River Chinook management approach which mainly covered more terminal fishery impacts, little information is presented to confirm that the management actions have achieved stated objectives. Acceptance that fishery impacts have decreased considerably due to the stated management actions seems premature when earlier in the document the authors describe that specific marine distribution information is lacking for most of the DUs. Willingness to conclude the low-to-medium threat assessment when it seems mainly based on belief is puzzling for a scientific investigation. There is surprisingly little acknowledgement of the lack of analysis to assess whether the fishery management actions have achieved objectives. Why is this not identified as a gap and problem? Should there not be advice coming from this process that the information used to devise the management actions be documented and assessment be carried out to determine whether management actions are having the intended effect? Identification of information gaps is a stated component of an RPA and yet these have not been clearly identified in the summary section of the document.

Section 4.1.8.3 Introduced genetic material: The observation made in this section of Chinook with red flesh occurring among spawners in the Harrison River is noteworthy when white-fleshed fish were only known occur historically. The identity of these fish needs to be determined and if there is evidence of introgression from red-fleshed Chinook, the source of these fish needs to be understood. Strays from Cowichan River were suggested as a possibility but there are other possibilities. Advice concerning research projects should be provided.

Section 4.1.9 Pollution and Contaminants: The contaminants section contains a good summary of relevant information on pollutants but information is missing concerning two key topic areas:

1. Studies by Washington Dept. Fish and Wildlife (WDFW) researchers have reported measured contaminant levels in Harrison R and Chilliwack R Chinook. These studies found that the measurements were at similarly concerning levels as measured in fish from Puget Sound rivers, levels that were high enough as to likely be reducing survival and resistance to common infections. A portion of text follows from the November 16 2018 report by the Southern Resident Orca Task Force (from page 31/148):

    Chinook Salmon

    Adult Chinook Salmon are a major source of persistent toxic chemicals to Southern Resident orcasM [82, 94, 88, 89]. Puget Sound Chinook Salmon and some Fraser River Chinook Salmon (Harrison and Chilliwack populations) accumulate higher

concentrations of PCBs and PBDEs than other Chinook Salmon populations because of their time spent foraging in the Salish Sea and the Puget Sound [82, 89, 95], where forage fish are highly contaminated [87, 86].

Additionally, the health and survival juvenile Chinook Salmon from Puget Sound and the Columbia River, may be reduced by their exposure to toxic contaminants [96, 97, 98, 99, 100]. In particular, toxics can reduce juvenile Chinook Salmon survival by reducing their growth and making them more susceptible to disease [101, 102, 100]. Specific contaminant hotspots for juvenile Chinook Salmon include the Duwamish estuary and river, Commencement Bay, Snohomish estuary, Anacortes, Portland Harbor, Hanford Reach, Sinclair/Dyes Inlet and Lake Union. Hotspots in British Columbia include Victoria Harbor and the Fraser Delta.

References cited in the report include the following:

[82] T. Mongillo, "Exposure to a mixture of toxic chemicals: Implications for the health of endangered Southern Resident killer whales," 2016.

[89] S. M. O'Neill and J. E. West, "Marine distribution, life history traits and the accumulation of polychlorinated biphenyls (PCBs) in Chinook Salmon (Oncorhynchus tshawytscha) from Puget Sound, Washington," Transactions of the American Fisheries Society, pp. 616-632, 2009.

[95] S. M. O'Neill, J. E. West and G. M. Ylitalo, "Toxic contaminant patterns in Chinook Salmon and southern resident killer whales provide insights into whale foraging habitat. In PSEMP Toxics Work Group.2016 Salish Sea Toxics Monitoring Review: A Selection of Research.," Puget Sound Ecosystem Monitoring Program, Tacoma, WA, 2017.

[96] S. M. O'Neill, A. J. Carey, J. A. Lanksbury, L. A. Niewolny, G. Ylitalo, L. Johnson and J. E. West, "Toxic contaminants in juvenile Chinook Salmon (Oncorhynchus tshawytscha) migrating through estuary, nearshore and offshore habitats of Puget Sound," Washington Department of Fish and Wildlife, Olympia, WA, 2015.

[97] C. A. Sloan, B. F. Anulacion, J. L. Bolton, D. Boyd, O. P. Olson, S. Y. Sol, G. M. Ylitalo and L. L. Johnson, "Polybrominated diphenyl ethers in outmigrant juvenile Chinook Salmon from the lower Columbia River and Estuary and Puget Sound, Washington.," Arch Environ Contam [101] M. R. Arkoosh, D. Boylen, J. Dietrich, B. F. Anulacion, Ginaylitalo, C. F. Bravo, L. L.

Johnson, F. J. Loge and T. K. Collier, "Disease susceptibility of Salmon exposed to polybrominated diphenyl ethers (PBDEs)," Aquat Toxicol, pp. 98(1): 51-59, 2010.

[102] J. P. Meador, F. C. Sommers, G. M. Ylitalo and C. A. Sloan, "Altered growth and related physiological responses in juvenile Chinook Salmon (Oncorhynchus tshawytscha) from dietary exposure to polycyclic aromatic hydrocarbons (PAHs)," Canadian Journal of Fisheries and Aquatic Sciences, pp. 63(10): 2364-2376, 2006.Toxicol, pp. 58(2): 403-414, 2010.

[98] J. P. Meador, "Do chemically contaminated river estuaries in Puget Sound (Washington, USA) affect the survival rate of hatchery-reared Chinook Salmon?," Canadian Journal of Fisheries and Aquatic Sciences, pp. 71(1): 162-180, 2014.

[100] M. R. Arkoosh, E. Casillas, P. Huffman, E. Clemons, J. Evered, J. E. Stein and U. Varanasi, "Increased Susceptibility of Juvenile Chinook Salmon from a Contaminated Estuary to Vibrio anguillarum," Transactions of the American Fisheries Society, pp. 360-374, 1998.

The Southern Resident Orca Task Force report is available online.

This research is ongoing by the WDFW researchers and I recommend that they be contacted to obtain relevant papers or a personal communication from them concerning more recent studies that include Harrison River or Chilliwack River Chinook Salmon.

On the basis of the documented contamination of Harrison River Chinook by pollutants that the threat risk be elevated to High. It doesn't seem that participants of the Threat Assessment Workshop were aware of this information and if they had been, the determination would likely have been something greater than 'Low-Medium'.

4.1.9.2 Industrial & military effluents, or, 4.1.9.5 Air-Borne Pollution: One source of contaminants not included in this report and potentially impacting Chinook Salmon in the Fraser River watershed is coal dust. A brief internet search revealed that that this is a notable contaminant source of polycyclic aromatic hydrocarbons (PAHs), sulphur dioxide, hydrogen chloride, mercury, arsenic and cadmium. Since coal dust is dispersed from open-top train cars from which it could be entering the Fraser River watershed as it's being transported to the Roberts Bank coal terminal.

The following passages were copied from the Sightline Institute website:

> In 2006, here in the Northwest, Ryan Johnson and Marc Bustin of the University of British Columbia evaluated 22 years of coal dust dispersal around the Westshore Coal Terminal, located just north of the US border. They found widespread coal dust on the surface of the water near the terminal, observing a film of fine coal particles floating on the water 200 meters east of the vessel loading dock, even when no coal loading was in progress and no ship was docked. They pointed out that ordinary tidal currents could disperse the coal particles 2.5 miles from the coal loading facility, and potentially over 56 miles under extreme conditions.
>
> On the sea floor, Johnson and Bustin were able to document a steady accretion of coal dust. They found that coal concentrations in marine sediments effectively doubled in the period covered by their analysis, increasing from a mean concentration of 1.8 percent in 1977 to 3.6 percent in 1999. Concentrations in the immediate area of the coal terminal were as high as 11.9 percent in the later samples, with quantifiable concentrations 1.5 miles away …
>
> …All of which, they conclude, could harm the flora and fauna living on the sea bottom. Oxidizing coal particles reduce the oxygen available for clams, mussels, barnacles, and crab larvae, with damage reverberating up the food chain. In fact, the bottom-dwelling invertebrates affected by coal dust make up a large share of the seasonal food for salmon and herring. (In fairness, however, the researchers also noted that low oxygen conditions deriving from coal dust would likely only occur within 300 meters of the terminal, and they claim that sea creatures in that area are more likely to be affected by physical changes to their environment, such as by dredging, than by oxygen depletion.)
>
> Ahrens and Morrisey were able to identify several studies that examined the effects of coal dust pollution on fish and shellfish. Unfortunately, most of the studies are old, poorly designed, or inconclusive. For example, a 1963 study found that coal washery solids in relatively low concentrations reduced the growth rate of exposed trout. An even older study from the late 1930s linked fish mortality to the irritation caused by coal particles entering a freshwater stream. And a 1979 study by an EPA researcher found that to PAH contamination from coal reduced the spawning success of fathead minnows from 90 percent to 36 percent.

Perhaps most worrisome for the Northwest, a 1997 study by government researchers in Canada found that coal dust altered genetic expression in juvenile Chinook Salmon. Although the consequences could be very serious, the study's authors state that "the physiological consequences of this are presently unclear." (In a concerning aside, the authors noted, based on earlier research, that "surfactants," the chemical adhesives commonly used to reduce coal dust on trains, can boost the ability of coal pollutants to enter the environment, and the Washington State Department of Natural Resources raises similar concerns about surfactants.) We were not able to find any follow-up analysis; however, PAHs have been linked to growth impairment and reproductive effects on Chinook.

A discussion of possible impacts of coal dust should be included in the document.

4.1.12 Summary: An addition to this section that I would've found helpful is a table that provided the threat risk for the DUs for all the threat factors that were assessed. This would mean taking the threat risk given in tables 23-32 and 35-54 and bringing them all together in a single table for each of the DUs.

4.3 Element 10: Natural factors that will limit survival and recovery, specifically 4.3.1 Predators: The most iconic of salmon predators – Grizzly and black bears – are missing from the discussion of predators.

Abstract and Concluding Remarks: The abstract and concluding remarks accurately summarize results of the trend analysis and assessment of all the threat categories. The summary statements, however, seem overly 'clinical' given the precarious situation that exists for some DUs simply due to very low abundance (DUs 4, 5, 7, 8, 14, 16), a single spawning location only is known for all fish in the DU (DUs 2, 4, 7 and 8), and the new and added impact of the Big Bar slide (DUs 9, 10 and 11). Some DUs are in both the first two categories (DU 4, 7 and 8). Fortunately, none in the first two categories also occur in the third. The seriousness of the situation for these DUs should be emphasized and advice given for immediate and elevated recovery planning response. This CSAS process can provide such advice (I believe) and I would like to have this advice included in the report.

Appendices: The Quality Plots for DU5 (CK-06) show that annual abundance estimates for Chilliwack River are filtered out in the stage 2 quality filtering but these data points were not present in the preceding plots. This issue will not affect the trend analysis because I don't think the Chilliwack River stock contributes data to the time series for the DU but it would be good to have the corrected plots for the published document.

Summary Comments

1. Is the purpose of the working paper clearly stated? The authors stated the purpose of the working paper clearly, however, it would've been helpful to me as a reviewer to have had more general understanding of the objectives of Elements 1-11 of a DFO RPA. For example, are the authors bound to using the outcome of the Threats Calculator from the Threat Assessment Workshop, or having completed research into a topic or threat, can they, with in-depth knowledge of a topic, can they draw a different conclusion? For review of an RPA, perhaps some brief advice could be provided to reviewers.
2. Are the data and methods adequate to support the conclusions? Yes.
3. Are the data and methods explained in sufficient detail to properly evaluate the conclusions? Yes.

4. If the document presents advice to decision-makers, are the recommendations provided in a useable form? It seems that the overall threat rating from the COSEWIC threats calculator workshop (e.g. Table 55) given in the Summary and Concluding Remarks sections is the main advice provided in the document. The authors state succinctly and clearly that all the assessed DUs are at critical risk of extinction and that concert, coordinated effort will be needed to ensure that extinction does not happen. They do not, however, give recommendations on specific actions that could guide the coordination and the efforts, or state initial actions that could be taken. Perhaps this will follow in Part II of this RPA but if that is not the case, this document should provide those recommendations. The authors are the most informed group concerning the list of DUs and impacts occurring to limit their recovery potential and they can recommend the most likely actions that can preserve and recover the DUs.
5. If the document presents advice to decision-makers does the advice reflect the uncertainty in the data, analysis or process? Yes. The overall threat rating from the COSEWIC threats calculator, which I consider to be the main advice given in the document, is presented as a range if the rating is not extreme. The process used to arrive at the range is clearly explained.
6. Can you suggest additional areas of research that are needed to improve our assessment abilities? The authors have identified many areas where information is lacking concerning the ecological features, habitat requirements or effects of specific threats. Recommendations for specific research to fill gaps or improve understanding have not been made in this document. I attempted to make some in my review but with limited time, I did not do this area sufficient justice and I suggest that the authors be asked to provide a list of those research topics they feel most critical in the Concluding Remarks section of this document.

Thank you for the opportunity to be a reviewer for this excellent document and to contribute to its final form.

APPENDIX E: ABSTRACT OF WORKING PAPER

Eleven Fraser River Chinook Salmon (FRC) (*Oncorhynchus tshawytscha*) Designatable Units (DU) 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). This first part of the Recovery Potential Assessment (RPA) (Elements 1-11) provides descriptions and status updates for the populations, an overview of the biology and habitat requirements, and an assessment of the threats and factors limiting recovery. The major threats impacting the DUs were assessed in a workshop with local experts, and were determined to be climate change, natural system modifications, fishing and pollution. Threats to individual DUs of note include: recent landslides posing serious risks to DUs 8, 9, 10 and 11, competition with hatchery fish for DU 2, and particularly high impacts due to natural systems modifications for DUs 9 and 14. All eleven DUs are considered to be at a high to extreme or extreme threat risk, due to the severity and number of threats these DUs are facing. Based on the assessed threats, over the next three generations it is expected that there will be a population level decline of 31-100% for DUs 2, 4, 5, 7, 16 and 17, and a 71% to 100% population level decline for DUs 8, 9, 10, 11, and 14. Alleviating the multiple 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. Recovery targets, options for mitigation, forward population projections and allowable harm will be provided in the second half of the RPA (Elements 12-22).