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Proceedings of the Pacific regional peer review on the Recovery Potential Assessment – Okanagan Chinook (*Oncorhynchus tshawytscha*)

May 28-30, 2019
Kelowna, British Columbia

Chairperson: Nicholas Komick
Editor: Kaitlyn Dionne and Nicholas Komick

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Foreword

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

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting of May 28-30, 2019 at the Cove Lakeside Resort in West Kelowna, British Columbia (BC). A working paper focusing on the Recovery Potential Assessment (RPA) of the Okanagan Chinook Salmon was presented for peer review.

In 2017, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reassessed the Okanagan Chinook population as Endangered. Previous assessments by COSEWIC occurred in 2005 (Endangered) and 2006 (Threatened) with the decision by the Federal Minister of the Environment to not list the population under the *Species at Risk Act* (SARA) occurring in 2010.

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 Okanagan Nation Alliance, Columbia River Inter-Tribal Fish Commission, and Colville Confederated Tribe.

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

The recommendation to list the Okanagan Chinook as Endangered by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) triggers the generation of a Recovery Potential Assessment (RPA) to inform the *Species at Risk Ac*t (SARA) process and subsequent recovery planning, should the population be listed. The RPA is a science-based, peer review process that assesses species status, potential recovery targets, biology, habitat usage, threats to recovery, and the potential mitigations of human-induced mortality from the outlined threats. The Terms of Reference for the meeting are presented in Appendix A.

The meeting occurred from May 28-30, 2019 and included participants from Fisheries and Oceans Canada (DFO) Science, Species at Risk, and Resource Management, the Okanagan National Alliance, Columbia River Inter-Tribal Fish Commission, and Colville Confederated Tribes (Appendix D).

The meeting Chair, Nicholas Komick, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the Canadian Science Advisory Secretariat process. The Chair discussed the role of participants, the purpose of the various CSAS Regional Peer Review (RPR) publications (Science Advisory Report, Proceedings and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, working paper, agenda and reviews of the working paper.

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identified the Rapporteur. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. 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 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, 25 people participated in the RPR (Appendix D). Kaitlyn Dionne was identified as the Rapporteur for the meeting.

Participants were informed that Catarina Wor and Tommy Garrison had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

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

ASSESSMENT

The assessment of the document began by going through both of the reviews of the working paper and allowing the reviewers to answer any questions from the meeting participants. Subsequent sections of the working paper were presented by the authors followed by discussion by meeting participants. The following sections summarizes this information below.

REVIEWS

Presenters C. Wor and T. Garrison

The presentation provided an overview of the reviews by Catarina Wor and Tommy Garrison. Each reviewer highlighted any gaps in the working paper to be considered during the discussion for each subsequent presented section by the authors.

DISCUSSION

A participant inquired if the exploitation rates (ERs) for Okanagan Chinook were related to estimates based on Coded-Wire Tags (CWTs) from Chief Joe hatchery and how additional enhancement at Wells hatchery might change these ERs. The ERs for Okanogan Chinook are based on the Wells Fish Hatchery indicator stock. Chief Joe has a segregated program that results in very low straying rates of these fish.

A participant asked if the yearling and subyearling hatchery programs (at Wells Hatchery) had changed recently. They have not changed in the past decade. They additionally inquired if there was any difference in the ocean distribution for yearling and subyearling cohorts. Their distribution is similar but maturation rate and ER estimates should be separated for yearling and subyearlings. It was suggested that a good way to separate the two might be to look at the ratio of genetic stock identified (GSI) samples and CWTs caught in nearby fisheries.

It was noted that the portion of the life cycle from spawners to smolts is missing for Okanagan Chinook. This is a limitation of the current data available.

Participants suggested that the research document would benefit from a section providing an overview on hatchery practices in the Columbia basin for spring and summer Chinook.

BIOLOGY, ABUNDANCE, DISTRIBUTION AND LIFE HISTORY PARAMETERS

PRESENTER R. BUSSANICH

The presentation provided a general overview of the biology and abundance for Okanagan Chinook. Much of the available information for Okanagan Chinook utilizes data from the hatchery populations in the Upper Columbia as a proxy to make inferences on Okanagan Chinook provided the lack of data specific to the population. It was identified that more background on the Upper Columbia hatchery populations used in the analysis would strengthen the research document.

DISCUSSION

An inquiry was made regarding the amount of available habitat surveyed for Okanagan Chinook. The mainstem of the Okanagan River (between Oliver and Penticton) is where the majority of the spawning habitat exists but there’s less confidence in the extent of the population within the tributaries to the river.

A participant asked if the Chinook were utilizing the same habitat through time. Deadpitch data from areas surveyed for Sockeye suggest that habitat utilization has been relatively constant but eDNA data provides new evidence of potential recolonization in Shingle Creek. These fish are also starting to use the restored areas in the Okanagan mainstem.

A question was asked regarding the extent of the survey for Okanagan River Chinook. Prior to 2009, fish were only able to access habitat up to McIntyre Dam so Area-Under-the-Curve (AUC) surveys only occur below this area. It was noted that this is where the majority of the fish spawn and upstream numbers have been ≤2 but the plan would be to incorporate these fish in future assessments.

Another participant inquired about any details regarding timing of harvest from traditional ecological knowledge (TEK) surveys. The TEK surveys focused mainly on the condition of the fish and focused on the potential for separate runs. There was indication within the surveys that Chinook did time their passage through Okanagan Falls in May and June (which were most likely spring Chinook), but noted 2-3 pulses of fish, probably indicating other races such as summer Chinook and fall Chinook.

During the discussion on the potential for different run times of fish, another participant inquired if there was any indication of differences in spawning habitat utilization between the early and later timed runs. That level of detailed information does not currently exist and the case studies that have been performed on the Okanagan River largely pertain to Sockeye Salmon. After this discussion it was reiterated that the COSEWIC assessment only pertained to the Summer Designatable Unit (DU).

Participants asked if abundance data prior to 2006 exists for Okanagan Chinook or if it was just based on TEK. DFO data from historical records exist but are very limited and likely biased as the surveys performed coincided with peak Sockeye Salmon returns. Information on Okanagan Chinook goes back to 1965 but it is not quantitative.

There was a lengthy discussion surrounding the nature of the population dynamics for Okanagan Chinook. It was noted that this is especially important if hatchery supplementation were to be considered as a mitigation strategy to maintain genetic integrity of the population. It was decided by the participants and authors that the Okanagan Chinook are likely a metapopulation of Upper Columbia Chinook but that further work would be required to assess the straying and contribution from other populations with in the US.

A participant noted that the research document stated that there was no direct Canadian fishing pressure on Okanagan Chinook, but that this was incorrect. Direct exploitation of Okanagan Chinook occurs in Canadian marine fisheries but not in freshwater.

HABITAT AND RESIDENCE REQUIREMENTS

PRESENTER K. ALEX

The presentation provided an overview of recent habitat restoration and management that occurred in the Okanagan River by the Okanagan Nation Alliance. While much of this work has been centered on Sockeye Salmon, the improvements to habitat quality are likely to benefit Chinook Salmon.

DISCUSSION

A participant asked about whether the lake habitat is simply used as a migratory corridor or if there was evidence of Chinook utilizing this habitat. They additionally inquired about whether or not predation was a limiting factor within the lakes. Nothing has been done to look at the usage of Osoyoos Lake for Chinook Salmon but that the habitat use and predation pressure of Shuswap Lake salmon could be used as a reference. It was noted that the reduction of European milfoil reduces prevalence of invasive bass in the lake.

Another participant inquired about where juvenile Okanagan Chinook rear. No information currently exists on the migratory path they take to the ocean or where they rear within the Okanagan River system.

There was some discussion on the potential effect of freshwater temperature regimes on Okanagan Chinook. The system was historically lake driven but now has flood control structures implemented via lowhead dams. The lowhead dams are unlikely to have increased the surface area of the lakes enough to change the thermal regime significantly, but calculations could be done from looking at the input of the dams. Thermal barriers exist in most years in Osoyoos Lake and at the confluence of the Okanagan River with the Columbia. While snowpack buffers the Okanagan River mainstem, the efficacy of this mechanism is likely to decrease under climate change conditions. It was suggested that future research should examine how Okanagan Chinook interact with the thermal barriers in the Okanagan River and Osoyoos Lake and determine when thermal conditions are approaching lethal levels. It was also recommended that commentary be included on the example of the Okanagan Sockeye to overcome the thermal barriers outlined above.

THREATS AND LIMITING FACTORS TO SURVIVAL AND RECOVERY

PRESENTER A. MAHONEY

The presentation provided an overview of the anthropogenic threats and natural limiting factors affecting the recovery of Okanagan Chinook Salmon. Threats were ranked based on their likelihood of occurrence, level of impact, causal certainty and threat extent.

DISCUSSION

Fishing Mortality

A participant pointed out that the research document had originally listed the threat of fishing mortality as low but that COSEWIC had stated that fishing was one of the greatest threats to this population. It was recommended that this be updated to include marine fishing and exploitation from fisheries within the Columbia River. This was followed by general discussion around the different fisheries within the Columbia River and whether or not they were mark-selective. A participant asserted their concern that using exploitation and survival rates from the Wells Hatchery population as a proxy is unlikely to be representative given that they are not subjected to the same number of fisheries upstream and Okanagan Chinook need to migrate further. Another participant inquired if exploitation rates could be split into wild and hatchery. It was suggested that the difference would be approximately 7% between wild and hatchery exploitation. It was recommended that a table of Columbia River fisheries be added to the threats section and to clarify within the document that exploitation rates are generated from a proxy.

Geological Events

A participant recommended the inclusion of land slides caused from the release of slurry from mines in the region.

Hatchery and Aquaculture Impacts

It was recommended that the group consider hatchery effects in a similar way as the Interior Fraser Coho Salmon RPA which considers hatcheries as introduced genetic material as opposed to considering it to be aquaculture.

It was suggested that to consider the threat of aquaculture to Okanagan Chinook that the migratory paths of other Columbia Chinook be analysed to determine if Okanagan Chinook are likely to encounter open net salmon farms in the marine environment.

Linear Development

It was noted that the Okanagan has the highest density of roads anywhere in the province and that the authors should elaborate on that in the narrative section to discuss the threats posed by roads and railways. This assertion should be supported by data from the provincial government.

Water Management

It was recommended that the authors include supplementary support for their decision to rank water management as a medium level threat but that this was based on the assumption that the water management tool used by the Okanagan Nation Alliance is effective.

A participant asked how often in the last 10 years has water temperature gone outside of the normal management range. Twice, once in 2017 and in 2018 which were due to rapid melt and rain on snow melt which led to out of control water management. There were approximately 4 in the last 20 years between unmanageable snow or drought events.

Modification to Catchment Surfaces

During the discussion for this section, it was brought up that while many of the activities associated with this threat are ranked fairly low, we were not considering the impact of cumulative effects. Participants asserted that we need to consider cumulative impacts of how and when things such as diking occur as they can lead to ease of future anthropogenic or agricultural development. It was recommended that a cumulative impacts be noted in the document.

Pollutants

A participant noted that aluminum levels in the Okanagan River are above the lethal dose for Atlantic Salmon. Another participant inquired what the cumulative effects of metals such as zinc, copper and aluminum are on Pacific salmon. Aluminum is known to be naturally high in the Okanagan region, but none of the participants were certain. Further research would be required to improve understanding of this potential threat.

The group suggested that further research into the effects of organochlorines on salmon would be required due to the high concentration of agricultural activities in the area. Additional research into PCB levels in the Okanagan and their impacts on salmon was also suggested.

Invasive Species

It was suggested by a participant that authors need to include narrative around introduced pathogens under invasive species and particularly the uncertainty around this threat. Another participant stated that Smallmouth Bass need to be added to the invasive species list as they are already established in the Okanagan region and will have a large impact on subyearling Chinook. The magnitude of the impact from Smallmouth Bass is most severe on subyearling Chinook due to the bass being most aggressive during the time when juvenile Chinook are emigrating along the river margins. It was also suggested the European Milfoil and Yellow Perch be added to the list of invasive species impacting Okanagan Chinook.

Although there has been no confirmed sighting of Northern Pike in this region, pike have been recorded moving into the Pend Orielle and Columbia systems. It is likely that Northern Pike will be able to colonize in the Okanagan River so it was suggested that they additionally be added to the list of invasive species impacting the recovery of Okanagan Chinook.

Limiting Factors

A participant suggested that the predation section under limiting factors be expanded upon as it doesn't adequately address marine competition. Another participant added that competition with and predation by Northern Pikeminnow should be included in limiting factors.

RECOVERY TARGETS

PRESENTER W. CHALLENGER

The presentation provided an overview of the population viability analysis (PVA) modelling methodology and results. During this session, the recommended recovery targets were also discussed.

DISCUSSION

The first question posed by the group during this session concerned where the values for juvenile survival came from. The data came from data between Rock Island and McNary. There was additional concern over the lack of inclusion of juvenile survival to Rock Island Dam, but the data do not exist.

A participant suggested that the PVA modelling would be strengthened by including survival to the first dam during outmigration for juvenile Okanagan Chinook.

During this session, much of the discussion focussed on hatchery production as a conservation measure. This population is unlikely to recover without hatchery intervention or influx of strays from populations in the US. The recovery target was set for 1,000 fish on average over 12 years (3 generations) and a positive population trajectory. It was asserted several times that the goal should be to operate a hatchery program with natural population principles to rebuild Okanagan Chinook without reliance on hatchery enhancement to persist into the future.

Further discussions centered on the time frame and magnitude of the benefit provided to the population through habitat restoration. While it was deemed to be important and likely beneficial, the group decided to exclude it from simulations due to the uncertainties around specific improvements to the spawning population.

A participant noted that the language surrounding the target needed to specify that this is based on total spawners and that this does not distinguish between hatchery and wild populations.

Another participant commented that the impact of the reduced fitness from hatchery fish was not included in the PVA. This was suggested as a future research recommendation

MITIGATIONS

PRESENTER D. ROBICHAUD

The presenter provided information on possible courses of action to mitigate threats to the population of Okanagan Chinook.

DISCUSSION

A participant noted that much of the information on hatchery practices at Chief Joe were in the context of spring run Chinook production. Given that the focus of the RPA is on a summer run population, the group suggested that the context be changed to focus on summer run Chinook rearing practices.

The Okanagan Nation Alliance already has habitat restoration programs underway to improve river conditions for Sockeye and Chinook Salmon habitat. It was recommended by the meeting participants that a subsection of "Ongoing Mitigations" be added to the mitigations section of the RPA.

A participant also suggested that there should be more uncertainty included in this section on pinniped predation and the threat of pinniped predation.

ALLOWABLE HARM

PRESENTER H. WRIGHT

During the discussion, what is meant by allowable harm was explained in the context of the SARA process and provided examples of statements that could be made within the RPA.

DISCUSSION

It was recommended that given the low abundance of Okanagan Chinook that any sources of harm will delay the recovery of the designatable unit.

The group recognized it was important to provide examples of how to reintroduce a population using a hatchery in this section and how to deal with hatcheries as both a threat and a mitigation.

APPENDIX A: TERMS OF REFERENCE

Recovery Potential Assessment – Okanagan Chinook (*Oncorhynchus tshawytscha)*

Regional Peer Review Meeting – Pacific Region

May 28-30, 2019
Kelowna, British Columbia

Chair: Nicholas Komick

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.

Okanagan Chinook (*Oncorhynchus tshawytscha*) was designated by COSEWIC as Endangered in an emergency assessment on 4 May 2005. Status was re-examined and designated Threatened in April 2006. In April 2017 status was again re-examined and Okanagan Chinook was designated Endangered, based on very low number of individuals, varying between 19-112 in the last four years.

DFO Science has been asked to undertake a Recovery Potential Assessment (RPA), 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, 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 Okanagan Chinook.

Objectives

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

Biology, Abundance, Distribution and Life History Parameters

Element 1: Summarize the biology of Okanagan Chinook.

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 Okanagan Chinook.

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Okanagan Chinook needs 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 in distribution 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 the Okanagan Chinook

Element 8: Assess and prioritize the threats to the survival and recovery of Okanagan Chinook

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 Okanagan Chinook.

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 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

CSAS Science Advisory Report

CSAS Proceedings

CSAS Research Document

Expected Participants

- Fisheries and Oceans Canada (Ecosystems and Oceans Science, and Ecosystems and Fisheries Management sectors)
- Province of BC
- Academia
- First Nations
- Industry
- Environmental non-governmental organizations

References

COSEWIC. 2017. COSEWIC assessment and status report on the Chinook Salmon *Oncorhynchus tshawytscha*, Okanagan population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 62 pp.

APPENDIX B: WORKING PAPER REVIEWS

CATARINA WOR, FISHERIES AND OCEANS CANADA

1 Major comments

The authors of this Recovery assessment plan did an excellent job in summarizing the available information and evaluating the recovery potential given the element list. A couple points, however, were unclear on the report. These are 1) the apparent uncertainty regarding of independence of Okanagan chinook from other US stocks; and 2) the minimization of potential fisheries impacts on the population. More information regarding these points of concern are given below.

1. Throughout the Recovery Potential Assessment (RPA) report, the language used suggests that it is unclear if the Okanagan Chinook Salmon population is independent from other populations inhabiting areas downstream of the Canadian Okanagan system (e.g., scenario options given under element 12). However, the 2017 COSEWIC report suggests that the Okanagan Chinook population is, in fact, part of a larger metapopulation receiving gene flow from other populations (see page 12 in Braun et al. (2017) and also the Genetic Population Structure section under element 1 in the RPA report). This distinction would be important to determine if the conservation efforts would be a recovery process (from brood currently spawning at the Okanagan) or a reintroduction effort (with brood from US populations that spawn nearby). This item would also relate to the potential impacts of hatcheries, as it is discussed in this report. It seems that there is enough evidence to assume that the Okanagan population is not independent, and therefore, the would be minimal harm from introducing US brood stock in the area. If my interpretation of is incorrect, and if it indeed unclear if the Okanagan salmon is a separate population, I would like to suggest that the authors of this report outline the requirements for a study that would answer the population independence question.
2. The exploitation rates in ocean and Columbia river fisheries were not taken into consideration in many sections of this report. Frequently throughout the report, the authors

state that fisheries impacts are minimal as there are no directed fisheries on the Canadian portion of the river. However the Okanagan population is exposed to harvest in other fisheries throughout its life migration. Is there a specific reason for not considering Columbia river and ocean fisheries? If so, the reason should be stated and explained. It is likely that the Okanagan Chinook has a similar timing and ocean distribution of the Columbia River Summers indicator stock (based on origin an timing). The exploitation rates for that stock is relatively high (greater than 50%) in many of the ocean and river fisheries (Figure 1 – included as Figure 3 in the Science Advisory Report 2019/052). These exploitation rates were taken into account in the population viability analysis, but not in the main body of the text.

2 Specific comments

This section contains comments that are specific to each section in the report. Additional editorial comments are inserted in the word document using track changes.

2.1 Element 1: Summarize the biology of Okanagan Chinook Salmon

The summary biology of the Okanagan Chinook Salmon section is comprehensive and well written. However, additional information regarding current data collection programs for the Okanagan Chinook populations would enrich the section. For example, table 3 only contains data up to 2006. If the data collection program was discontinued after that date, this should be stated in the document.

In addition, a few recent studies highlight declining trends in productivity and in size at age in Chinook Salmon populations in Canada and the US. Although most of these studies are based on hatchery fish information, it is likely that wild salmon populations are similarly affected. See, for example, (Dorner et al., 2018) for trends in productivity and (Ohlberger et al., 2018) for trends in size at age.

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

Despite the fact that information on the Okanagan Chinook Salmon is sparse, the authors do a good job in summarizing the information available. This is evident from Figures 1 and 2 in the report. A few more specific questions relating to the subsections under this item are listed below.

2.2.1 Distribution by Age

In this section the authors describe samples taken of adult fish in river up to 2006. The authors indicate that corresponding maturity data are not available for the sampled fish. What is the rationale not to assume that all fish, older than a year old are not mature (i.e., returning fish)? Also, why no data for recent years is available? Did sampling programs for wild and hatchery components stop? If that is the case, please state so.

2.2.2 Abundance

It seems that most of the information comes from surveys designed to count Sockeye Salmon, would it be possible that the spawning population of Okanagan Chinook is actually larger than the observed? i.e. what is the expected sampling detection? At such small population sizes, small changes in sampling detection could make considerable difference. Also, is abundance information available prior to 2005? Historical trends in abundance might help inform decisions about target population levels.

2.3 element 3: Estimate the current or recent life-history parameters for Okanagan chinook salmon.

2.3.1 growth and mortality

It seems that only in-river fishing mortality is considered in this section. Is there a reason for that? The authors state: “Since there is no fishing pressure currently on Okanagan Chinook Salmon, exploitation rates for hatchery fish are likely not as relevant to the wild stocks as survival rate”.

This statement is likely not true as the Okanagan Chinook Salmon population is exposed to a number of ocean fisheries during their ocean years. Many of those fisheries are not mark selective and therefore may catch Okanagan Chinook. The exploitation rate estimated for the SUM stock for ocean fisheries are likely to be a good proxy to the exploitation rate of the Okanagan Chinook Salmon population.

Figure 4A - I am not sure if Total mortality is an appropriate label as the figure excludes natural mortality (e.g. predation ,disease, etc.). Fisheries mortality and escapement distribution would be a more appropriate label. Also, What is the source of this information? Is this just in-river mortality? Please include color labels in the figure.

Figure 4B - Include color label in the figure.

Figure 7 - Include color label in the figure. Explain what the error bar represent. Also, please provide more information in the body of the text regarding the origin of this information and how it is calculated.

2.4 Element 4: Describe the habitat properties that Okanagan Chinook Salmon needs for successful completion of all life-history stages

Also evaluating Elements 5 and 6.

This section provides an excellent overview of the current state of the freshwater habitat occupied by the Okanagan Chinook population, particularly in respect to how human development may affect water characteristics such as temperature and dissolved oxygen.

Additional information could include trends in water temperature, nutrient composition, plankton community, and pollutants (if that data is available). Recent trends in predator abundance in the freshwater environment might also help inform the habitat conditions. Regarding the Ocean conditions, the authors state that poor ocean survival was associated with poor ocean conditions but Figure 6 does not reflect declines in survival. Is there are reason believe that the Okanagan chinook population has lower survival? Also, What is the current understanding regarding survival conditions in the past 10 years?

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

The concept of residence has been properly applied to the species.

2.6 Threats and limiting factors to survival and recovery of Chinook Salmon

I am finding table 5 very difficult to understand. What are the white lines in between the threats listed? They do not always relate to the threats discussed in the subsections below.

2.6.1 Habitat impacts due to transportation and service corridors (T4)

Could the authors elaborate on the linkage between road development and Chinook habitat degradation? Is this related mainly to vehicle-related wastes or would it also include the impacts of increased access to the watershed?

2.6.2 Population decline due to biological resource use (T5)

Could be added to knowledge gaps: unknown magnitude of fishing impacts outside of the Pacific Salmon treaty area. This includes bycatch in groundfish fisheries.

2.7 Element 8: Assess and prioritize the threats to the survival and recovery of Okanagan Chinook Salmon also evaluating elements 9 – 11

A more explicit priority list of the threats could be done by presenting them in a table with some sort of ranking, listing the most important threats to the less worrisome.

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

Is the estimate of a population size of 2500 fish a result of 1000 spawners? Or were these items set independently? It is unclear to me how the population recovery targets were set. If the target was reached would the population become self-sustained? Or would hatchery additions always be required? Given the current and recent history of the population, the targets seem very high and somewhat unrealistic. In addition, there seems to be major uncertainty regarding the impacts of habitat quality on population capacity and survival.

2.9 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 population dynamics parameters

See comments on Appendix A - PVA report.

2.10 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

Evaluation of habitat demands is appropriate. However, the authors could highlight the uncertainty surrounding habitat quality (i.e. water temperatures and dissolved oxygen) and physiological impacts on the population.

2.11 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.

See PVA review.

2.12 Scenarios for mitigation of threats and alternatives to activities

Most of the proposed mitigation activities are associated with improvements in the freshwater and estuarine environment. However, fisheries impacts are likely to be significant for the Okanagan Chinook population. In the PVA, it was assumed that exploitation rates for ocean and in river fisheries are 25% and 42%, respectively, which is quite high (67% total fishing exploitation rate). If we assume the productivity parameters used in the PVA , U_{msy} would be in between 14% and 43%, assuming marine survival between 1-2% (following Hilborn and Walters (1992) equation:

$$U_{msy} = 0.5 * \log(a) - 0.07 * \log(a)^2$$

In addition, it is possible that stock recruitment parameters are less productive than shown by nearby larger stocks, which would lead to even lower U_{msy} estimates .

Additional initiatives that could help monitoring fisheries impacts and recovery potential, would be to tag all (or a significant portion) hatchery released fish in the Okanagan population with CWT tags. This would allow for direct measurement of exploitation rates in all sampled fisheries.

Table 10 - Threat categorization in this table (high/moderate/low) does not meet the categorization in Table 5 and when the threats were first listed. For example, The threats related to geological events (T10) is set to very high when the threat was first listed and set to low in the table. Also, regarding the reduction in mortality column: is it total or relative reduction? Estimated of mortality reduction seem very high. How is this number calculated? More background into these calculations would be helpful.

Table 10 -Population decline due to biological resource use (T5) - The Okanagan stock probably follows a similar ocean distribution to the SUM hatchery fish. Because of that, the fish is likely caught in many ocean fisheries along the Northeast Pacific. So both Commercial and recreational fisheries are affecting that stock. In the PVA, fisheries harvest rates added up to 67%.

2.13 Threat-mitigation advice details also Elements 16 - 18

2.13.1 Habitat impacts due to agriculture and aquaculture (T2)

The authors pose the following consideration: "If there is acceptance that the Canadian Okanagan population is a genetically distinct unit". Based on the background literature cited in this document, it seems that there is enough evidence that the Canadian Okanagan population is not genetically distinct from other populations spawning in nearby areas in the U.S..

2.13.2 Population decline due to biological resource use (T5)

As mentioned before in this review and as is illustrated in the PVA, the Okanagan chinook are likely to be subject to many fisheries, both commercial and recreational. Both in the lower Columbia River and in the ocean.

2.13.3 Elevated mortality or sub-lethal effects due to climate change (T8)

Add: continuous monitoring of conditions (i.e. temperature, dissolved oxygen, water flow, etc.) both in river and ocean. Continuous monitoring and analysis is an important tool for threat mitigation.

2.14 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.

The reductions in mortality seem high and somewhat arbitrary. It would be good if more detail regarding these estimates and references (published literature or personal communication) were provided.

2.15 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

See comments under Element 19.

2.16 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.

It seems that the determination of this stock as a unique genetically distinct structure is essential to determine if there will be a recovery of the current stock or if a reintroduction (based on US brood) is necessary. Is there any plan to execute a comprehensive study to determine if the Okanagan stock is genetically distinct? If so, expected time lines should be provided. If not, why not?

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

The authors indicate that no human induced mortality could be allowed, but they do not consider the harvest from the ocean fisheries. Please revisit.

2.18 Knowledge gaps and sources of uncertainty

In relation to item: Can physiological limits of Okanagan Chinook Salmon and other salmon populations be predicated by mathematical models?

A: Yes. One could do this by building and individual based model IBM. As long as there is a mechanistic relationship between temperature and survival, this relationship could be incorporated in a modeling framework. In the PVA presented in this document, this could be done by modeling survival to natural causes as a function of temperature or dissolved oxygen availability.

2.19 Review of Population viability analysis

The population viability analysis methods are appropriate and the analysis is well documented. However, I have a few questions regarding the choice for input parameters.

- Choice of carrying capacity of 2400 spawners. This number seems to be high in comparison with the estimate of maximum habitat usage of 1460 spawning pairs. How was the decision made?
- The reductions in mortality implied by habitat improvements seem very high and arbitrarily set. Is more detailed information available?
- It is unclear to me why the 2500 (or 2400?) individuals target was chosen as the target population size recovery.

References

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TOMMY GARRISON, COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION (CRITFC)

This document reviews the CSAS working paper *Recovery Potential Assessment for the Okanagan Chinook Salmon (2019)*. The review of this recovery potential assessment (RPA) is structured in three sections. In the first section I respond to a list of questions provided by the chair. In the second section I comment more generally on several reoccurring themes in the RPA that are important for the authors to consider. The third sections provides comments on specific portions of the RPA and are organized by the 22 elements identified in the Terms of Reference. I have also provided separate editorial comments in the electronic version of this RPA.

Response to provided questions

Is the purpose of the working paper clearly stated?

Yes, the purpose of this paper is stated in the 9th paragraph of the Introduction.

Are the data and methods adequate to support the conclusions?

The authors provide three overall conclusions. The first conclusion is that there remains ambiguity in the genetic origins of this stock and consequently it remains difficult to provide recommended recovery strategies as these strategies would depend on the degree of isolation and uniqueness of the current spawning population. The second conclusion is that hatchery intervention will be necessary to achieve recovery targets. The third conclusion is that there is a general lack of quality data and understanding during several life-stages of Okanagan Chinook. In particular, there needs to better assessments of juvenile rearing habitat quality.

The first conclusion stands more as an issue rather than advice. I appreciated that the authors clearly stated in the beginning of the RPA when describing the genetic population structure (p. 8 and several other sections) that it is *"highly unlikely that genetically distinct, original Okanagan River-sourced population of Chinook Salmon is still reproducibly viable".* However, this conclusion becomes muddled when the authors discuss three genetic scenarios outlined by Davis et al. (2008) when reporting on recovery targets as part of Elements 12 and 13 (pages 41-45) and also in Element 21 (page 60). Since the authors state their stance on the genetic origins of the current Okanagan Chinook spawning population, it would have been clearer if they state their preferred actions for recovery in the conclusions of this report.

The second conclusion is supported by the work of the Population Viability Analysis (PVA) in Appendix A. The PVA does support this conclusion. I have some concerns and suggested improvements for the PVA, but these would likely not change this conclusion. Additionally, I have concerns about the stated recovery targets and whether these targets are realistic given physiological habitat constraints and juvenile rearing capacity limitations. Recovery targets might need to be revised in light of these constraints.

The third conclusion also stands as more of an issue rather than advice. I strongly agree that more comprehensive studies on juvenile rearing habitat should be conducted in addition to gaining a better understanding of whether the lakes in the Okanagan drainage are used primarily as migration corridors or for longer durations of time during juvenile rearing. A key goal of a comprehensive juvenile rearing assessment should be to estimate rearing capacity. This would help to identify whether juvenile rearing habitat is a limiting factor to recovery if the spawning population were to be fully seeded.

Are the data and methods explained in sufficient detail to properly evaluate the conclusions?

Much of the advice and conclusions presented in this RPA are from previous studies and assessments of Okanagan Chinook. It is understandable that the authors did not always explain the data and methods with detail and instead cited the original work. However, there were instances where more thorough explanations of the cited work would have been helpful (e.g. the three estimates of adult spawning capacity in the Okanagan River).

The work of Davis et al. (2008) appears to be the primary source for the conclusion that there remains ambiguity in the genetic origins of this stock. I did not extensively review this paper.

The PVA did provide adequate detail in order to properly evaluate the conclusions, but specific alternatives modeled in the PVA need more description. The structure of the PVA was described and easy to understand, but no description is provided of what in the PVA changed to model the alternative scenarios. For instance, the PVA modeled "Problematic Species" or "Habitat Impact" scenarios but did not describe how this was accounted for in the PVA. Was the Ricker productivity parameter changed or was juvenile out migration survival increased? A description of the assumptions in each of these alternative scenarios needs to be provided in order to determine the credibility of the results.

The authors provided citations to several studies on juvenile rearing habitat in the Okanagan. I did not extensively review these cited studies.

If the document presents advice to decision-makers, are the recommendations provided in a useable form, and does the advice reflect the uncertainty in the data, analysis or process?

A main advice from this RPA is that hatchery intervention is needed in order to achieve recovery targets for Okanagan Chinook. This conclusion is supported with estimates of uncertainty in the PVA by presenting the 1st and 99th percentiles from population projections. Decision-makers will likely be uncertain about what form of hatchery intervention is necessary depending on how the genetic origin of Okanagan Chinook is classified. The authors state their stance on this, but a more conclusive document on the genetic origin classification of the of the current spawning population is needed for decision-makers to reach conclusions on particular hatchery rebuilding strategies.

Can you suggest additional areas of research that are needed to improve our assessment abilities?

There are several additional areas of research that would improve the ability to assess the Okanagan Chinook population. These include:

1. Estimates of pre-spawn survival from Rock Island to Zosel Dam at a minimum should be estimated. Ideally these estimates would extend to McIntyre Dam. It's understandable that estimates are currently not available, but returning Passive Integrated Transponder (PIT tagged fish from the Penticton Hatchery should enable such estimates in the future. With river temperatures regularly exceeding optimal ranges of 13 - 16°C in the summer and early fall months, adult loss to thermal stress and disease could be substantial. Adult loss due to dam passage up to Rock Island Dam are provided in Appendix A. One could potentially estimate survival per kilometer from these estimates to get a very crude estimate of survival from Rock Island to Zosel Dam. Additionally, reporting estimates of pre-spawn survival from Rock Island Dam to spawning grounds on the Similkameen would be insightful if there are such estimates.

2. As stated in the conclusions of the RPA, estimates of juvenile rearing capacity are critical in my opinion to gain a better understanding of life-stage specific limiting factors. The RPA states multiple times that adult spawning capacity is not limiting, but this could have no bearing on the recovery potential of this population if density dependence is strongest at the juvenile life-stage. Even by fully seeding the adult population, it is entirely possible that there is only enough juvenile rearing capacity to support some fraction of the fully seeded adults. Estimates of juvenile rearing capacity will then inform reasonable recovery targets. For instance, there may not be enough juvenile rearing capacity to support a recovery target of 1,000 spawners.
3. There is likely some degree of avian predation in the Canadian Okanagan and certainly in the US portion of the Columbia River. There was little mention of this in the RPA, nor were any estimates provided. A proxy estimate could be derived from PIT tagged Well's Hatchery summer Chinook. PIT tag detections of salmonids on avian colonies can be found at: Bird Research Northwest.
4. A life-cycle model should be developed in order to estimate more realistic population projections for PVA. In general, life-cycle models require more estimates of parameters than standard population dynamic models like the one used in the PVA. This may come as a contradiction given the paucity of data on Okanagan Chinook. However, the current PVA is likely not capturing complex mechanisms that occur during each life-stage such as density dependence during juvenile rearing. Furthermore, life-stage specific parameters could be modeled as function of important environmental factors such as river temperature. This would also help in modeling future climate change scenarios. In general, a life-cycle model will necessitate more assumptions and borrowing of data than the current PVA, but would enable a better understanding of what portions of the life-cycle are currently limiting the recovery of Okanagan Chinook.

General comments

The authors did a great job of summarizing studies on Okanagan Chinook and also relevant Chinook studies from the United States portion of the Columbia River. The information presented was very thorough and provides the necessary context to understand the status and knowledge gaps of the Okanagan Chinook population.

I found several contradictory statements throughout the paper and suggest that the authors attempt to reconcile these statements. This could be done by presenting statements from cited studies in less absolute terms by acknowledging the limitations of the citied study and why these limitations might result in another line of reasoning. Some examples of contradictory statements found in the RPA include:

1. The authors state several times that spawning habitat is not a limiting factor to recovery and that spawning capacity is above recovery targets. The authors also acknowledge that Okanagan summer Chinook return to spawn when river temperatures greatly exceed optimum ranges of 13 - 16°C and that nearly all redds are placed in areas with groundwater influence. It isn't until Element 18, however, that the authors acknowledge that spawning capacity estimates do not include physiological habitat considerations such as optimal temperature and oxygen conditions. Rather than stating multiple times that spawning habitat is not limiting, the authors should attempt to consistently make this statement with the caveat that spawning capacity estimates do not include physiological considerations. Furthermore, these capacity estimates might not consider mesohabitat features such as groundwater influence. Due to this, spawning capacity could be much lower than the numbers reported in this assessment.

a. Furthermore, the conclusion that spawning habitat is not limiting factor to recovery should also be stated with the caveat that Porter et. al (2013) concluded that the Okanagan Conservation Unit is at high risk (100%) of cumulative habitat impacts due to urban, agricultural, roads, riparian altered habitat, and wastewater discharge.

2. In several sections of this RPA the authors state that the Okanagan Chinook population is expected to collapse in the future. This conclusion was drawn from the PVA which did not include the effects of straying. However, the authors also state that genetic analysis (Davis et al. 2008) support the conclusion that the Okanagan Chinook population is genetically exchangeable with U.S. Upper Columbia summer Chinook populations. Consequently, the productivity of the Canadian Okanagan Chinook population is dependent on straying rates from U.S populations. The authors should aim to be consistent with their conclusions and clearly state their opinion on the role that straying has on maintaining the current population. This opinion needs to be consistent with the assumptions and conclusions of the PVA.

In light of (1) in the preceding paragraph, the authors should discuss the stated recovery goal of 1,000 spawners and whether this is a reasonable target given current river temperature regimes on the Okanagan River. One thousand spawners may very well be a reasonable recovery goal, but this number should be given more discussion and debate as it has implications on the degree of hatchery intervention and habitat improvement projects that are needed to achieve this goal. If lower recovery goals are decided upon, some of the scenarios in the PVA that were deemed unlikely to achieve recovery targets would be more viable.

Finally, there is one technical note (also made in other portions of this review) that I would like to emphasize here. Well's Hatchery releases both subyearling and yearling summer Chinook with coded wire tags (CWT) and passive integrated transponder (PIT) tags. The authors need to be careful with what tags are being utilized when reporting estimates of life history parameters derived from these tags. Ideally, the authors should only use tags from subyearling releases as this would be most reflective of the ocean-type life history strategy of Okanagan summer Chinook. Detections and recoveries of tags from yearling releases tend to outnumber those from subyearling releases due to higher juvenile survival rates both in-river and during the first year of ocean residence. The stock assessment model utilized by the Pacific Salmon Commission's Chinook Technical Committee (CTC) fits to the combined return of subyearling and yearling Upper Columbia summer Chinook. As a result, life-history parameters (e.g. survival or maturity) derived from CWTs are made by pooling subyearling and yearling tag codes. Thus, metrics in this RPA that are taken from CTC reports reflect both subyearling and yearling recoveries and the metrics are likely skewed towards yearling fish due to higher survival and recovery of those tags. An attempt should be made to only report PIT and CWT derived quantities from subyearling tag codes or explicitly state the short coming of using estimates of life-history parameters derived from the CTC.

Section comments

Element 1

This section states an important conclusion of this paper in the 'Genetic Population Structure' (pages 7-8) section and that is "*Okanagan population is unlikely to be a longstanding remnant population that is independent from nearby populations"* and *"it is highly unlikely that genetically distinct, original Okanagan River-source population of Chinook Salmon is still reproducibly viable".* For context of the entire paper, I would find it helpful if these statements were made up front in either the Abstract or the Introduction.

The section on 'Interspecific Freshwater Interactions' (pages 8-9) could use more commentary on avian predation which has recently been quantified and researched for Chinook Salmon and steelhead populations in the U.S. portion of the Columbia River. There is likely some impact on U.S. Upper Columbia summer Chinook juvenile migrants, but I am unaware of any report or published paper on this. PIT tag detection data from avian colonies on the Columbia River are available at Bird Research Northwest. Querying databases for PIT tag detections of Well's Hatchery summer Chinook could be insightful and could be used as a proxy for Canadian Okanagan Chinook.

Element 2

As stated in the 'General Comments' section of this review, this report needs to be careful with reporting CWT derived quantities from the CTC. It is unclear whether the CWT derived maturation rates in the 'Distribution by age' section (page 11) were taken from CTC reports or specifically calculated by Antonio Velez-Espino. The CTC reports CWT derived quantities from Well's hatchery by pooling subyearling and yearling tag codes. These estimates of maturity will not represent an ocean-type life history.

In the 'Marine and Estuarine Distribution' section (page 12) the authors state that Upper Columbia summer Chinook likely occupy a wide range of latitudes and movement rates rather than having a more northward migration pattern. The authors do not provide a citation or reason for this conclusion. Examining the distribution of CWT recoveries would suggest a more dominant northward migration pattern.

The trend in abundance presented in Figure 1 (page 13) is similar to other Columbia River Chinook populations that observed very large returns from 2014-2016. It would insightful to correlate these escapement estimates with other estimates in nearby summer Chinook populations such as the Similkameen or the Wenatchee to infer whether the Okanagan population is following a similar trajectory.

In the 'Abundance' section (page 12) the authors state that the Okanagan spawning population from 2007-2012 which number in the 10's were unlikely to have produced the population numbering in the 40's from 2014-2016. Before coming to this conclusion, I would recommend examining adult per spawner estimates in other nearby populations such as the Similkameen or Wenatchee from the same time period, which reflected very high adult-to-adult productivity estimates for most Columbia River Chinook populations. Additionally, summer Chinook smolt-to-adult survival rates could be derived from Well's Hatchery PIT tags which may also corroborate this period of high productivity.

Element 3

In the 'Freshwater Growth and Mortality' section (page 16) the authors should provide more information about the PIT tags used to derive survival estimates. For most years, only subyearling hatchery Chinook have been PIT tagged at Well's Hatchery, but yearling released hatchery Chinook have also been PIT tagged. Also, the timing of these releases has changed over time (switching from May to June) which also result in in-river survival estimates that change depending upon the month of release.

The numbers presented in Figure 4A (page 17) appear to be incorrect. The most recent estimates of the percentage of total mortality reported by the CTC indicate that the percentage of CWTs recovered in escapement has ranged from 32.5 to 48.5% from 2008 to 2017. The percentages presented in 2015 appear to be especially erroneous and indicate that only 11% of CWTs were recovered in escapement.

Again, the authors need to state whether the quantities presented in Figures 4A and 4B (page 17) are directly from CTC reports which would reflect recoveries from both subyearlings and yearling tag codes, or if the quantities are derived solely from subyearling CWTs.

In the ‘Fishing Mortality’ section (page 16-20), the authors state since estimates of juvenile survival are lacking for wild populations, that hatchery fish can be used as a proxy. This is fine, but the authors should at a minimum state the caveats of making this assumption and the direction of bias expected in the estimates. In general, due to differential timing and size-at-release, as well as lack of adaption to natural environments, juvenile hatchery fish often exhibit much different outmigration survival than natural origin fish.

Element 4

Several statements are made in the ‘Spawning’ section (pages 22-24 and in other sections of the report) that spawning habitat does not appear to be a limiting factor for adults and the current spawning capacity is above any recovery target. River temperatures during spawning months are likely a limiting factor for successful adult spawning. Statements about spawning capacity estimates should be presented with the assumptions of the methods used to derive the estimates.

In the ‘Spawning’ section (pages 22-24), it would be helpful if the authors could provide background on the three methods that were used to estimate spawning capacity in the Okanagan River. The authors state that the “channel intersection method” is the most defensible estimate of spawning capacity, but they do not state why. Information about this method would help to understand why the authors think it is the most defensible method.

Elements 8-11

In the ‘Aquaculture’ section (pages 31-32), more information of the future plans of the Kł cp̓əlk̓ stim̓ hatchery in Penticton, B.C would be helpful to the reader. What are broodstock collection goals? How many, where, when and what life-stage are juveniles planned to be released?

In the ‘Dams’ section (pages 33-34) it would be helpful if the authors stated more information about knowledge gaps and the effect that the Okanagan dams might have on the current population. Much of the studies cited are from research on the mainstem Columbia and Snake River where millions have dollars have been spent over decades to retrofit these dams for safe salmon passage. The extensiveness of the facilities at these dams and the scale of these dams themselves are likely different than the dams on the Okanagan River. The conclusions from these studies might not be applicable to the smaller scale dams on the Okanagan River.

In the ‘Invasive and Problematic Species’ section (pages 38-40) the authors should mention the status and ongoing monitoring of the Northern Pike population in Lake Roosevelt above Grand Coulee Dam. Spread of these fish past Chief Joseph Dam could be detrimental for Columbia River salmon populations. This invasive species represents a serious threat to Okanagan River Chinook given the locality of the Okanogan River to Lake Roosevelt.

The ‘Habitat Availability’ (pages 40-41) section has statements that suggest that adult spawning habitat may be more limiting than the estimates reported (1,460 per the “channel intersection method”). In the ‘Habitat Availability’ section it is stated that high water temperatures exceed thermal tolerance limits and the spawning habitat is currently concentrated to a single few-kilometer stretch of river. Thus despite adult spawning capacity not being limiting as stated in other sections of the report, this section states that the concern of hatchery fish competing with natural origin fish for space. This is highly suggestive of mesohabitat features and that the adult capacity estimates could be overestimated by ignoring these features.

Element 12

The conclusion that the PVA suggests a minimum population size of 2,500 and average population size of 5,000 by the year 2050 (pages 41-42) needs to be qualified. What scenarios in the PVA is used to make this conclusion? What were the assumptions of this scenario? The

PVA utilizes standard population dynamic equations and does not consider habitat features or life-stage specific density dependence. The limitations of the PVA should be stated and why ancillary targets are greater than adult spawning capacity estimates.

Element 15

The basis for considering a scenario to be successful when there is greater than a 99% chance of surpassing the management target (page 45-47) should be stated. This is a stringent criterion. Rebuilding strategies for species listed under the Endangered Species Act in the United States are required to have to at least a 50% probability of achieving management targets in specified time frames. Viable rebuilding strategies may be eliminated by only considering plans that have a 99% probability of success.

I would caution against making alarming statements like a "complete collapse of the population is expected" (page 45). This a limitation of the PVA which did not consider the effects of straying nor the planned releases of 15,000 fry from the Penticton Hatchery. These fry would be expected to produce 194 returning adults each year.

Elements 16-19

The 'Rescue Potential' section (pages 51-53) states that "*little suitable rearing habitat is available in the Okanagan River, however the spawning habitat that is currently available is not fully seeded*". This statement deserves more attention and is one of the only sections in the report that acknowledges that recovery potential depends on density dependence or limitations at multiple life-stages. I strongly agree with this statement. This idea also supports using a life-cycle model for the PVA to more adequately account for limiting factors at all life-stages.

Natural system modifications that reduce temperature regimes are worthwhile mitigation actions given that this population currently experiences river temperatures well beyond their optimum range. Drawing cooler water from the bottom of reservoirs described in 'T6' (page 56) should be considered if the cost of such a measure is economically feasible.

Element 21

The authors should restate their conclusion provided in preceding sections of the report that the "*Okanagan population is unlikely to be a longstanding remnant population that is independent from nearby populations"* and *"it is highly unlikely that genetically distinct, original Okanagan River-source population of Chinook Salmon is still reproducibly viable".* This would provide clarity to this section (page 60) so that the reader is not left to choose between the three biological scenarios and their implications for recovery goals and targets.

Appendix A

As stated in other sections of this review, the authors need to be careful with borrowing CWT and PIT-tagged derived quantities reported from other sources such as the CTC. The authors state in this section that "*in-river data on US Okanagan stocks indicate that the fish might mature at later ages (primarily age 5 and 6".* This could be largely a function of using CWTs from yearling hatchery releases. This maturation schedule also would not comport with the ocean-type life history strategy for Upper Columbia summer Chinook populations.

Given the lack of data and estimate of life-history parameters for Okanagan Chinook it is understandable that the authors had to borrow estimates from the US populations. The most sensitive parameters in this PVA are likely the stock-recruitment parameters and this should be emphasized. The stock-recruitment relationship presented in Appendix A is derived from spawners ranging from 7,500 to 35,000 where as spawners in the Okanagan has ranged from the 10 to 50. Depensatory stock-recruitment dynamics are certainly possible given the size of the Okanagan spawning population. Depensatory stock-recruitment dynamics would imply that assumptions about productivity at larger population sizes aren't the same at smaller population sizes. In general, this PVA might benefit from varying more stock-recruitment related parameters.

The population dynamic equations are an adequate representation of the life-cycle of Chinook, but could be improved to consider more accurate estimates of spawning abundance. The authors should consider the effect of strays on the adult spawning population and also pre-spawn survival from Rock Island Dam to spawning grounds.

It appears that the authors used an estimate of in-river harvest and loss to dam passage (which does not include harvest) to estimate adult survival to Rock Island Dam. An alternative to this, which may be more accurate, would use PIT-tags of returning adults detected at Bonneville Dam. Survival which would include both harvest and dam-loss could be estimated to Rock Island Dam and perhaps even Zosel Dam if 100 percent detection probability is assumed.

In order to correctly estimate early ocean survival, the authors need to estimate in-river survival from release at the hatchery to McNary Dam, instead of survival from Rock Island to McNary Dam. Since the survival to age 2 is from release at the hatchery to "age 2", the in-river survival estimate also needs to start from release at the hatchery instead of Rock Island dam. Furthermore, this early ocean survival estimate could be biased if the source of in-river survival data is from subyearling PIT tagged fish and the survival to age 2 is from subyearling and yearling CWTs.

APPENDIX C: AGENDA

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific

Regional Peer Review Meeting

Recovery Potential Assessment – Okanagan Chinook

May 28 to 30, 2019

The Cove Resort, West Kelowna, BC

Chair: Nicholas Komick

DAY 1 – Tuesday, May 28, 2019

Time	Subject	Presenter
9:00	Welcome and Introductions, Housekeeping	Nicholas Komick
9:10	CSAS Overview & Meeting Procedures, Review Agenda	Nicholas Komick
9:45	Review presentations and questions	Catarina Wor / Tommy Garrison
10:30	***Break***	
10:45	Biology, Abundance, Distribution and Life History Parameters	Authors / General Discussion
12:00	***Lunch (not provided)***	
1:00	Habitat and residence requirements	Authors / General Discussion
1:45	Threats and Limiting Factors to Survival and Recovery	Authors / General Discussion
3:00	***Break***	
3:15	Recovery Targets	Authors / General Discussion
5:00	***Adjournment***	Nicholas Komick

DAY 2 – Wednesday, May 29, 2019

Time	Subject	Presenter
9:00	Recap of Day 1, Plan for Day 2	RPR Participants
9:15	Scenarios for mitigation of threats	RPR Participants
10:30	***Break***	
10:45	Allowable Harm	RPR Participants
12:00	***Lunch***	
1:00	Draft SAR	RPR Participants
3:00	***Break***	
3:15	Wrap up	RPR Participants
5:00	***Close and Adjournment***	Nicholas Komick

DAY 3 – Thursday, May 30, 2019

Time	Subject	Presenter
9:00	Recap of Day 2, Plan for Day 3	RPR Participants
9:15	Draft SAR	RPR Participants
10:30	***Break***	
10:45	Finalize SAR	RPR Participants
12:00	***Close and Adjournment***	Nicholas Komick

APPENDIX D: PARTICIPANTS

Last Name	First Name	Affiliation
Alex	Kari	Okanagan Nation Alliance
Baldwin	Casey	Colville Confederated Tribe
Bussanich	Richard	Okanagan Nation Alliance
Candy	John	DFO Centre for Science Advice Pacific
Challenger	Wendell	LGL Ltd.
Dionne	Kaitlyn	DFO Science
Enns	Joe	Okanagan Nation Alliance
Fisher	Chris	Colville Confederated Tribe
Fuller	Chad	Okanagan Nation Alliance
Garrison	Tommy	Columbia River Inter-Tribal Fish Commission Chinook Tech Committee
Gerick	Alyssa	DFO Species at Risk Act program
Grant	Paul	DFO Science
Hall	Peter	DFO SARA program
Holt	Carrie	DFO Science
Hyatt	Kim	DFO Science
Jenewein	Brittany	DFO Resource Management
Kanno	Roger	DFO Science
Komick	Nicholas	DFO Science
Mahony	Amelia	DFO Science
Ogden	Athena	DFO Science
Parken	Chuck	DFO Science
Pearce	Robyn	DFO Species at Risk Act program
Pearl	Andrea	Colville Confederated Tribe
Robichaud	David	LGL Ltd.
Sharma	Rishi	National Oceanic and Atmospheric Administration (NOAA)
Wor	Catarina	DFO Science