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Proceedings of the Pacific regional peer review of the Recovery Potential Assessment – Sakinaw Sockeye

April 25-26, 2017
Nanaimo, British Columbia

Chairperson: Christie Whelan
Editors: Nicolette Watson and Brock Ramshaw

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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

Sakinaw Sockeye (*Oncorhynchus nerka*) was first assessed in 2003 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered. The species was not listed under the Species at Risk Act (SARA), nor a recovery strategy formalized, however, Fisheries and Oceans Canada (DFO) undertook recovery measures to ensure the survival and recovery of the species. The species was reassessed by COSEWIC in 2016 and the status of Endangered was re-affirmed.

These Proceedings summarize the relevant discussions and key conclusions that resulted from a DFO Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting held April 25-26, 2017 at the Pacific Biological Station in Nanaimo, British Columbia (BC), where the working paper for the Recovery Potential Assessment for the Sakinaw Lake Sockeye Salmon was presented for peer review.

In-person and web-based participation included: DFO Science, Species at Risk, Resource Management, Oceans, and Salmon Enhancement Program (SEP) sector staff; and external participants from First Nations, and one consultant.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to the Species at Risk sector to inform SARA recovery planning.

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

INTRODUCTION

Sakinaw Sockeye (*Oncorhynchus nerka*) was first assessed in 2003 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered (COSEWIC 2003). Following the assessment, a national recovery strategy was developed by the Sakinaw Sockeye Recovery Team 2005. Although not formally endorsed, many of the recovery measures were undertaken to ensure survival or recovery of the species. After the 2003 assessment, identifying critical habitat requirements was also recommended based on population viability analysis (Godbout et al, 2004). Different forecasts (Wood and Parken 2004) and updates on smolt emigrations have been documented over the last 12 years including a pre-COSEWIC review in 2015 (DFO 2015). The species was reassessed in 2016 by COSEWIC and the status of Endangered was re-affirmed.

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held on April 25-26, 2017 at the Pacific Biological Station in Nanaimo to review the Recovery Potential Assessment (RPA) for the Sakinaw Lake Sockeye Salmon. The advice in the RPA may be used to inform scientific aspects of the listing decision, development of a recovery strategy and action plan, as well as support regulatory 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 SARA. The advice in the RPA may also be used to prepare for the reporting requirements of SARA s.55.

The Terms of Reference (ToR) for the science review (Appendix A) were developed in response to a request for advice from the SAR program (SARP). Notifications of the science review and conditions for participation were sent to representatives with relevant expertise.

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

Recovery Potential Assessment for the Sakinaw Lake Sockeye Salmon (*Onchorhynchus nerka*) (2017) by Brock Ramshaw, Wilf Luedke and Josh Korman. CSAP Working Paper 2015SAR005.

The meeting Chair, Christie Whelan, 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 CSAS 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, and draft Science Advisory Report (SAR).

The Chair reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying the Rapporteur for each review. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions 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, 27 people participated in the RPR (Appendix D). Nicolette Watson was identified as the Rapporteur for the meeting.

Participants were informed that DFO science staff, Lyse Godbout and Jim Irvine had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report to the Species at Risk program to inform recovery planning. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

REVIEW

Working Paper:	Recovery Potential Assessment for the Sakinaw Lake Sockeye Salmon (*Onchorhynchus nerka*) (2017) by Brock Ramshaw, Wilf Luedke and Josh Korman. CSAP Working Paper 2015SAR005.
Rapporteur:	Nicolette Watson
Presenter(s):	Brock Ramshaw

TOPICS OF DISCUSSION

INTRODUCTION

The lead author of the Working Paper, Brock Ramshaw, presented the prepared information on Sakinaw Sockeye in the sections below, which outlined the working paper and addressed the elements of the Terms of Reference. Two formal reviewers provided reviews of the working paper prior to the meeting, and were also given the opportunity to comment on each section below after the information was presented. Questions were raised on the clarity of guidelines for writing and reviewing an RPA, as these guidelines were not publicly available. It was discussed how the guidelines are not complete or finalized and some policies are still being developed and evolving. Having the current RPA guidelines should be easier to find on the CSAS website.

On the second day, the reviewers noted that the abstract of the document is more of a summary than an abstract; an abstract needs to outline major findings of study and how the results lead to the conclusions. Also, the introduction of the working paper did not clearly state the purpose which is to satisfy the objectives of the RPA and there was no reference to a guide for the RPA. The chair concluded that the working paper (once accepted), will be revised before being finalized as a research document. It was noted that the key points of the abstract need to be addressed in the SAR.

BIOLOGY, ABUNDANCE, DISTRIBUTION AND LIFE HISTORY PARAMETERS

An overview of Sakinaw Lake characteristics and historical context was presented. The decline of the Sakinaw Sockeye population and the establishment of the captive brood program were described. The life history stages of Sakinaw Sockeye were described, including the relationship to Kokanee and residual males. Marine distribution and migration was outlined, including timing of adult escapement and delay to spawn timing. The small size of returning adults and low fecundity, compared to other Sockeye populations, was noted. Historical spawning areas were described as well as observed redd size. Egg to fry life stage was outlined, noting that there is a lack of data on egg to fry survival. Fry to smolt life stage and hatchery releases were described in terms of abundance and average survival; it was noted that hatchery fry to smolt survival rate is not related to the number of fry released (no relationship). Data indicates that the average

natural fry to smolt survival is 19% (plus or minus 18%, based on average fecundity, female ratio and contributing adults). Smolts are relatively large compared to other populations, and average smolt migration timing peaks around May 16. Average marine survival is very low, at 0.2% for hatchery fish and 0.5% for natural origin fish.

Meeting participants complimented the lead author on his work but pointed out that the working paper lacks a reference to the Terms of Reference that guides the RPA.

The lead author and some participants pointed out that the large size of smolts historically, and past conditions of the lake, have proved to not be limiting. The last limnological survey was 13 years ago, and is proposed to be updated to determine if the lake capacity has changed or if competition is a factor. Questions on the survival of hatchery releases due to release sites and genetics relatedness of Kokanee and Sockeye in the lake were raised but these questions remain unanswered. We do not know the effects of different release sites and sizes and also don't have enough genetic information from Kokanee to tell if they are genetically distinct or have been hybridizing, or if the releases of hatchery fry are competing with the Kokanee and the Kokanee are actually the source of reestablishment of anadromous fish in the lake (i.e. are we doing more harm than good?). More genetic samples and analysis is warranted, especially of residual Kokanee. The Kokanee and Sockeye population interactions in Sakinaw Lake seem to be an anomaly and need to be better understood. Questions were raised on the population abundance of Kokanee and if it has changed. No formal abundance or catch per unit effort (CPUE) data of recreational Kokanee fishing exists, but it might be worth asking lake resident fishers if the CPUE has changed over time.

Sechelt First Nation representatives pointed out that the First Nation has historical information of their use and harvest of Sakinaw Sockeye and the historical fish weir. This information as well as concerns related to the dam installation documented through time should be included in the working paper. SARP representatives requested to include more information on the marine distribution of Sakinaw Sockeye. However, participants acknowledged that there is a lack of knowledge on the true Sakinaw Sockeye marine distribution since they are not a typical Sockeye population and could utilize the marine environment differently than other populations. Therefore, the marine distribution of Sakinaw Sockeye is a source of uncertainty.

Participants noted that there are issues with both the freshwater and marine survival in that they are chronically low, whereas other populations fluctuate more. Marine survival is the biggest factor that limits rebuilding. It was noted that loss of kelp forests may be affecting early marine survival.

Discussion on the stock-recruit (S-R) analysis concluded that the assumed exploitation rates (ERs) should be removed from the analysis as they could influence the results, and that the Ricker S-R parameters should be tabulated for display in the working paper which would also give the ability to calculate a capacity estimate. Caution must be used and the data converted to make it comparable which could provide a contrast in what the actual production could be.

Participants confirmed that we do not have good enough samples of spawning Kokanee genetics to determine if there has been occasional mixing with Sockeye or separate spawning populations. There has only been the identification of the occasional allele that was not in the captive brood genes of Sockeye. We would need a much larger sample size of known origin Kokanee to determine if the populations have been mixing or hybridizing. The minimal samples DFO does have only suggest that the Kokanee and Sockeye are not very different from each other, and not as different as other lakes. Participants also confirmed that the Sockeye effective population size went from 500 fish in historical DNA samples to just over 100 in captive brood program (and is usually about 1/3 to 1/10 of the total population size). It is possible to increase genetic diversity of the Sockeye with Kokanee genes, if needed. However, this could decrease

adaptation of the population, and possibly marine survival, and is not recommended or warranted at this time. DFO has tried to give the returning adults the best chance at spawning in the lake and not taking them for broodstock, but since the survival has been so low, it might be time to start taking them to give the hatchery program the best shot at recovering. Adaptation in the wild might have something to do with mate choice, but we cannot duplicate that in the hatchery and there is has no evidence that genetic diversity loss has negatively affected marine survival of Sakinaw Sockeye. Participants discussed the ratio calculation called proportionate natural influence (PNI) from Ford's (2002) domestication but concluded that due to the fact that the proportionate natural origin brood is 0 that the PNI would be equal to 0.

HABITAT AND RESIDENCE REQUIREMENTS

Spawning habitat requirements were presented as well as findings and historical information on the extent of spawning habitat and required area for a target population size. The creek is critical habitat and the only fish passage in and out of the lake for migration. Marine rearing requirements include unrestricted corridors for migration.

DFO's Guidelines for the Identification of Residence and Preparation of a Residence Statement for an Aquatic Species at Risk (DFO 2015) uses the following four conditions to determine when the concept of a residence applies to an aquatic species:

1. there is a discrete dwelling-place that has structural form and function similar to a den or nest,
2. an individual of the species has made an investment in the creation, modification or protection of the dwelling-place,
3. the dwelling-place has the functional capacity to support the successful performance of an essential life-cycle process such as spawning, breeding, nursing and rearing, and
4. the dwelling place is occupied by one or more individuals at one or more parts of its life cycle.

The SARA definition of residence was described to help determine residence requirements and identification. Spawning area redds are the most critical residence under these guidelines, as they are essential for success. It was identified that the working paper needs to specify that redds are re-used each year on the main spawning beaches, which qualifies the area to be a residence and that the act of building is involved. It was also noted that DFO Science does not recognize and identify critical habitat, but instead provides advice as to what it could be. It was advised that the author be conscious of the terminology as critical habitat is a legal term. Participants confirmed that they loosely use the term critical habitat, and that these points need to be taken back to be reviewed more broadly.

THREATS AND LIMITING FACTORS TO SURVIVAL AND RECOVERY

The lead author described how the threats and limiting factors workshop held in December 2016 used an adapted framework for risk-assessment from the Government of Canada Treasury Board. Definitions of threat and limiting factors were described. Workshop participants scored exposure and impact on these threats and limiting factors where increasing impact and exposure increases risk. Categories of assessment included likelihood of occurrence, level of impact and causal certainty. Population-level threats were described, and threat frequency and threat extent were scored. Results of the scoring showed 1 moderate threat, 4 moderate limiting factors and 5 high limiting factors.

A question was raised on whether or not the report from the December 2016 workshop would be published. Participants described how the workshop followed a risk assessment method developed for salmon and appears to be usable in most situations, whether data rich or poor, and the intent is to produce it with other salmon system results as a set. If a report is published, then the decisions and results from the risk assessment workshops are citable. There was consensus on the decision that the working paper and the SAR need definition sections that are specific and that they are agreeable to definitions used under the SARA.

It was identified that the threats and limiting factors must be in separate tables in the working paper and the SAR. The participants agreed with the previous scoring of the threats and limiting factors. Threats are very important in the RPA and mitigation scenarios for threats must be described, as well as clarity of future prohibitions, such as pollutants and the threats that tankers and marine traffic pose in respect to pollutants, specifically hydrocarbons. Additionally, it was noted that fishing needs to be included as a threat, even though it was scored low. Fishing causes mortality and was designated as a threat by COSEWIC; therefore, the extent of this threat needs to be described in the RPA. Development around the lake also needs to be included as it was mentioned in the COSEWIC assessment. The threats of exposure to fish farms, as well as invasive species, were also noted. There was also discussion on predators as limiting factors, what those predators are, and what the losses to predation are in the marine environment.

There was agreement on how the working paper and the SAR need to address the use of the terms hatchery, non-hatchery, or natural salmon. There was discussion around the threats that the hatchery pose, including domestication and intraspecific competition. Also the limits to freshwater survival, due to transport stress before release, and release strategy were discussed. It was noted that there is not much known on the distribution of fry in the lake and whether the low survival is a hatchery effect, or an environmental effect from releasing them all in one place.

The chair specified that the working paper and SAR need to be clear on what a human-induced threat is and what an environmental limiting factor is. There should also be one table in the RPA on anthropogenic threats and one table for limiting factors. Protection of natural fry and hatchery fry must be similar in the lake habitat. Participants noted that SARA allows the restoration of an extirpated species, but from a Wild Salmon Policy point of view, the Sakinaw population is not a wild salmon population so the CU does not exist anymore, until such time as the generations become wild again. The chair explained that by the COSEWIC definition, the population has not been extirpated until the captive brood hatchery program is discontinued.

Questions were asked about the genetics, including the opportunistic contributions of returning adult males to the captive broodstock, straying (as clipped Sakinaw Sockeye were found in Tzoonie River in 2015), effective populations size, and any evidence we have on Kokanee genes in the Sockeye population. Participants confirmed that we do not know how distinct the Kokanee are from Sakinaw Sockeye and the degree of intermixing is the question as the Kokanee spawn timing is quite spread out, so it is very likely that there is gene exchange and hybrids, but the extent is unknown.

Questions on spawning habitat noted that there is an anthropogenic component on threats to this habitat, but also naturally there could be washouts, logs, etc. The natural component could pertain to activities that have happened in the past that have altered spawning beds. It was noted that this should be included in both threats and limiting factors as threats to habitat that could cause destruction, blocking creek, and historical log storage describe how some causes are anthropogenic, but some causes that could just happen are natural. It was noted that even if some of the threats and limiting factors were scored low, they still need to be listed and scored

as not a concern so there is not speculation on why they were left out. SARP representatives agreed that including threats and limiting factors that were scored low is helpful for future conversations and planning.

Discussion returned to the threat of pollution. It was noted that this includes a range of many pollutant threats, the cumulative effects and the large amount of uncertainty around the impacts. In addition to hydrocarbons from potential spills, these could include algal blooms, other toxins, excess nutrients from aquaculture, and net pen rearing that induces changes in water quality and causes mortality. The chair noted that the potential of these pollutants would likely only affect a portion of the population in the marine environment, and we need to be clear on the cumulative impacts that are permitted.

Threats impacting other species were discussed, including the potential benefits or disadvantages to other species (Element 11). Participants noted that the enhancement of Sakinaw Sockeye is likely negatively affecting Kokanee. The chair also noted that maintaining access to the lake is a benefit to other species such as Coho and Cutthroat Trout. Habitat restoration also has benefits to other species as well. Also noted was the benefit to multiple populations (Sockeye stocks in particular) in the marine environment due to the restrictions to the Sockeye fishery timing and location.

RECOVERY TARGETS

Minimum survival and recovery thresholds were outlined. The criteria to achieve survival thresholds (6 items) and whether Sakinaw Sockeye could meet any of these was discussed. In the proposed policy on survival and recovery, there is a continuum of probability of persistence, and SARP is now setting new goals where the question is: could the survival or recovery thresholds ever be met? It was stated that all salmon Designatable Units (DUs) are fragmented (survival threshold #4). The chair noted that some items do not apply (#1 – very terrestrial focused) and they will need a guidance document for marine species. It was agreed that the population is not stable and will not increase without the continuation of the hatchery captive brood program. A DFO scientist questioned the extent of the financial cost of the hatchery program and asked at which point cost comes into question to enhance the population. Additionally, they proposed the potential of the captive brood program having a detrimental effect over time due to domestication. The chair described that this is a science meeting which includes what needs to be done to attempt to reach targets. From a cost perspective, it is not a DFO Science or SARP program decision.

The lead author continued with the survival and recovery presentation describing the targets that were proposed in 2005 and how the average return continues to be low (since 2004, average return of 328 hatchery and 130 natural). The author also stated that the targets were not achieved mainly due to low marine survival. The Population Viability Analysis (PVA), adapted from the Korman model for Cultus Lake Sockeye (Korman and Grout 2008), was described and how it tracks abundance of 3 stock types (wild, natural, hatchery). The model uses number of smolts by stock type and various inputs (Appendix C of the working paper). The 1992 to 1994, 2001 to 2006, and 2011 to 2014 brood years were used. The results of the PVA with the various scenarios were reviewed and it was described how to reach the higher recovery targets, the spawning habitat area would need to be increased.

A reviewer commented on how more information is needed in the text where model modification was incomplete and not described thoroughly. It was asked how the results of the Ricker model, and the Bayesian fit, can be a good representation with limited years of data. It was confirmed that there are lots of missing data for Sakinaw Sockeye, so the Cultus Sockeye data were used in many cases. A reviewer described how looking at covariation, and standardizing z-scores for

nearby populations, that there was similar variation for Sakinaw Sockeye and Birkenhead Sockeye. The stock recruit data set for Birkenhead Sockeye is more complete, so you could use those data, scale it, and apply to Sakinaw Sockeye. It was suggested that the results would likely be more robust and there would be more confidence in the results.

The lead author noted that based on the results of this model, we need to reach at least 4% marine survival to have a probability of reaching the targets. The question was raised about what is an acceptable probability level. A SARP representative confirmed that management looks for what is achievable. If we want 95% certainty of success, we choose the less ambitious spawner target and manage the population to achieve that.

It was asked if there is any hope of population recovery without increasing marine survival to 4%. Participants suggested that the only recovery strategy that might work to reach recovery targets is to produce a huge number of fry, which would decrease the size of the smolts and potentially removed the depensatory issue. This may be the only way to get a significant increase in survival and learn something more about this relationship. In other systems DFO has encountered the problem of predators controlling the populations where the predators prefer bigger fish and they do this when the larger animals are at low abundance.

Consensus was achieved on the suggestion to add marine survivals of 1%, 2% and 3% to the PVA. This was to be more realistic and to meet the need about the likelihood of achieving these marine survival values. This would also not present an overly optimistic scenario when it may not be possible. A participant also recommended having better interaction with an oceanographer to better anticipate the likelihood of these marine survivals being achieved, and to discuss if the oceanographic conditions the past 15 years are any evidence of what the next 15 will be like. It also stated that if we left the population alone that we might be surprised that the population might do better than what it is currently doing with all effort put into recovering the population. It was also noted that the model could show how much enhancement would have to be increased to reach recovery targets. Finally, it was stated that running the simulation model backwards in time to before the decline might be an opportunity to learn about the unique problem with Sakinaw Sockeye.

A SARP representative stated that the abstract should state what marine survival values it would take to get Sakinaw Sockeye off of the endangered criteria and return it to threatened status.

SCENARIOS FOR MITIGATION OF THREATS

The presentation described mitigation of threats, limiting factors and alternative activities, including predation on all life stages and other causes of mortality. The lead author noted that the removal of predation on Sakinaw Sockeye was to see what the effect of removing early marine mortality would be even though this may not be feasible. A participant pointed out that the results of simulation modeling must be interpreted with caution, but they serve as a tool to understand how one factor is influencing something else (sensitivity analysis), and how it is important to determine what is really driving the model by looking at relative influence of each factor alone instead of just showing that all factors need to be adjusted to make a big difference to the population.

Another participant discussed the types of mitigation experiments that could be done to test the near term depensatory mortality hypothesis. These experiments include holding outmigrating smolts in a net pen in the estuary until the aggregate joins them in the straight and provides the outmigrating smolts a protective shadow effect. If this experiment was to be done, there needs to be something to compare it to, to see if the reason smolts are surviving better is from the manipulation.

A question was raised regarding whether predator composition at the mouth of the creek has changed. When adults return to Sakinaw Lake, it was noted that the mortality River Otters can cause when the Sockeye population abundance is low and very few fish are moving in to the lake each night. Participants discussed how the Strait of Georgia has changed a lot over the past 25 years with respect to major shifts in salmon populations; predator abundance (with seal abundance at its highest point); the marine ecosystem; species composition; water temperature; salinity; and shifts in timing of spring bloom and zooplankton. The fact is that there is a lack of understanding in the effects of these changes. Sakinaw Sockeye are not exhibiting the same behaviour as other stocks, but there is enough imprecision in a lot of the Sakinaw Sockeye data.

The presence and abundance of other fish species in Sakinaw Lake was briefly discussed. Sechelt First Nation representatives confirmed that the province has released large numbers of Cutthroat Trout into the Sakinaw Lake/Ruby Lake watershed in the past (believed to be from Ruby Lake non-anadromous natural stock), but the size of the current population (anadromous or non-anadromous) and downstream contribution from Ruby Lake is unknown. DFO Stock Assessment has collected abundance information of lake rearing Coho smolts emigrating from the lake to the marine environment each year along with the Sockeye smolt assessment, but we have not assessed the number of adult Coho returning to the lake and the Coho stream counts were discontinued years ago. Also, Sechelt First Nation representatives noted that sport fishing of Kokanee has been popular, especially in the past, but only anecdotal information is available from fishers.

ALLOWABLE HARM

In the presentation, the author stated that no allowable harm should be permitted unless the hatchery captive brood program continues. In the marine environment, the exploitation rate (ER) has ranged from 1% to 6.7%, and restrictions to fishing effort in Johnstone Strait since 1997 have reduced ER. It was clarified that marine survival includes exploitation, therefore, the marine survival estimates are post-fishing mortality and the 5% ER does not change the recovery in a significant way. The ER in 2014 was calculated to be only 1% even though it was one of the biggest fishery years for Sockeye ever, but DFO Fish Management confirmed that the fishery was regulated to later in the season (mostly in mid-August) and much of the fishery was on lakes and in the Fraser River area. The ERs presented in the paper included some years where the ER could not be calculated and were assumed. Consensus was achieved that the assumed ER years should be removed from the report. SARP representatives noted that the allowable harm should state that an exploitation rate of 5% is allowed while enhancement continues, and that this needs to be stated in the document and the abstract, instead of no allowable harm. It was suggested by the chair that the author add in additional ER scenarios, including 0% and 10% to show the effect of small changes in ER to the simulations.

A SARP representative noted that there are additional human caused threats, such as habitat degradation, and it was confirmed that these threats are not included in the 5% ER, which only includes fishing mortality. A SARP representative clarified that allowable harm includes allowable destruction of critical habitat, so it was agreed that the statement on allowable harm should include spawning and rearing habitat, and protection of freshwater capacity. The chair agreed that information on this topic should be added but that we do not have data to put a percent allowable harm associated with the freshwater habitat.

The author confirmed that the model shows that the population will decrease to zero quickly without hatchery enhancement and participants confirmed that the benefits of the hatchery outweigh any threats. DFO Science staff stated that hatchery fish are considered wild under SARA, and SARP staff clarified that there are two options of advice to provide here, one where

we do not recommend listing and fishing is allowed to continue, and the other is to list and add additional protections where no harm will be allowed (no fishing).

SCIENCE ADVISORY REPORT

The meeting participants reviewed the draft SAR and worked through the main portions with the chair and lead author. Recommendations and additions were made and the group approved the changes. The draft SAR will be sent to the meeting participants for review and comments following editing after the meeting.

SOURCES OF UNCERTAINTY AND RESEARCH RECOMMENDATIONS

The participants of the meeting assisted in listing the sources of uncertainty to be included in the SAR. There are various sources of uncertainty in the Sakinaw Sockeye data, including lack of data in some areas, limited and unreliable data and these uncertainties are difficult to quantify in many cases. Discussion in the above sections noted uncertainties and the section on research recommendations in the WP attempt to address these data gaps.

DEFINITIONS

It was clear during the meeting and agreed by all participants that many terms need to be clearly defined in the Res Doc and the SAR and that the documents need to be very clear what term is being referred to. These definitions will be specific to the terms used in the documents, and include the specific use of these terms in the SARA process and the Wild Salmon Policy.

CONCLUSIONS AND ADVICE

The chair specified that the Res Doc and SAR will be updated with the recommendations and changes that were discussed during this meeting. If there are parts where more feedback is needed, the chair and lead author will get in touch with that participant. Comments are more relevant to the SAR, and some people will definitely be contacted for help with finishing the SAR and it will be recirculated with a 10 day commenting period. Upon review, if anything contentious arises, a call will be arranged to discuss the disagreeing points. The res doc will not necessarily be sent to anyone for any more review. But the authors will make changes and updates to the analyses that were recommended in the meeting.

Peer review participants were adamant in making sure that it is clear that the original intent of the recovery process is not possible, as this population cannot be considered wild anymore due the extirpation from the wild, the captive brood program and the population will never recover as wild. It has to be clear what this process is trying to recover now, which is a hatchery population and not wild fish.

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Wood, C.C. and Parken, C.K. 2004. Forecasted status of Cultus and Sakinaw Sockeye salmon in 2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/127. 58p.

APPENDIX A: TERMS OF REFERENCE

RECOVERY POTENTIAL ASSESSMENT – SAKINAW SOCKEYE

Regional Peer Review Meeting – Pacific Region

April 25-26, 2017

Nanaimo BC

Chairperson(s): Christie Whelan

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* (SARP). 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 SARP processes including recovery planning.

Sakinaw Sockeye (*Oncorhynchus nerka*) was first assessed by COSEWIC as Endangered in 2003. For various reasons the species was not listed under SARP. As a result a recovery strategy was never formally developed, however DFO undertook recovery measures to ensure the survival and recovery of the species in Canada including habitat restoration, reduction in fishing pressure and a captive brood program. The species was reassessed by COSEWIC in 2016 and the status of Endangered was re-affirmed.

Following the assessment in 2003 (COSEWIC 2003) a national recovery strategy was developed (Sakinaw Sockeye Recovery Team 2005). Although not formally endorsed by the Government of Canada, many of the recovery measures were undertaken to ensure survival or recovery of the species. After the 2003 assessment critical habitat was also recommended based on population viability analysis (Godbout et al, 2004). Different forecasts (Wood and Parken 2004) and updates on smolt emigrations have been documented over the last 12 years including a DFO led pre-COSEWIC review in 2015 (DFO 2015a).

In support of listing recommendations for Sakinaw Sockeye by the Minister, DFO Science has been asked to undertake an RPA, based on 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 SARP. The advice in the RPA may also be used to prepare for the reporting requirements of SARP s.55. The advice generated via this process will update and/or consolidate any existing advice regarding Sakinaw Sockeye

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 Sakinaw Sockeye.

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 Sakinaw Sockeye.

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Sakinaw Sockeye 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 Sakinaw Sockeye's 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 Sakinaw Sockeye

Element 8: Assess and prioritize the threats to the survival and recovery of the Sakinaw Sockeye.

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 Sakinaw Sockeye.

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 Sakinaw Sockeye 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

Participants

- Fisheries and Oceans Canada (Ecosystems Management Branch, Science Branch, and Fisheries Management)
- Province of BC
- Aboriginal communities
- Industry (commercial)
- ENGO
- Sports Fishery Advisory Board

References

COSEWIC. 2003. COSEWIC assessment and status report on the Sockeye Salmon *Oncorhynchus nerka* Sakinaw population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 35 pp.

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Wood, C.C. and Parken, C.K. 2004. Forecasted status of Cultus and Sakinaw Sockeye salmon in 2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/127. 58p.

APPENDIX B: WORKING PAPER ABSTRACT

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.

Sakinaw sockeye (*Oncorhynhcus nerka*) was first assessed by COSEWIC as Endangered in 2003. For various reasons the species was not listed under SARA. The species was reassessed by COSEWIC in 2016 and the status of Endangered was re-affirmed. Following the assessment in 2003 (COSEWIC 2003) a national recovery strategy was developed (Sakinaw Sockeye Recovery Team 2005). Although not formally endorsed by the Government of Canada, many of the recovery measures were undertaken to ensure survival or recovery of the species. Different forecasts (Wood and Parken 2004) and updates on smolt emigrations have been documented over the last 12 years including a DFO led pre-COSEWIC review in 2015 (DFO 2015).

In support of listing recommendations for Sakinaw sockeye by the Minister, DFO Science was asked to undertake an RPA, based on 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 SARA. The advice in the RPA may also be used to prepare for the reporting requirements of SARA s.55. The advice generated via this process will update and/or consolidate any existing advice regarding Sakinaw Sockeye.

Sakinaw sockeye experience a variety of threats and limiting factors. Predation during migration through Sakinaw Creek as an adult and smolt is believed to be a limiting factor, as well as predation during as smolts during the early marine phase. Fry to smolt survival is low for hatchery fish (13%) and believed to be low (~19%) for wild fish, relative to other populations. However, Sakinaw Lake is believed to be productive but competition and predation within the lake could be factor. Even a two fold increase in freshwater survival would not be sufficient to achieve recovery.

The greatest limiting factor is very low marine survival (<0.5%) and there is nothing that can be done to directly mitigate this factor. Under current marine conditions, the recovery of Sakinaw sockeye is not feasible. To sustain this stock, under current conditions, and to prevent another extirpation event, the captive brood program must continue with the annual release of hatchery fry for the foreseeable future.

Fisheries management plans implemented during the 1990s have been effective in reducing exploitation of Sakinaw sockeye. The average exploitation rate for Sakinaw sockeye has been 5% over the last five years (2011 to 2015). Due to very low marine survival and small population size, no allowable harm should be permitted to Sakinaw sockeye or their habitat.

APPENDIX C: AGENDA

Day 1 Tuesday April 25, 2017

Time	Subject
9:00 – 9:30	Welcome and Introduction (Chair)
9:30 – 10:30	Biology, Abundance, Distribution and Life History Parameters
10:30 – 10:45	Break
10:45 – 12:00	Habitat and residence requirements
12:00 – 1:00	Lunch (*not provided – tea room on site*)
1:00 - 2:30	Threats and Limiting Factors to Survival and Recovery
2:30 – 3:00	Recovery Targets
3:00 – 3:15	Break
3:15 – 4:30	Scenarios for mitigation of threats

Day 2 Wednesday April 26, 2017

Time	Subject
9:00 – 9:15	Recap of Day 1, Plan for Day 2 (Chair)
9:15 – 10:15	Allowable Harm
10:15 – 10:30	Break
10:30 – 12:00	Draft SAR
12:00 – 1:00	Lunch (not provided – tea room on site)
1:00 - 3:00	Finalize SAR
3:00 – 3:15	Break
3:15 – 4:15	Wrap up
4:15 – 4:30	Close & Adjournment (Chair)

APPENDIX D: MEETING PARTICIPANTS

Last Name	First Name	Affiliation
Bates	Dave	shíshálh Nation
Brekke	Heather	DFO Species at Risk Program
Bukta	Christine	DFO Resource Management
Burgoyne	Aaron	DFO Salmonid Enhancement Program
Christensen	Lisa	DFO Centre for Science Advice Pacific
Desrochers	Dale	DFO Salmonid Enhancement Program
Folkes	Michael	DFO Science
Godbout	Lyse	DFO Science
Hyatt	Kim	DFO Science
Irvine	James	DFO Science
Korman	Josh	Ecometric Research
Luedke	Wilf	DFO Stock Assessment
MacConnachie	Sean	DFO Science
MacDougall	Lesley	DFO Centre for Science Advice Pacific
MacKinlay	Don	DFO Oceans
Makkay	Kristina	DFO Species at Risk Program
O'Brien	David	DFO Stock Assessment
Pechter	Beth	DFO Fisheries Management
Quinn	Sid	shíshálh Nation
Ramshaw	Brock	DFO Stock Assessment
Shaikh	Sharlene	DFO Species at Risk Program
Silverstein	Adam	DFO Salmonid Enhancement Program
Watson	Nicolette	DFO Stock Assessment
Whelan	Christie	DFO Science
Willis	David	DFO Salmonid Enhancement Program
Wilson	Jim	shíshálh Nation
Withler	Ruth	DFO Science