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Proceedings of the regional recovery potential assessment (RPA) of Bull Trout, *Salvelinus confluentus*, (Saskatchewan-Nelson rivers populations)

June 4–5, 2014 and June 15, 2016
Winnipeg, MB and WebEx

Chairperson – Kathleen Martin
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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

A regional Recovery Potential Assessment (RPA) for Bull Trout (*Salvelinus confluentus*) was held over two meetings, June 4–5, 2014 and June 15, 2016, in Winnipeg, Manitoba and via teleconference/WebEx. The purpose of the RPA was to assess the recovery potential of Bull Trout populations in the Saskatchewan-Nelson rivers based on the Fisheries and Oceans Canada (DFO) National RPA frameworks.

In November 2012, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Bull Trout in the Saskatchewan-Nelson rivers populations as Threatened. Although the species is not currently listed under the Canadian *Species at Risk Act* (SARA), it is classified as Threatened under Alberta's *Wildlife Act*.

The Science Advisory Report resulting from this RPA will provide the information and scientific advice to inform the SARA listing decision. If listed, this scientific advice will also be needed to fulfill SARA requirements, including the development of a recovery strategy, and to support decision-making with regards to SARA agreements and permits.

Meeting participants included experts from DFO, Parks Canada Agency, U.S. Geological Survey, Alberta Environment and Sustainable Resource Development, U.S. Fish and Wildlife Service, and the Canadian Columbia River Intertribal Fisheries Commission.

This proceedings report summarizes the relevant discussions from the peer-review meetings and presents revisions to be made to the associated research documents. The Proceedings, Science Advisory Report and the supporting Research Documents resulting from this advisory meeting are published on the DFO Canadian Science Advisory Secretariat Website.

Compte rendu de l'évaluation du potentiel de rétablissement (ÉPR) à l'échelle régionale de l'omble à tête plate, *Salvelinus confluentus*, (Populations des rivières Saskatchewan et Nelson)

SOMMAIRE

Une évaluation du potentiel de rétablissement (EPR) de l'omble à tête plate (*Salvelinus confluentus*) a eu lieu au cours de deux réunions, les 4 et 5 juin 2014 et le 15 juin 2016 à Winnipeg, au Manitoba, et par téléconférence et WebEx. L'objectif de l'EPR était d'évaluer le potentiel de rétablissement des populations d'omble à tête plate (*Salvelinus confluentus*) de la rivière Saskatchewan et du fleuve Nelson d'après les cadres nationaux d'EPR de Pêches et Océans Canada.

En novembre 2012, le Comité sur la situation des espèces en péril au Canada (COSEPAC) a désigné les omble à tête plate comme étant menacée. Quoique l'espèce ne soit pas actuellement inscrite en vertu de la *Loi sur les espèces en péril* (LEP), elle est désignée comme espèce menacée en vertu de la *Wildlife Act* en vigueur en Alberta.

L'avis scientifique découlant de cette évaluation du potentiel de rétablissement fournira les renseignements et les conseils scientifiques nécessaires pour éclairer la prise de décisions concernant l'inscription de cette espèce en vertu de la LEP. Si l'espèce est inscrite, cet avis scientifique sera également nécessaire afin de satisfaire aux exigences de la LEP, telles que l'élaboration d'un programme de rétablissement, et d'éclairer la prise de décisions concernant les ententes et les permis en lien avec la LEP.

Parmi les participants à cette évaluation figuraient des experts de Pêches et Océans Canada, de l'Agence Parcs Canada, du Geological Survey des États-Unis, de l'Environment and Sustainable Resource Development de l'Alberta, du Fish and Wildlife Service des États-Unis, et de la Canadian Columbia River Inter-Tribal Fishery Commission.

Le présent compte rendu résume les discussions tenues et expose les révisions à apporter aux documents de recherche connexes. Le compte rendu, l'Avis scientifique et les documents de recherche qui découlent de la présente réunion de consultation scientifique sont publiés sur le site web du Secrétariat canadien de consultation scientifique du MPO.

INTRODUCTION

In November 2012, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Bull Trout (*Salvelinus confluentus*) Saskatchewan-Nelson rivers populations (Designatable Unit [DU] 4), as Threatened (COSEWIC 2012). This was the first assessment of the species. Bull Trout is now being considered for listing under the *Species at Risk Act* (SARA).

A Recovery Potential Assessment (RPA) was conducted on June 4–5, 2014 and June 15, 2016 to inform development of a recovery strategy and to support decision-making with regards to SARA agreements and permits. The intent of these meetings, as described in the Terms of Reference (Appendix 1), was to assess the recovery potential of Bull Trout using the National RPA frameworks (DFO 2005, 2007a, b, 2011, 2014). The RPA is a science-based peer review that assesses the current status of a species and possible recovery targets, what is known about its biology, habitat and threats to it or its habitat and potential mitigation measures or alternatives to the threats, and scope for human-induced mortality from threats.

Meeting participants (Appendix 2) included Fisheries and Oceans Canada (DFO; Science, Species at Risk, and Policy), Parks Canada Agency, U.S. Geological Survey, Alberta Environment and Sustainable Resource Development, Alberta Environment and Parks, U.S. Fish and Wildlife Service, and Canadian Columbia River Intertribal Fisheries Commission.

A working paper was drafted and distributed to participants in advance of the first meeting. This report included information on biology, habitat and threats to the species and its habitat. During the second meeting, updates to this non-modelling report included detailed information on the population status and a threats assessment at the HUC8[1] level, and potential mitigation measures or alternatives to threats. A modelling working paper was drafted and reviewed by participants at the second meeting. It included information on growth patterns, stage-specific annual mortality, fecundity-at-stage, population sensitivity, recovery targets (abundance and habitat) and allowable harm. The meetings generally followed the agendas in Appendix 3.

This Proceedings report summarizes the relevant meeting discussions and presents the key conclusions reached during the meetings. Science advice resulting from the meetings is published on the DFO Canadian Science Advisory Secretariat website in the Science Advisory Report series. The technical details supporting the advice are published in the Research Document series. The complete list of references for material cited in this report can be found in the Research Documents (Caskenette et al. 2016, Sawatzky 2016).

DETAILED DISCUSSION JUNE 4–5, 2014

The Chair provided an overview of SARA-related processes beginning with COSEWIC's assessment and designation of Bull Trout, then DFO's recovery potential assessment, and finally the listing process by the federal government. One working paper was reviewed during the meeting which contained information on the species biology, habitat preferences, current status and threats (i.e., Sawatzky 2016). Participants were encouraged to add to or change the material in the working paper, as needed, to ensure that the most accurate information was included. Participants discussed the information presented and suggested revisions for the

[1] Alberta Sustainable Resource Development has moved to standardized watershed units called hierarchical unit codes (HUCs) similar to what is used by the U.S. Fish and Wildlife Service. These spatial units, based on 8-digit Hydrologic Unit Codes (HUC 8), are a series of hierarchical (nesting) hydrological units within a watershed.

working paper. Discussions at this meeting were meant to inform the development of the modelling approach and data inputs for a second working paper. The second working paper was developed following this meeting to provide information related to recovery targets and times to recovery using a modelling approach (i.e., Caskenette et al. 2016).

PRESENTATION – INFORMATION TO SUPPORT THE RPA

Information in support of a Recovery Potential Assessment of Bull Trout (*Salvelinus confluentus*) (Saskatchewan-Nelson rivers populations)

Author and presenter: Chantelle Sawatzky

Species description

An overview of the biology of Bull Trout was provided. There was a discussion about the confusion between Bull Trout and other species. Bull Trout are often confused with Brook Trout (*Salvelinus fontinalis*) and a participant pointed out that they are also mistaken for Lake Trout (*S. namaycush*), for example, in the upper Athabasca and upper North Saskatchewan rivers. There does not appear to be evidence that Bull Trout and Lake Trout hybridize although they look the same, spawn at the same places and at the same time (mid-late September). In the upper North Saskatchewan they were found in the spawning streams at the same time. One participant wondered if fluvial spawning of Lake Trout was common in the Athabasca and North Saskatchewan drainages as they hadn't heard of that anywhere else, at least in areas of overlap with Bull Trout. Bull Trout were found near springs coming into Rock Lake and in upwellings but maybe the difference could be attributed to full fluvial versus upwellings. One participant suggested post-zygotic hybrids of Lake Trout and other *Salvelinus* may not be viable so it might be a post-zygotic mechanism but that would need to be verified through the literature. In the Nahanni watershed in the Northwest Territories, both species occur, but there is no evidence that they occur together in the spawning areas.

Life history diversity

A participant commented that although categorizations are useful (resident[2], fluvial[3], adfluvial[4]), it should be recognized that fluvial life histories are a continuum with a lot of variation in fish movement patterns. Some might move up one stream order and may become a stream resident as an adult before they return to spawn, whereas others might move up two or three stream orders in a system.

One participant asked about the data to support the idea that fluvial Bull Trout migrate around age 2, as they thought it seemed to be a bit early and there is variability around when juveniles leave natal streams. The author will check on this information. Another participant pointed out that for systems where people have looked, there is a continuum (across all dimensions of life history), which is important. There is huge variability in the time of migration, age of migration, and distance migrated. For some systems, it is thought that there is a predominant age, but that seems to vary through time and environmental conditions.

[2] Stream resident fish spend their entire life cycles in flowing waters and spawn in the headwaters of the streams they inhabit.

[3] Fluvial fish reside in larger free-flowing streams or rivers as adults and return to headwater streams to spawn.

[4] Adfluvial fish reside in lakes as adults and return to headwater streams to spawn.

A participant talked about an out-migration study that was conducted at Trestle Creek, Idaho, a tributary to Lake Pend Oreille. Otolith growth patterns were looked at in successfully returning and spawning adult Bull Trout. Based on the otoliths, they determined the age of out-migration for those fish that had spawned and then died. The age that corresponded to a jump in growth was assumed to be the age they out-migrated. They found that the age of out-migration was usually 2 or 3. They also found that fish out-migrate at age 0 and age 1 but very few were found as successful spawners. Across systems there is a shift in ages that are successful under different conditions. That project shows that there are fish that migrate throughout the season as well. There is tremendous variability. Participants were provided with the reference.

Interspecific interaction

A participant suggested that Brown Trout (*Salmo trutta*) and Cutthroat Trout (*Oncorhynchus clarkii*) should not be lumped together as having comparable potential impacts on Bull Trout. The rationale for this is that Brown Trout replaced Bull Trout in streams where Bull Trout numbers declined due to over-fishing. In Clearwater River, there are both Brown Trout and Bull Trout though a replacement could be occurring. In the Waterton River, Brown Trout have totally taken over where Bull Trout once existed. When asked if anyone knew if these two species co-exist, a participant asked whether this meant do they occur in the same areas or whether they are spawning, rearing and using the same habitat throughout their life cycle. After confirming the former, it was noted that in the United States they co-occur in drainages in Montana including the Bitterroot, the Clark Fork and upper Blackfoot. The upper limits of the distribution of Brown Trout overlap with Bull Trout, so they see juveniles together and there must be some interaction. But there is not a lot of work suggesting there is active displacement, rather it is more a numerical replacement as temperatures change and conditions in the streams change (e.g., stream warming related to large fires and climate shifts).

Relevant to this topic is the historic legacy. Bull Trout have been overfished in some areas, and subsequent to that other species have come in and taken over. It is not displacement but replacement. It doesn’t mean that these species are an obstacle to the recovery of Bull Trout, but certainly temperature interactions and habitat changes will complicate the matter. By having Brown Trout in a system it makes angling pressure higher, thereby increasing pressure on Bull Trout. This may be what is happening in the Bow River.

A participant commented that the statement ‘70% of Bull Trout populations are thought to have been extirpated’ is actually referring to a paper about range contraction of Bull Trout in southwestern Alberta. The range contraction information is also misleading in that it would have predated, rather than have been caused by, competitors. The statement implies Brook Trout are the cause, whereas other factors were the cause, and Brook Trout were able to occupy or were moved there (sequential not cause-and-effect). It was likely due to overfishing, habitat degradation and subsequently fragmentation from damming. The author will remove the statement from the working paper.

Special significance

The official fish of Alberta, Bull Trout is the only native char to historically occupy all the drainages of the eastern slopes of Alberta, and is the only native stream-dwelling char species in the North Saskatchewan and Red Deer River basins. Lake Trout also occur in all drainages, but Bull Trout are the only native “stream dwelling” char species.

Bull Trout play an important role in food webs, and given their nature as a high-level predator, may have an important influence on the structure of the food webs. This is different and should be separate from the statement in the research document, “Fluvial and adfluvial Bull Trout link food webs and energy and nutrient flows between habitats". They also link the various populations or subcomponents within the DU so gene flow amongst populations is an important point.

Element 1. The biology of Bull Trout was summarized.

Distribution

The presenter gave a definition of the DU to participants and showed the various DUs for this species in Canada. A participant commented that there is an overlap with the U.S. *Endangered Species Act* (ESU) in the St. Mary River population. This DU overlaps with an already designated Evolutionarily Significant Unit (ESU), a conservation unit in the U.S. Another participant commented that an updated map exists with conservation risks and they will circulate this information to all participants. Core areas were identified in the working paper. These areas were taken from the COSEWIC report and Bull Trout Conservation Management Plan. Core areas are analogous to meta-populations and are considered habitat areas in watersheds with one or more closely linked Bull Trout subpopulations that form a population unit.

A participant pointed out that in Alberta the whole core area assessment was recently updated and changed. The province has moved to a standardized watershed unit called hierarchical unit codes (HUCs), similar to what is used by the U.S. Fish and Wildlife Service. HUCs are a series of hierarchical (nesting) hydrological units within a watershed. So rather than trying to sort out population units, the assessment identified which watersheds Bull Trout are found in. The RPA will be updated with the new areas and assessments. A participant noted that despite the change in areas, the general findings are the same, i.e., things are bad.

Abundance

The presenter explained how the population assessment was undertaken in the working paper. Abundance data were obtained from the Alberta management plan for each of the waterbodies in the Oldman River, Bow River, Red Deer River and North Saskatchewan River basins. This was the same approach used by COSEWIC when they developed the Bull Trout status report. Population status was determined by evaluating relative abundance compared to the most abundant population (Brazeau River) and population trajectory based on the core area assessment.

The Alberta Fish Sustainability Index (FSI) uses slightly different abundance indices and is more quantitative and replicable, but the basic concepts are very similar. The FSI is based on the standardized HUCs. This section will be updated with the new population status and trajectory information. A participant suggested that the approach taken in the working paper should be compatible with the new system.

A participant asked if there has been any comprehensive assessment of extirpated HUCs. The original evaluation made reference to areas where Bull Trout were extirpated but there was no effort to actually identify the extirpated core areas. The new approach has moved away from core areas and focuses on HUCs where Bull Trout have been found in the past and where they currently exist, so it is possible now to identify the percentage of HUCs that are extirpated. A participant asked if there was a formal process or sampling requirement to identify if populations or fish are not present in a watershed. It is general interpretation (whether or not anyone has seen them over the last 20 years) because there is no standardized sampling process. This is confounded by the odd 'wanderer' that shows up. Has there been an attempt to find small watersheds that may have had Bull Trout, for example in the foothills areas (North Saskatchewan, Red Deer, and Athabasca) where we might suspect Bull Trout to have been at one time but we don't have a historic sampling record? At one time this might have been appropriate habitat but we have no records. For historic adult density we look for real data first and then consult historical angling reports, talk to old-timers and retired biologists and ask if there were Bull Trout in an area in the past. Certainty (quality, quantity, timeliness) is ranked around each metric. Stories would rank lower. Good historic photographs and reports of large Bull Trout near Edmonton exist but there are no reports of small fish in the area. It is a judgment call, based on existing evidence. Adults may be moving within the system but the population is based in a different location (e.g., vagrant fish).

Element 2: The recent species trajectory for abundance, distribution and number of populations was evaluated to the extent possible but would be revised following the meeting with the material provided by the Alberta government.

Habitat requirements

The types of habitat where each life history stage and type are found were described in the working paper. There was a suggestion to ensure the 'four Cs' are cold, clean, complex and connected (i.e., change clear in the presentation to complex). A participant pointed out that they need cover which is part of the "complex" habitat or structure requirement.

Spawning and overwintering locations

One of the meeting participants will provide coordinates of where redd locations have been found to the working paper author. As well, there are more recent data on new areas of spawning that need to be added. Another participant wondered what was the point of mapping redds since we are hoping they will move and expand as the species recovers? We know right now that the areas being shown are very important and they have specific threats but they should be considered a bare minimum. There is specific protection for residences and critical habitat under SARA; redds are considered a residence.

A comment was made that a broader definition (holistic) of critical habitat is needed to be more protective of the species. For the Westslope Cutthroat Trout (*O. clarkia lewisi*), critical habitat was considered to be the known reaches of streams occupied by pure (over 99% purity) Westslope Cutthroat Trout. However as we have seen with the Bull Trout in the upper Oldman River, there is quite a bit of variability from year to year in spawning and overwintering habitat use. For example, following a major flooding event four years ago the stream courses changed; Bull Trout which had been spawning in a creek 2 km below a lake changed their spawning location to 6 km upstream, to a different creek above the lake. Within one year they moved to an area never used before. If critical habitat is identified down to specific spawning beds, it might not offer sufficient protection for species recovery. It also needs to include migration routes, overwintering habitat, rearing habitat, etc. The areas identified as critical habitat for a species are designated by the Minister and recommended by the recovery team in the recovery strategy. What we are doing is detailing the important habitat needed by the species throughout its life which lays the framework to identify critical habitat. We should be identifying attributes of what might constitute critical habitat rather than points on a map. The points on the map are provided for information purposes as the extent of spawning habitat in DU4 has not been quantified.

It was also noted that if it can be demonstrated that previous spawning or overwintering areas are no longer used (preferably with reasoning for this) this would be key information supporting the designation of critical habitat. Re-occupancy of areas, should this occur, is a measureable way of assessing whether there is improvement or not. Benchmarking previous circumstances, present circumstances and potential future circumstances, allows for an assessment of trends. This has to be considered within the natural variability in the use of their habitat. The FSI approach provides a tangible measure of recovery by establishing where they were and where they are now.

It was suggested that the provincial process may be timelier in responding to new information about critical habitat than the federal process so using the provincial process may provide more protection for the species. However participants indicated that the provincial process is not necessarily more adaptive than the federal one.

Participants agreed that there is a need for fundamental research into how and why the fish use their habitat and what drives the variability in that use.

Function, features, attributes

Participants reviewed the functions, features and attributes table in the working paper. Functions correspond to a biological requirement for Bull Trout. Features are considered to be the structural component of the habitat necessary for the survival or recovery of Bull Trout. Attributes of the habitat describe how the features support the function for each life stage.

Spawning/incubation

The group agreed that groundwater influence is an important habitat feature for Bull Trout and that Bull Trout and groundwater-influence are inseparable. Participants discussed further and agreed that groundwater needs to be defined because what is meant by groundwater depends on the scale of the influence and whether it is temperature or actually upwelling. There are short-term hydrologic movements where you have strong interaction between surface and ground water. In the U.S. there are streams with long reaches that are colder in summer and warmer in winter because of upstream groundwater influence. Spawning sites are defined by the interactions between ground and surface water (the area of interaction is known as the hyporheic zone). You could influence the hyporheic zone by increasing sedimentation or some strong influence on the hydrologic process in the basin. The major groundwater sources that are influencing temperature might be impacted by different processes.

A participant indicated they were referring to hyporheic interactions. This feature should be highlighted as things that disrupt groundwater flow (hyporheic interaction) are the biggest habitat threat (e.g., loss of cover, roads that alter groundwater flow). This species needs the warmer winter temperatures. The hyporheic and groundwater interactions are complex, and overwintering temperature is always a function of water that has gone underground somehow.

In the north, Bull Trout spawning habitat is always associated with groundwater zones. This connection needs to be established definitively based on experimental evidence, expert opinion or anecdotal observation. Establishing this is important to underlie the process and provide the information base for decision-making. It needs to take into account the variability or uncertainty in the evidence being used to establish a key element of association between the fish and their habitat. Once this is done, the linkage to threats that could potentially alter the connection can then be more definitively established. This will aid in the establishment and implementation of protection regimes. An example would be to look at areas that once had Bull Trout and evaluate winter water temperatures to see if they have changed, then one could look at land-use practices that may have resulted in the change. The author will look at the wording in this section of the working paper to ensure it is captured appropriately.

A few suggestions were put-forward with respect to the table:

- Participants were not sure what exactly was meant by ‘high gradient’ and since the range of water velocities was included, it should be deleted from the table.

- Participants discussed whether turbidity or sedimentation is the issue. Turbidity needs to have specific limits and be linked to the life history or season. The range during the spring freshet can be quite high. The range provided was meant to be for spawning, but one participant pointed out that they may still spawn even when turbidity is high because groundwater is present. A lot of silt coming downstream in mid-winter and landing on the eggs would be a problem for hatching success. Another participant questioned whether the mechanism is associated with substrate or if it is turbidity that influences the spawning success? It is the infilling afterwards and survival of incubating eggs. This is usually associated with substrate concentration so wouldn't a better metric be related to substrate composition? Is there a quantitative predictor of the central tendency of substrate size for Bull Trout incubation and redds? This is difficult as it is dependent on other hydrological features and there is a temporal aspect to it as well. During the incubation period how much sedimentation do you get in the stream, particularly when some of it can be event based? It is associated with some land-use impacts (e.g., quads through streams after spawning).
- Specifying clearly that the temperature limits are associated with successful spawning and incubation.
- The table needs to specify which of these the Attributes apply to:
- general habitat – adult choice of the area to go into, and
- specific habitat to build redds.
- Sub-divide the spawning section of the table to gaining access and choosing the site, location of redds, incubation and survival of eggs and fry.

The author has agreed to further develop this table and send it out to participants for review.

The group discussed whether Bull Trout spawn in sand. Sand may be a fractional component of gravel/cobble substrates but it was agreed that the wording should be changed to gravel/cobble-dominated substrates and sand should be removed from the description. As well, 'Areas with minimal disturbances and low levels of sediment' will be changed to 'Areas with minimal disturbances and low levels of *fine* sediments'. The author asked if the group could provide more accurate velocity ranges. Do the ranges look appropriate? It should be clarified that this is based on observations where spawning has occurred and it may not be the best or preferred habitat. So we are not necessarily providing predictive (or prescriptive) parameters. The author will ensure these caveats are included in the working paper under this section and in the sources of uncertainty section. 'Observed' will be added to the attributes title and 'inferred' will be added to identification of critical habitat.

Young-of-the-year (YOY)

It was suggested that connectivity and ease of connectivity should be added (e.g., between spawning sites and rearing locations).

Juvenile and adult

The group discussed whether adults and juveniles should be separated in the table since the scale of their movement differs. Adult movements may be further (e.g., overwintering to spawning locations and back) than juveniles. Along with distance, where they move may differ. Sub-adults make more random movements whereas adult movements are more purposeful. Adults feed in downstream habitat, move into spawning tributaries to spawn and then move back down to feeding and overwintering areas. A participant also noted that there is seasonality to movements. Summer temperatures may impede migrations in some locations.

Unimpeded access to overwintering and spawning habitats should be included.

Research in the Northwest Territories indicates individuals from age 1–3 remain in natal streams for some period of time. They leave their natal streams and join the adult populations and move based on the stage of their life history. This has not been captured in the table.

If there is more detailed information, it will be added to the table. The Edmonton example of large migrants should be captured to support the large scale movements. Those movements would have been prior to the large dams on the rivers and the rivers may have looked quite different at that time.

Participants discussed whether the temperature presented was historic and if it is no longer available to Bull Trout. The 12 °C value seems cold for the prairies. The daily maximum is way off base for both juveniles and adults. Stream rearing for juveniles can go way above this. For adults, they would have migrated into areas that were well above the presented temperature as well, and they showed movements to thermal refugia. They would have made long migrations (and still do in the Columbia and Snakehead basins) into areas well above 12 °C. It was agreed that the temperature will be more specific and juvenile and adult will be separated in the table to the extent possible. The review paper by Al-Chockhachy et al. (2010) should be included in the working paper.

Information to support the identification of Critical Habitat

- Groundwater (upwellings) (i.e., perennial and seasonal)
- Connectivity (e.g., unimpeded access to overwintering or spawning areas)
- Complexity (e.g., large woody debris)

One participant indicated that connectivity offers dispersal connection, gene flow and potential life history expression, however it should be noted that the size of the network is also important. They need enough suitable habitat(s) for spawning and rearing in order for a population to be large enough to persist. So connectivity plays into that as well, i.e., the juxtaposition of habitats within some defined area. Another participant indicated that they need more than the stream where they spawn; they essentially need the whole watershed. They need the whole watershed to do all the things they do throughout their life history, but there is a critical size to the network of habitat needed. The size is the amount or extent of closely connected habitat that would essentially regulate the size of the population and its diversity and structure. They have the ability to move throughout the watershed and have to have the connectivity to allow that. Isolation analyses have been done for various riverine salmonids (patch network) which indicate Bull Trout need much more habitat than other species, such as Westslope Cutthroat Trout. Connectivity also allows for the reestablishment of populations after they have been extirpated as a result of perturbations. Participants agreed that these ideas regarding essential habitat use for Bull Trout should be captured in the working paper.

A participant noted that we often look at what are the ideal conditions but it should be noted that streams alter and change all the time and that it is important to also capture that statement in the working paper.

Element 4: The habitat properties that Bull Trout need for successful completion of all life-history stages were described as were the function(s), feature(s), and attribute(s) of the habitat. Quantifying how the biological function(s) that specific habitat feature(s) provides varies with the state or amount of habitat, including carrying capacity limits, if any, was not addressed.

Element 5: Information on the spatial extent of the areas in Bull Trout's distribution that are likely to have these habitat properties was not addressed directly as this information was not available.

Residence

SARA defines a residence as "a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating". Residence is interpreted by DFO as being a constructed place (e.g., a spawning redd). The group agreed that Bull Trout do construct a redd, which fits with DFO's interpretation. However, other areas may also fit under the SARA definition. This should be incorporated into this section of the report.

Element 7: The concept of residence applies to this species, and the species' residence was described.

LIMITING FACTORS

This section looked at naturally occurring limiting factors for the species (e.g., specific habitat requirements, competition). A participant commented that the introduction of Lake Trout where they did not naturally occur has had a huge impact on Bull Trout and should be captured in this section. Exotics were included (interactions with introduced species) but participants agreed that it should be moved to the Anthropogenic Threats section.

Element 10: An assessment of any natural factors that will limit the survival and recovery of Bull Trout is captured in the Research Document.

ANTHROPOGENIC THREATS

Fragmentation

Under fragmentation, a participant pointed out that some populations migrate through an area with high harvest pressure that effectively results in fragmentation. Over-harvest is causing a connectivity issue. The same can be said for thermal barriers that reduce connectivity by creating unsuitable thermal habitat that restricts passage between areas that would have been connected at one time. The shift in fish community should be noted, what was once Bull Trout habitat has now become Lake Trout habitat (i.e., the upstream reservoir effect).

The smaller streams act as refugia in the National Park. Hanging culverts result in habitat denial to fish while streams are flooding or are infilled (e.g., culverts and temperature barrier).

Element 6: The RPA didn't quantify the presence and extent of spatial configuration constraints, if any, such as connectivity, barriers to access, etc. Barriers were discussed during the meeting and information is included in the non-modelling research document about barrier locations.

Alteration of natural flow regimes

A participant commented that the loss of peak flow would slow the cleaning of stream beds subsequently causing sedimentation. It should be noted that Bull Trout are adapted to a natural hydrograph so disruption of the hydrograph (flattening or larger than normal peaks) is a disruption in the pattern Bull Trout have evolved under. High flows can be important for migration and access to spawning areas. A shift to more frequent winter flood events and the potential for redd scours threaten Bull Trout populations. This can be aggravated by climate change, timber harvest and clear-cut activities.

Roads

Participants agreed that all linear developments (e.g., roads, pipelines, power corridors, seismic lines) across the landscape lead to a higher risk of impact on Bull Trout, not just roads. The collective impact of linear developments is recognized through both the linear aspect (channelization, altering natural flow regimes, runoff, or increase sediment loading) and increasing human access. Access by motorized vehicles to Bull Trout habitat is considered to be a threat. This needs to be captured in the working paper explicitly – linear developments kill Bull Trout (cause and effect, and correlative mechanisms). For example, diurnal oxygen and temperature fluctuations became more severe near roads, whereas levels were more constant away from roads.

Turbidity and sediment loading

The group discussed the turbidity and sediment loading section in the working paper. A participant thought that they needed to be careful with the wording ‘turbidity and sediment loading’. Turbidity refers to the suspended material and clarity of the water (or even colour of the water) while sedimentation often refers to the material deposited on the substrate. They can have very different effects on fish. The group agreed that this section should be called ‘Suspended and deposited sediments’.

Interaction with introduced species

Participants provided a number of references for Bull Trout and Brook Trout interactions including a range-wide assessment that was conducted in Alberta. They also have lab tests to confirm a cause and effect basis to competitive superiority of Brook Trout over Bull Trout in warm water temperatures and habitats with low complexity, possibly also in systems with resident rather than migratory life histories. These should be captured in the report.

Participants discussed the issue of hybridization. Generally, as anthropogenic perturbations in the environment increase the frequency or potential for hybridization also increases. The group agreed that hybridization between Bull Trout and Brook Trout is currently low, but does exist. Currently it is more common where there is a large congregation of Bull Trout spawning activity and nearby Brook Trout. A few hybrids have been found in the Elbow River, Elk Creek and Waterton River drainages. It is more frequent in some areas of the U.S. Hybrids can be identified by experts with visual cues. Hybrids have been seen in the National Park and in the lower Crowsnest (via the Castle River system). It is unclear whether the incidence of hybridization is increasing. It is not known what the post-zygotic barriers are to having viable offspring between the two species. What is the successful fertility rate of a spawning event between a Bull Trout and a Brook Trout? It could be an increase in wasted reproductive effort if the offspring are not viable. It was agreed that hybridization in this species is a much lesser threat than it is for the Westslope Cutthroat Trout/Rainbow Trout hybridization issue.

It was suggested that as the individual abundances of the population decrease and perhaps as additional anthropogenic influences are exerted in some systems, the likelihood of hybridization could increase and therefore could be considered a future threat. However participants felt that factors other than hybridization would impact Bull Trout in this situation.

Over-exploitation

A participant suggested adding that the catchability of Bull Trout is higher than other species making this species vulnerable. It may be because they evolved in a system of low diversity and they are therefore generalists. There are several relevant references on catchability, vulnerability to harvest, and catch and release mortality by M. Sullivan that should be cited.

There has been discussion of allowing harvest in Kananaskis Lake but it has not yet gone beyond discussion.

There is some evidence for misidentification of salmonids by anglers but the levels have dropped.

Climate change

A participant commented on the notion that the impacts of climate change are speculative, suggesting it is correct, in terms of the absolute hydrologic effects largely around precipitation, but the effects of temperature and changing hydrological regimes are not speculative. There has been and continues to be huge amount of effort put into modelling these effects and it is probably the single greatest research focus concerning impacts to Bull Trout and their response. Another participant commented that they didn't think that results would be speculative but in fact can be modelled and are part of the management background. Even the range of uncertainty is headed in the wrong direction.

Recognizing that stream temperatures are rising may mean that more forest has to be kept on the landscape. Land-use practices (e.g., incentives for retaining in-stream flows) and fishing regulations (e.g., reduce harvest amounts) could be used to mitigate impacts and put in place where effects are likely to be strongest. Also, predictions and capacity to predict where Bull Trout habitats (and networks of habitats) are located is going to be are an important conservation focus (for salvageable populations).

The author will develop the section on climate change in the document and then the group can decide if they want to add it separately under the threats assessment section. References related to modelling climate change impacts on Bull Trout elsewhere in their range should be included in the report. M. Sullivan will send a paper on modelling that was done in Alberta.

At the very least, climate change will exacerbate all of the other problems.

Cumulative impacts

Climate change will be added under this section.

SUMMARY OF BASINS

It was noted that there is grazing in the headwaters throughout DU4 which could impact spawning habitat and erosion. There was no forestry information included in the working paper. That information is available for each of the sub-watersheds so the forestry information (and all the main threats), where available, will be included in the revised report. There are some groundwater reports that may have relevant information for the research document. They will be evaluated and, where appropriate, information from them will be included.

Oldman River Basin

A state of the headwaters assessment has been recently completed, where the Bull Trout distribution was broken down into fourth-order watersheds with calculated road densities in each, as well as erosion risk potential. Recent and more relevant information will be sent to the author.

There is intensive grazing in the headwaters of the Oldman.

Bow River Basin

The threat metrics, like linear disturbance have been rolled up for the HUC8s during the FSI process. Road thresholds were defined and calculated. Pipelines and seismic lines were excluded. They are available internally and will be used in this report. The advantage to the smaller watershed scale (HUC) and FSI is that they better identify where the problems exist.

The author rolled up the sub-basins in the watershed reports to the basin level. The lower-level details can be included in the research document, possibly as an appendix. The SAR may just summarize the information at the basin level.

Red Deer River Basin

Agriculture is outside of the distribution of the species. It is not an issue because they are extirpated where there is agriculture, although Bull Trout used to exist in these areas at one time.

North Saskatchewan River Basin

Some of the State of the Watershed report numbers are dated, and the FSI assessment is considered more appropriate. Often Lake Trout is an introduced population so there is a mixture of native and introduced. Westslope Cutthroat Trout would also be introduced in this watershed, so it is also a mixture of native and introduced. Golden Trout (*O. aquabonita*) should be added as an introduced species in all the watersheds.

Element 6: The presence and extent of spatial configuration constraints, if any, such as connectivity, barriers to access, etc. were discussed but not quantified.

THREAT LEVEL ASSESSMENT

There was a discussion around the level of assessment needed for the threats i.e., do they need to be broken down to the watershed level or whether an assessment at the basin level is appropriate. For the FSI process, the threats are assessed for each HUC but it is possible to evaluate on a broader scale by just looking at the maps. If the threats are linearly accumulating then you can address them at any scale and they will be applicable. On the other hand, if you scale up in space, and the threats accumulate in some other fashion (e.g., geometrically) then the threats have to be addressed individually at the different scales. It was suggested to assess at the basin level and then determine if there is a need to assess at other levels.

Climate change will be added.

The group went through the threats table and began filling it out at the DU level. The references would be added later. The chair filled in the table as the group discussed the threats.

Interactions with introduced species

There are both correlative and causative studies for this threat. Several references that characterize where Brook Trout replace or displace Bull Trout and the range-wide assessment within Alberta were provided. Information can be inferred from elsewhere. There is also expert opinion for this.

Over-exploitation

There are studies from Alberta on over-exploitation. A paper on the assessment of alternative harvest regulations was provided to the participants which uses data from lower Kananaskis Lake to provide evidence that catch and release may not be a sustainable practice.

Incidental harvest resulting from recreational bycatch includes cryptic mortality (hooking or illegal) and handling stress (delayed mortality). Fluvial Bull Trout have high fishing pressure and are fished throughout the growing season. How does this affect their energetics and growth, do they have energy to put into gonad development? How does this affect reproductive success?

Habitat fragmentation

After discussing whether the threats under habitat fragmentation should be left separate (culverts, dams and irrigation canals) or combined, the group decided that they should be kept separate. Some culverts will pass fish at certain flows, the dams in question are generally not passable and the irrigation canals have a different suite of issues.

For culverts, the impact is cumulative, one hanging culvert might not jeopardize the population but 50% will. Medium impacts are the median likelihood across the DU but there are local areas that are considered High. In some cases culverts prevent Bull Trout from reaching historical spawning locations. Once culverts have been fixed, Bull Trout moved back to areas from which they were once excluded.

There are 14 dams, none of which have fish passage though there may be movement downstream. Are there any dams proposed for the next five years? Is this assessing the likelihood of new dams? Are we looking at Bull Trout the way they were (1900s) or how they could be in 2030 if mitigation measures were put in place? What is the recovery target we are aiming at? How does this fit with the threat assessment? How are dams presently affecting the historical habitat? That is a realized threat. For example, dams on northern Saskatchewan have fragmented the populations. Threats to the fragmented populations are higher and more serious because they can cause extirpation. Fragmentation from dams has caused a cumulative effect, if they were not there, the threat from over-exploitation might not be so bad. Adding a new dam to the remaining habitat for a highly perturbed species will negatively impact recovery and would be disastrous for the remaining Bull Trout populations. There is a proposal on the table for a dam on the Athabasca River at the boundary of Jasper National Park that would be a fish barrier. Without a dam it provides a rescue affect to recover downstream populations of Bull Trout. It is a threat to the sustainability of this DU and should be noted in the report.

Details regarding the significance of future dams, if they were to occur, would be captured in the text and not in the table.

One participant wondered if dams and weirs should be separated in the table. Weirs are sometimes passable when the water is high. Some may be in place for municipal intakes, flood control or irrigation. They are generally downstream of the big dams but are not the ultimate barrier. They can be impassible particularly on low water years (High impact). They are generally in areas where Bull Trout have been lost (Low impact). The chair added weirs to the table as a separate category.

There was a discussion around canals and whether they should be combined with weirs but it was decided to leave them separate. Entrainment and population loss occur in the irrigation canals. Bull Trout salvage in canals occurs annually with fish rescues in the Crowsnest area. In some areas, Bull Trout are already lost, but it is difficult to identify which activity caused the loss.

Habitat alteration

Alteration of natural flow regimes

Water withdrawals would be included in this category. Recently there have been altered flow impacts to the Bow River system with flooding in 2013. Measures for flood control in the Bow River are being considered with limited consideration for fish values including off-stream dams, dry dams, and tunnel diversions around Calgary. A participant suggested changing ‘disruption’ to ‘modification’ of natural hydrograph and ‘roads’ to ‘linear developments. There is a broad range of ways that natural flow regimes can be altered, such as diversions and dams with obvious impacts and good data to support them. Other changes, like changes in land-use (e.g., clear-cut logging) may increase the magnitude of peak flows or reduce groundwater inputs through reduced groundwater recharge. However, although it is recognized that there is a connection here, there are less data to support this. Another participant provided a paper from northern Idaho with support for timber harvest influence (Tonina et al. 2008). The High impact selection reflects the current state of the Highwood tributary to the Bow River, whereas the Medium impact reflects areas elsewhere in the DU, such as the North Saskatchewan.

Suspended and deposited sediment

This is related to the change from natural levels. Bull Trout occur in glacial outflow streams where you can’t see more than one centimeter deep. Moreover, Bull Trout are grey and difficult to see in the water. Timing is relevant, since they use the habitat during the time of peak glacier melt in July. At times they are considered sediment-loving fish. The issue of sedimentation is cumulative and pervasive throughout the whole DU. Similar to natural flow regimes, clear-cutting and recreational activity occur throughout the DU (notwithstanding the Parks). Some areas are worse than others.

The following activities could be a source of sediment, all of which should be captured in the working paper:

- Agriculture (cattle grazing, land clearing/cultivation-eastern margins)
- Urbanization
- Land management practices
- Industrial development
- Storm events
- Forestry
- Linear Development practices
- Oil and Gas Development (including possible future threats, proposed fracking, groundwater impacts, seismic lines)
- ATVs unregulated back country access

Alteration of stream temperatures

This section is related to natural and directional changes. In southern Alberta there are observed increases in stream temperatures, even in summer. Daytime temperatures are high even in areas where increased groundwater flow exists. At night, temperatures do fall back down and the habitat becomes a refugium. In areas with increased land-use (e.g., clear-cuts), the streams stay warm at night. Of the nine streams assessed in the Wapiti area, Bull Trout remained in only two, which may be attributed to these types of temperature changes.

Clearly established thresholds for different life stages would be helpful to better understand how temperature changes could impact a population. In the U.S., a modelling exercise was conducted that relates temperature to the presence of juveniles as a measure of the probability of adults moving up into a stream and successfully spawning. It uses a summer (August) mean stream temperature. This temperature was associated with the occurrence of < 150 mm Bull Trout (i.e., juveniles). The study observed a broad geographic distribution and asked the question: At what point along the temperature gradient of streams are Bull Trout present and absent? The study found that as mean temperatures dropped below 10–12 °C, the probability of finding juvenile Bull Trout increased dramatically. We know Bull Trout will use temperatures much higher than that, and that they can use micro-refugia, but the probability of maintaining a population seems to be strongly associated with having a habitat network that is generally colder than 10–12 °C.

The same type of data from Alberta would be very useful. One participant noted that work is ongoing in a remote valley in Jasper, in an Athabasca system that has been instrumented to record temperatures throughout the valley hourly over the next five years. Other recent references relevant to this topic (e.g., MacDonald et al. 2013, Eby et al. 2014, Jones et al. 2014, MacDonald et al. 2014) were identified and distributed to participants.

Others winter season studies are being conducted that have found lower winter temperatures are associated with delayed or unsuccessful egg development. The studies have found that permanent ice cover exists in the winter, instead of gaps in ice cover. The ice was also found to be thicker and water temperatures were lower, in the range of 0.1–0.4 °C and 0.8–1.2 °C. It appears that cold over-winter temperatures are a function of land-use and a lack of groundwater. In areas that are typically cool, like Alberta, winter temperatures can get too low if you don't get the groundwater inputs, resulting in the loss of Bull Trout.

Alteration of groundwater (quantity or quality)

Data on groundwater properties is limited, but changes have been observed. There is more ice and water temperatures are colder, both of which are linked to changes in groundwater. The quality of groundwater includes temperature, and it is colder, but this aspect is addressed in the previous category (alteration of stream temperature). Based on this, it was suggested that the likelihood for alteration of groundwater should be ranked as Likely. One issue is that we don't know how anthropogenic stressors affect groundwater (i.e., cause-effect linkage), although climate change is expected to impact groundwater in a number of ways. For this species we know groundwater is an essential habitat requirement (both quantity and quality), which supports the High impact ranking. It was suggested notes be added indicating the complexity of groundwater inputs and the uncertainty in cause-effect relationships with anthropogenic activities. The information on changes in winter thermal regimes (ice and water temperatures) from natural conditions associated with development should also be captured. Groundwater changes (overland flow, hyporheic flow including subnivean flow and the other deep groundwater flows or upwellings) can alter habitat availability for Bull Trout. The systems are now becoming flashier and recharging of groundwater may not be occurring to the extent it once was. There may be information from seismic exploration relevant to this topic.

Climate change

Climate change is already occurring and the impact is High as there are multiple pathways and intersections of those pathways within individual populations. Modelling potential effects during winter will help to determine changes in the length of seasons. The possibility of a shorter winter season would mean less time for egg incubation. Changes in precipitation may not be the most important effect of climate change in Alberta. Currently most rivers in Alberta, within the range of Bull Trout, are ice-covered in winter.

Modelling results in the Columbia basin include altered hydrologic regimes including winter flooding. If winter flooding increases, there would be increased scour effects which could negatively impact fall spawning species. This is based on winter temperatures and the increasing frequency of rain versus snow. The general change occurs throughout the system but it is much more prominent at moderate or lower elevations and it is less of a driver (less frequent) at higher/colder elevations.

Increased amounts of glacial meltwater are also expected. For example, in the North Saskatchewan River, the glacial input has already occurred and snow melt (rain in the winter) has become a greater issue. Flow in the North Saskatchewan used to be 15–20% glacier water and now it is down to 4% at the park boundary and 2% in the foothills (NSWA 2009).

Rain on snow events will become more likely and systems will become flashier.

Cumulative Impacts

It was suggested that cumulative impacts be added. The group agreed and it was added to the table. Cumulative impacts are known to occur and the ranking was considered Very High. For example in Banff, overexploitation has reduced Bull Trout abundance; this has allowed introduced salmonids to increase, which evidently has prevented Bull Trout from recovering. These impacts were all the result of changes to the habitat. They occurred interactively. Cumulative is therefore a multiplicative integrated effect rather than simply being additive (i.e., the whole is greater than the sum of the parts). Bull Trout have been protected by a zero bag-limit since 1995 and for the most part we are not seeing major improvements. In the areas where improvements are noted it is usually where there are single threats impacting the species.

There are two ways to look at cumulative effects, the addition of multiple stressors to a population or the accumulation of stressors over the life-time of the fish, particularly for these long-lived iteroparous[5] fish.

Other threats

Participants were asked whether they expected the threats to be similar or different since the DU was divided into HUCs. Several thought there would be minor differences. One participant asked about impacts from irrigation. There would be less irrigation in the North Saskatchewan and Red Deer – there are irrigation districts in the Oldman and Bow. Agricultural impacts are greater in the south than in the north.

One participant asked whether exploitation and cumulative impacts would change if they were evaluated at a basin or sub-basin level. Overexploitation is the key driver across all basins or sub-basins. There is some level of protection in Banff National Park, but even there Bull Trout have been impacted by introduced species and loss of habitat. Although over-exploitation is less of an issue in the Parks they may still not be able to recover and recolonize without significant human intervention. A participant noted that for climate effects in Montana, they find that they vary substantially across the watersheds either from a topographic effect or differences in general weather and climate patterns. Another participant indicated that the Alberta watersheds were more similar than that. You would expect to have more sensitivity to climate effects from south to north. There are higher stream temperatures at similar elevations in the Oldman versus the North Saskatchewan. The Oldman might also be less glaciated than the others. There may be more within-basin variation than between-basin variation.

The scale of the assessment is fairly coarse so one would expect to see discernable differences between watersheds. The nature of the threats might not differ but the cumulative impacts may. The FSI does include a threats assessment at the HUC level which can be captured in the

[5] A species is considered iteroparous if it has multiple reproductive cycles over the course of its lifetime.

document as an appendix. Participants will look at that once we have the watershed information to see if it makes sense to include it. The watershed information will be provided to the group.

Participants were asked if predation, parasitism and diseases, and other invasive species (e.g., Rock Snot; *Didymosphenia geminata*) impact Bull Trout. Currently other salmonids are the only identified threat but predation (along with competition and hybridization) could impact Bull Trout depending on the life stage and the non-native species. There may be other issues in the future but there is no evidence of them now.

Are contaminants and toxic substances an issue for Bull Trout? The passes in the Rockies where Bull Trout are found are also where rail traffic, pipelines, etc. are located and spills could be a risk. Point source spills along transportation corridors (rail/road/pipelines) should be added to the Threats. There are also selenium contaminants from coal mines. There are also inputs of polychlorinated biphenyls (PCBs) from glaciers and mercury from snow. There are no data for Bull Trout in Alberta because the fish are not sacrificed for testing.

Nutrient loading from linear development (phosphate) should be included. In the small streams there are summer- and winter-kills resulting from oxygen depletion (increased Biological Oxygen Demand; BOD).

Scientific sampling can cause mortality. If temperatures are warm during the handling of fish this could cause stress. Scientific sampling within Alberta is very limited, but if it does occur there should be some sampling protocol that indicates a maximum temperature above which sampling cannot occur.

Element 8: The threats to the survival and recovery of Bull Trout were assessed and prioritized to the extent possible.

Element 9: Activities most likely to threaten the habitat were evaluated under the new HUC classification scheme as part of the Program Activity Tracking System for Habitat (PATH) analysis.

Element 11: Ecological impacts of threats were not specifically identified for Bull Trout and co-occurring species. Benefits (to Bull Trout and co-occurring species) from threat abatement were not discussed nor were existing monitoring efforts. Knowledge gaps were identified.

Spatial and temporal extent of threats

Participants discussed the spatial and temporal extent of threats. Threats were considered Widespread if they were likely to affect a majority of the range and Local if they were not likely to affect a majority of the range. Chronic threats were likely to have a long-lasting or re-occurring effect on the population while Ephemeral threats were likely to have a short-lived or non-recurring effect on the population.

MODELLING DISCUSSION

Author and Presenter Jennifer Young

Preparations and planning for the modelling component have already been undertaken, including the parameter literature review, deciding on structure and output needed. During this meeting we are looking for feedback prior to the simulations. The plan was to do a stage class population dynamics model with four classes: young-of-the-year (YOY), juvenile, and fast growing or slow growing adults. The two adult life history types were chosen rather than migratory versus resident life-histories. In terms of parameters, the growth curve (i.e., slow and fast growing) affects how all the other parameters are defined. This model can represent a resident (slow) population by setting alpha to zero, a (fast) fluvial population by setting alpha to 1, or a mixed population of any proportion. It will be run for slow growing, fast growing and some combinations of both.

The model assumes that life history type is independent of the life history of the parent (i.e., all fry go into the same stage) and the proportion of life history types within a population is relatively constant (except for environmental variation). If this turns out not to be true, and resident and fluvial populations are independent (and only breed with others of the same type), this scenario can be modeled by running a slow and fast growing population separately and adding them together.

The modelling evaluates elasticities, a measure of sensitivity of population growth rate to perturbation in each parameter by life stage. The goal is to establish a minimum viable population abundance to achieve an acceptable risk of extirpation which differs based on life history stage and depends on how the variance in estimated parameters is defined. Another goal is to establish a minimum area to support that population.

Outputs will be compared for different types of populations (slow growing only, fast growing only, different proportions of mixed). How limited habitat for one stage affects dynamics and abundance will also be explored. This may be a useful tool for managers.

For each life history type the following information is required:

- growth pattern,
- annual survival (by stage),
- age (or size) at maturity,
- lifespan,
- fecundity, and
- The required area per individual (by stage) for living and for spawning (inverse of density).

The model will be generic and will represent generalized numbers for the two life history types to guide decisions. There are few populations with sufficient data to be modelled.

Several growth curves were presented. Mortality information was also provided. Participants were asked to look at the data to see if anything was missing. It was noted that a few estimates in the literature were used for missing data. Egg to fry estimates from Bowerman (2013) appeared useful. There are some estimates of hooking mortality. To evaluate other estimates, allometries with growth parameters will be used to determine mortality estimates in comparison with the few mortality estimates that have been measured. Maximum age is extremely variable in the literature. Participants were asked for input into choosing a mean maximum age with a range around it. Age at maturity seems to range from 5–7 in the literature. Is there a difference in age at maturity between slow and fast growing fish?

Part of the allowable harm process is to identify which threats may cause the most harm (or which mitigations would be the most effective) based on the life history and population dynamics of the species. It is helpful for model interpretation to refer to any and all known quantitative links between harms/mitigations and the life history parameters. Participants were asked if they had any such information.

Discussion about core areas and the FSI/HUCs does not affect the model outputs because the model will be a generic representation of how Bull Trout dynamics react. However, the model refers to a population of individuals that can all (or mostly) breed with each other. So to interpret results in a meaningful way to apply to actual populations, we need to know what a population looks like in whatever terms are being used to group fish. Participants will provide the author with the FSI unit definitions.

Area per individual (density) is important for defining critical habitat (how much area is required for a sustainable population) and also goes into modelling density-dependence. In lieu of maximum density data, the model will use area per individual (API) allometry (Minns 2003) based on fish size. Redd density data will also be used to define physical space needed for spawning. Maximum density is required, where available, for carrying capacity.

Is there any way to represent life history variation other than growth rates? For example, if there are different probabilities for transition to maturity, the length of time at maturity, or multiple spawnings, can they be incorporated into the model? Each type has a different value for the transition, survival and fecundity parameters. Stochastic simulations are done within that so the variability can be defined however we choose. Bull Trout recruitment may be extremely variable between years and there is the potential for generations to overlap so that if there is a failure it will be largely irrelevant to the larger population over time. Probability of a failure of recruitment can be included if it is important (e.g., 20% chance of failure).

Cumulative effects of incidental fishing mortality include shortening the age class distribution. This is noticeable in its affect when you have variable recruitment. Also, a large number of adults in multiple year classes suggest there may be more variable recruitment that is compensated. You can’t have fishing and variable recruitment at the same time. The model should be able to accommodate large versus small year-class strengths and structure. You can have ages up to 12 or only up to 5 as a consequence of fishing that is affected by variable recruitment. The number of adult age classes is important. The author will discuss further with some of the participants off-line before the model is run.

The growth curves were discussed. The Post et al. curve started at age 4 with linear juvenile growth so the figure should be changed. The two blue curves came from different densities of the Kananaskis Lake population and at the time the data were collected (1990s) there was no stocking. There are several lake (three Post references) and river (Bowerman 2013) population curves. The author is looking for help in determining the appropriate growth curves to use. There are limited length-at-age data for Bull Trout. What is more important, the range in growth or the sample size? Variability is extremely important as it drives decline. The models divide out into two broad types, fish that get over 600 mm versus some that stay under 300 mm. Mixed populations occur in Alberta. Lake populations look to have more asymptotic curves versus more linear curves. This can be explored.

What would happen if you looked at variation in size around each age class on the Bowerman curve? Presumably the sample size and variance goes down as the fish get older. The smaller fish would be both fluvial and adfluvial. The older fish would transition to one or the other. Can you see mixtures in the data that went into the model? There are mixes in Alberta beginning as residents and then changing to migratory individuals. We are better off trying to get a generic model rather than trying to model specific populations. There could be four populations from Alberta two of which are in lakes, is this sufficient? We are aiming to capture the variability. There may need to be a fork length to total length conversion done on the data. There are very few very large Bull Trout (700–800 mm range). The Oldman watershed is at the southern end of the range of Bull Trout in the Rockies. There may be some age data available for the modelling from this area. They do have some 800 mm sized fish. These data will be provided. One participant felt that it is more important to know the variation, stream resident fish can get to 10–15 years of age and 40 cm, while big river fish can get to 80–85 cm and it takes them 15–20 years.

Bull Trout can live a long time, but whether they do or not is variable. Oldest observed were thought to be from Montana at 12–14 years as post-spawning mortalities. In Alberta, they are 10–12 years but sampling is very limited and they probably get older than that. There are data from the north (Mochnacz et al. 2013) with maximum age (lifespan) for slow versus fast growing populations. It should be noted that there is a latitudinal influence on the maximum age; they will be older as you go north. For Alberta, one participant suggested 15 ± 5. Do residents or fluvials live longer? Big lake fish must live longer than the residents.

In the Athabasca system in Alberta, which is similar to the North Saskatchewan, the fast growing lake fish females come in at 4 but usually 5–6 years old. That is similar to the stream fish in Tri-Creeks, a few come back at 4 but by 5 and 6 years old, most are mature. The lakes and streams seem to be similar. These sizes are different but the ages are not. Does it matter if we are talking about males or females? The model is female based unless there is a compelling reason to consider survival of males differently. If this is the case, it can be modelled but will be complicated.

One participant noted that the Bowerman (2013) data from Oregon had lower ages and steeper length-at-age curves and it might be better not to use those data. Maybe the system is more productive or warmer than in Alberta.

As most of the populations of Bull Trout are so depressed, current densities will be nowhere near maximum densities for carrying capacity. There are some densities for lake populations which will be provided to the author. There are data from Kananaskis, but it is likely limited by spawning area, not lake area. There are density data from Oregon that may help as some of the size classes use the river differently (R. Al-Chokhachy).

As fishing pressure goes up do fecundity and growth rate go down? Can this be included in the modelling?

Everyone was thanked for their participation and the June 2014 meeting was adjourned.

DETAILED DISCUSSION JUNE 15, 2016

The meeting began with a round of introductions. The Chair reviewed the purpose of the meeting and the Terms of References (ToR). The Chair also went over the SARA listing and RPA processes and pointed out the elements from the ToR that still needed to be discussed.

A participant wondered why there was such a long gap between meetings. The Chair responded that it took that time to develop and run the modelling.

A meeting participant from the Species at Risk Program gave an overview, including the role of the Species at Risk recovery planning process. He reiterated that one objective was to define Critical Habitat for Bull Trout and this begins with the RPA. The Chair clarified that information to support the identification of Critical Habitat, in addition to the other conclusions and advice from the RPA, is provided to the Recovery Team that determines appropriate recovery targets and identifies Critical Habitat.

The Chair went over the elements in the ToR with the group. She explained that at the June 2014 meeting participants decided to use HUCs to be consistent with the provincial assessment. The biological working paper has been updated accordingly, including an assessment of threats at the HUC level.

A participant asked how the RPA process fits into the SARA process. The RPA is the backbone of the process at the federal level for recovery planning. It supports the listing process, the socio-economic analysis, Recovery Team and Recovery Strategy and underpins the Action

Plan. It is also considered for permitting. It is a snapshot in time and is typically done once. It is not updated unless COSEWIC's assessment changes. The Recovery Strategy, once it is written, is reviewed every five years and includes progress against the Recovery Strategy and Action Plan. COSEWIC reassesses the species at least every ten years.

PRESENTATION: ALCES/STELLA OVERVIEW

Presenter: Jessica Reilly

The Alberta Fish Sustainability Index (FSI) is a province-wide planning tool used to bring consistency to individual fish stock assessments. Bull Trout was listed as Threatened in August 2014 in the Eastern slopes of Alberta. In all of the HUC8s, there are 20 functionally extirpated Bull Trout populations. The Bull Trout threat assessment includes seven categories of threats; climate, water quality, water quantity, water flow, competition, fragmentation, and direct mortality. To determine the most important driver(s) in the threat assessment for Bull Trout a model was created using mechanics, hypotheses, and the best available data. Additionally, a cumulative model was developed to make the process more strategic. This model required the creation of dose-response curves. For example, for temperature impacts, they looked at Bull Trout presence/absence data and temperature to develop the dose-response curve. Mean August air temperature was obtained from ALCES Online © and plotted on the dose-response curve for each HUC. Cumulative impacts were modelled using STELLA modelling software.

Discussion

A participant asked how the presenter developed the temperature predictions. Air temperatures were used, although a preliminary model including stream temperature data is being developed. A participant thought it was great that they were looking at temperature but they thought the temperature thresholds looked high compared to recent publications from the northwestern U.S. and thought maybe this is related to the resolution of the model. The participant encouraged looking at spatial models (stream temperature model). They developed a stream-temperature model recently for the watershed they are working on which was a basic multiple-linear regression and their predictive accuracy increased substantially. This could shift the thresholds. The presenter acknowledged that going through the process allowed them to highlight gaps in knowledge and data gaps. They recognized the need to get a better handle on stream temperature.

A participant commented that in the recent publications from the northern U.S. they found that the headwater streams, especially those with groundwater inputs, are less susceptible to climate change influence. Air and stream temperature relationships may be confounded by groundwater inputs and elevation.

In the future, the hope is for Alberta to be able to use the model predictively but they are just not quite there yet. They need to make some assumptions in order to move forward. A meeting participant commented that it tends to be easier to find the relationship between air temperature and stream temperature the further out from headwater streams you get. It may be more informative when looking at the lower end of the river reaches. The presenter responded that they aren't drilling down to the reach level but are focussing more at the watershed level or HUC8 level for now. There are challenges with averaging at this scale as well. The Chair asked if the paper that the participant was referring too could be sent to all meeting participants. The participant agreed to send out it to the group.

A participant asked how far along was the cumulative effects modelling process. The presenter indicated they have drafted all 15 dose response curves and received feedback from the provincial advisory committee. They have built the model in a STELLA platform and also run the model and discussed internally about the differences between the predicted and current FSI scores. They have also used the model to inform which watersheds to focus on for recovery and what actions to take in those watersheds. The model is meant to be iterative, updating dose-response curves as more information becomes available.

The group then discussed STELLA. A participant noted that it was a multiplicative model and asked for clarification if they are multiplying all the scores together. The presenter confirmed that scores are multiplied together and then standardized back to a 5-point score. They are testing this modelling approach.

The plan is to use an adaptive management process for the recovery of Bull Trout. There would be five-year projects in watersheds, controlling sport fishing or restoring habitat. There would be two treatments, a recovery rest periods of 3–5 years (e.g., temporary sport fishing closures) and then either fixing the bad habitat issues or striving for compliance with management best practices. There are good rules in place but compliance and enforcement have been challenging. In some watersheds there will be variations on the treatments (e.g., full, partial, no treatment). The hope is to select two watersheds per recovery unit (i.e., major watershed) to implement these plans. A participant asked what indicators they would be monitoring if they expect to see in improvement population responses for Bull Trout over this period. The presenter said the period should be bumped up to five years. They have seen electrofishing catch rates and occupancy improve. In the Athabasca River, where treatments range from open fishing, some harvest, complete catch-and-release, to seasonal closure, they have seen an increase in Bull Trout catch rates. They need to learn more about what they are expecting to see, certainly increase in catch rates, increase in percentage of sites were Bull Trout are found, maybe shifts in other population parameters. Because they haven't recovered Bull Trout anywhere they will have to learn as they go. They are seeing improvements in lake populations.

A participant asked if they were looking at adults or juveniles. The presenter responded that the model is tied to adults but, in the field they are looking at both adults and juveniles. Sampling methods include both mainstem and tributary electrofishing. A participant commented that their experience with juvenile electrofishing is that they get a huge amount of natural variability and they think it would be difficult to see any positive response, especially based on the suggested time scale.

A participant noted that another study had been conducted using occupancy modelling. The presenter responded that they are moving away from occupancy modelling because they are interested in not only Bull Trout but fish communities as well. Monitoring is going to be based on the HUC8 watershed boundaries and instead of Bull Trout-centric type modelling, they are also sampling for whitefish and grayling and the modelling project will answer questions for all of these species. They have found the FSI helpful in terms of natural variation. They would be looking for large shifts in Bull Trout populations. It has helped them understand what they are trying to achieve. Currently there are five thresholds that are being used for their FSI and the presenter thinks that may be over-reaching a bit. Considering logistical constraint, they might only be able to answer a few more basic questions like, are Bull Trout collapsed or are they doing ok or are they doing really well? They are using more of a community approach.

A participant asked the range for the FSIs. The presenter responded that the range was from 1–5, with 0 for extirpated. The participant then asked what the FSI indicated (i.e., what is the metric?). The presenter said the FSI represented extirpation risk. For adults, they looked at naïve occupancy (% of sites visited where Bull Trout were caught), if those data were not available, then angling catch rates relative to the best angling catch rates in the Province, and then expert opinion. For juveniles, they looked at % hits and generally had enough data for an FSI score. Since it is a blend of scores it is a risk score rather than density or abundance score.

The participant noted this was therefore a probability of a particular location becoming extirpated. The presenter was asked if they considered other ways to combine the FSIs other than by multiplication. The presenter hadn't considered any other ways but was open to other ideas. The participant noted that if it was a probability and you are multiplying the scores but are not using values between 0–1, the model may be doing things other than what you would expect. There is a way to use values of 0–1 instead of 1–5 and you would end up with quite a different response model. To get around the problem it is better to use values from 0–1. For example, if 1–5 were abundance levels, and you were interested in knowing the average abundance given the various parameters that go into the population, then averaging a value between 1 and 5 may be the same thing as if you had used abundance values. If it is a probability that is being multiplied then the results would be different. The participant noted FSIs with categorical levels are very useful when combining various types of data (e.g., abundance, expert opinion). But you should step back and think about what the index is supposed to be a measuring and if you actually had that measure how would you combine that information? For example, for each of the plots where you had the probability of extirpation versus temperature, extirpation versus sedimentation rate, how would you go about combining them? You should be making sure that when you combined categorical values they are consistent with what you would get if you actually used the data that the metric represents.

Another participant suggested considering weighting the different affects. The presenter said that because they always use the same y-axis, they are in fact weighting.

The presenter gave an overview of the results from the modelling. So far, it was only run for the Peace and Athabasca watershed, but they were very pleased with the results. The presenter said they wondered why the model didn't predict accurately in all cases. The FSI wasn't perfect or even correct, as some of the data were older or data existed for only 1/3 of the watershed. They also thought that maybe they missed and didn't account for a major threat. They noticed that at Latornell River near Grand Cash, Bull Trout are functionally extirpated but the model predicted that they should be there. The presenter commented that this model is only looking at current data not historical events (not legacy events). She said that the next question is what would happen if they stocked Bull Trout there? The model suggested that they should be able to exist in the watershed so it was flagged as a potential for feasibility assessment for stocking Bull Trout.

A participant asked if the presenter knew what the angling pressure was in this watershed. The presenter responded that for angling pressure they looked at road density, how roads are positioned in the watershed, proximity to the city and then reached out to local experts to find out about poaching and angling. They took all the information and came up with a fishing mortality rate.

The coarse model was built on assumptions and its doing a good job lining up with what is known about these watersheds. Now that they have these results, they can start asking some really interesting questions, like would it make a difference if they closed fishing? They found that in some watersheds it would make a big difference. A participant asked if a proposed closure would be a complete closure or just no catching Bull Trout. The presenter responded that it would be a complete closure. They also looked at reducing road crossing densities to reduce habitat fragmentation and it didn't jump out as something critical that needs to be done in the watersheds they looked at. As a whole, out of the 15 limiting factors, the factors that came out as important were temperature, fishing pressure and phosphorus. The presenter met with some of the regional biologists about these findings and they created a list of ten watersheds that have potential for Bull Trout recovery and suggested which four watersheds should be focused on for recovery efforts over the next five years.

PRESENTATION: THREATS AND MITIGATIONS

Author and presenter: Chantelle Sawatzky

The author gave an overview of the threat assessment process. Participants were reminded that DFO (2014) provides the guidelines on assessing threats. In the working paper, threats were assessed at the HUC8 level first, then for rolled up to the watershed, and then to the DU level.

The Chair reminded the group that threats are being considered to have an impact at the population level rather than having an impact on individuals. The presenter began by reviewing the threat categories and impact levels from the June 2014 meeting for the DU-level threats assessment, to ensure these levels were still appropriate.

Competition with introduced species

The Chair showed participants the section in the proceedings from the 2014 meeting which captured the discussion about interactions with introduced species. They rated impact High for interaction with introduced species (excluding hybridization) and the likelihood of the threat as Known. In the threat risk matrix this results in a High threat risk. So if Brook Trout are present in the system, the threat will be High. A participant noted that when Brook Trout are found in streams which were occupied by Bull Trout in the past, there are uncertainties about whether they took over the habitat or if they came into the area after Bull Trout left. In the FSI model there needs to be evidence of competition before they are considered a threat not just presence of the species. Evidence of competition relates to abundance (relative to carrying capacity) and whether or not Bull Trout were ever in the waterbody. Participants agreed that for the introduced species category, High level of impact is appropriate. The likelihood of the threat needed to be re-examined. Alberta has to some extent gone beyond the information from the FSI when evaluating threats, since they were published several years ago. The only information on introduced species in the threats assessment is the FSI and that only gives presence and absence of introduced species (not just Brook Trout), and presence or absence of Bull Trout without any other details. Now the province is looking at whether the presence matters. The FSIs will be updated in 2019. The Chair asked if there was any other information they could use to evaluate the threat. One of the participants would try to pull together some additional information to resolve this. This would be captured as an uncertainty in the working paper.

Hybridization with Brook Trout

Hybridization with Brook Trout was discussed. Where Brook Trout and Bull Trout co-occur, the level of hybridizations occurs at a very low level. There are data for the percent of hybrids. It is difficult to imagine that the levels of hybridization would result in the higher impact levels. There was discussion about whether the level of hybridization reflects impact or likelihood. Most of the time there is little hybridization occurring.

One participant asked whether evaluation of impact level considered whether it was reversible (e.g., fixing a culvert to reverse fragmentation, addressing hybridization). The Chair noted that this was likely considered implicitly in the assessment and scoring of impact.

Participants agreed with the High Impact but discussed whether there was sufficient information beyond the FSI that could be used to better describe the risk likelihood at the HUC level. Presence of an introduced species may not be sufficient to know hybridization is a risk. The abundance of the species in an area is important as is the base life history. The base life history of Bull Trout influences competition and hybridization with Brook Trout where they are co-occurring. There is some evidence to suggest higher hybridization rates with stream resident Bull Trout and increased susceptibility to be competitively excluded (i.e., lower competitive ability relative to Brook Trout). This information however is not available from the FSI or fisheries database, so expert opinion would be needed. Some of the information might be available in the previous management plans. The provincial fisheries database has information on catch rates that would help with this part of the assessment and can be used along with area knowledge. Likelihood would be re-examined during discussion about the individual HUCs.

Exploitation - Recreational bycatch

Participants agreed with the High impact.

Habitat fragmentation

In the June 2014 meeting, this category was subdivided into culverts (High impact), dams (Extreme impact), weirs (High impact) and irrigation canals (Medium impact). Participants agreed with these scores.

A participant asked whether a High risk for an irrigation canal in one HUC would result in a High risk for the watershed. The presenter indicated that it would. The threats assessment uses the worst-case scenario.

Habitat alteration

In the June 2014 meeting, this category was subdivided into alteration of natural flow regimes (High impact), suspended and deposited sediments (High impact), alteration of stream temperature (Extreme impact), and alteration of groundwater quality or quantity (Extreme impact). Participants agreed with these scores. Water withdrawals would be captured under alteration of natural flow regimes.

Contaminants and toxic substances

In the June 2014 meeting, this category was added and scored as a High impact. This was only assessed at the Watershed and DU-level.

Nutrient loading

In the June 2014 meeting, this category was also added and scored as High impact. This was only assessed at the Watershed and DU-level.

Climate change

In the June 2014 meeting, this category was assessed at the DU-level only and scored as Extreme impact.

The Chair suggested the group read the section on climate change and send the author feedback. There is more detail in the research document, including mitigations and adaptations, than previously captured in other RPAs.

Interactive and cumulative effects

In the June 2014 meeting, this category was assessed at the DU-level only and scored as Extreme impact.

A participant asked whether entrainment is considered a threat for irrigation canals and dams. The presenter indicated that it is discussed in the working paper but is not given a separate category. They asked about whether research and monitoring is considered a threat. Scientific research was not included as a threat. The Chair agreed that it would be important to include at the DU and watershed level. Whenever there is sampling or monitoring being undertaken there is a risk of harming individuals. When there are few adults in a population this could result in population level effects. The author agreed to include a discussion on sampling and mortality in the working paper.

A participant suggested that if entrainment is captured under dams, then the term would be better changed to hydro power infrastructure. Dam implies only connectivity but in this report, they are only identified as leading to fragmentation. For some RPAs fragmentation is separate from mortality from impingement/entrainment. In Alberta, they have a direct mortality category under which they include angling, bycatch, entrainment, research and monitoring and natural mortality. Under Fragmentation, Alberta includes road crossings, dams, weirs, etc. The author would consider altering the categories to better capture the anthropogenic mortalities.

The author then presented the watershed-level threats table.

A participant asked if there was a time frame for the completion of the RPA reports. The Chair responded that there is a SARA listing decision for Bull Trout scheduled for September 2016 so the documents need to be finalized soon. There will not be time to wait for Alberta to complete their threats assessment (ALCES/Stella) prior to this. The RPA threats assessment was based heavily on the Alberta FSI information. The participant asked if there was a risk of the watershed-level assessment not matching with the Alberta's watershed-level assessment. For example, if the RPA identifies Brook Trout as a High threat to Bull Trout, but Alberta doesn't consider them as a threat, could someone use the RPA to support a Brook Trout eradication effort in a watershed? The information from the threats assessment in the RPA would be used to inform recover efforts by the recover team and would be used to support the listing decision. However differences between the two threats assessments wouldn't limit recovery efforts. It is based on a snapshot in time. Alberta would make decisions about where to focus recovery efforts based on their modelling. The author will add a paragraph in the research document on Alberta's efforts and the STELLA modelling and that it will be updated on an ongoing basis. The Chair clarified that the threats assessment in the RPA flags activities that might need to consider impacts on Bull Trout when the activities are reviewed for permitting and authorizations. The author added that we are producing advice to address the needs of the Department but it should not tie anyone's hands when it comes to managing for the recovery of the species.

The author asked the group to read the section on the individual HUCs and send in changes that are needed. A participant asked if there was a data-deficient option. The author responded that there was an unknown option. The Chair asked the group to send any new or additional information to the author. The Chair also suggested the report author go over the HUCs on separate teleconference calls with individuals more familiar with the specific areas. That way, participants can provide feedback and note any changes that need to be addressed, as well as include relevant context to better understand the threats. The author will update and send the working paper to meeting participants for feedback and comments.

A participant noted that the document doesn't seem to incorporate the idea that fish can move between HUCs and they wondered how that was accounted for. The author responded that is one of the issues with going to this particular spatial classification. Because the threat assessment is based on HUCs which are not isolated, the impact of movement needs to be identified as an uncertainty. A participant commented that when they consider dams, the watershed where the dam is located and any connected watersheds are considered to be impacted by the dam. By doing that they are in a sense scaling up. The author noted that in Appendix 1 prior to each HUC assessment an overview of the watershed is provided.

A participant commented that one of the HUCs they were familiar with is below a dam, but it is a location that historically would never have been has never been a spawning or rearing location for Bull Trout. So some of the threats wouldn't apply (e.g., hybridization with Brook Trout). Adults migrate through and use the area for part of their life cycle for feeding and rearing but it would be a mixed stock area. Maybe this is a detail lost in the framework of the HUC analysis. A participant noted that hybridization in HUCs that only contain migratory adult fish would be scored appropriately if no spawning occurs there. If there is no chance of hybridization because there is no spawning, then there is a threat risk of zero. The author also made note of this in the report. A participant reiterated that some HUC boundaries don't always make biological sense. Alberta is looking at a finer scale analysis (HUC10) for the future. The author will add a comment about this in the report.

Element 9: The threats assessment identified the activities that threaten (i.e., damage or destroy) the habitat properties for Bull Trout and provides some information on the extent and consequences of these activities.

Element 11: There was limited information on the potential ecological impacts of the threats identified Bull Trout and other co-occurring species. There was no information on the possible benefits and disadvantages to Bull Trout and other co-occurring species that may occur if the threats are abated. Alberta is carrying out monitoring efforts. Uncertainties related to this element were discussed and are captured in the reports.

Current and candidate mitigation measures

The Chair commented that the table with the summary of works, projects and activities identifies projects that proponents have submitted for DFO review and authorization. The table gives an indication of the types of activities may be impacting this species in the DU and includes reference to relevant mitigation measures. It may also give a sense of intensity on a watershed basis.

A participant noted that there is a publication linking culverts to changes in stream temperature which may be a new pathway (Maitland et al. 2016).

A participant wondered if they could make a connection between some of the stream crossings and fishing pressure. Another participant responded that they were not sure that level of detail is available in the database. Some might be culvert replacements and not roadbuilding giving access to new areas.

A participant commented that the table doesn't include anything specific about work on dams and weirs. Dams and weirs are considered structures in water and would be captured under instream works or structures in water depending on how the data were entered and categorized. The spreadsheet doesn't identify how many dams and weirs are in the watersheds or how much work has been done on them.

There are some activities and threats where associated pathways of effects have not been described which are discussed separately in the working paper.

A participant asked if the data were in available in a shape file. They are in an Excel spreadsheet with more location details included as well as a shape file that presenter had created. A participant commented that with the recent changes to the *Fisheries Act* reporting requirements had changed so in some cases proponents no longer have to report their activities. So activities which in the past may have been capture were no longer being reported. It would be worth discussing with the Fisheries Protection Program to evaluate the change. The numbers should not be considered “hard” numbers. The chair suggested adding text to the report about the uncertainty with these data. The author will also try to add a map to support the information presented in Table 20.

The group then reviewed the mitigations section in the report text. The author asked the group if there was anything that needed to be added to the exotic/invasive species. In the report, it indicated to use native species with respect to authorized introductions. The participant asked for clarification on what was meant by native species in the report. Is it native to the province, or to the DU? The author will check the National Code on Introductions and Transfers of Aquatic Organisms and see what they used for a definition. Alberta is developing a guidance document on recreation stocking or recovery stocking. The author asked the group to review the bullets in the climate change section and send any feedback. The author also noted that the Westslope Cutthroat Trout Critical Habitat within Bull Trout DU4 is identified in the report.

Element 16: An inventory of feasible mitigation measures and reasonable alternatives to the activities that are threats to the species and its habitat were identified, to the extent possible.

Element 17: The mitigation measures discussed are consistent with the goal of increasing survivorship, by reducing threats to the species directly or indirectly by improving habitat quality.

Element 18: The feasibility of restoring the habitat to higher values was discussed to the extent possible.

Element 19: The reduction in mortality rate expected by each of the mitigation measures or alternatives and the increase in productivity or survivorship associated with each measure were not estimated. There are insufficient data with which to do this.

PRESENTATION: RECOVERY POTENTIAL MODELLING

Recovery Potential Modelling of Bull Trout (*Salvelinus confluentus*) (Saskatchewan-Nelson Rivers Populations)

Authors: Amanda Caskenette, Jennifer Young and Marten Koops

Presenter: Amanda Caskenette

Abstract

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed the Saskatchewan – Nelson River populations of Bull Trout (*Salvelinus confluentus*) as Threatened in Canada. Here we present population modelling in support of the recovery potential assessment of the species. Results include a sensitivity analysis, determination of allowable harm, and minimum viable population (MVP) estimates to inform recovery targets for population abundance and required habitat. The analyses demonstrate that the dynamics of Bull Trout populations are particularly sensitive to perturbations that affect survival of immature individuals. Harm to these portions of the life cycle should be minimized to avoid jeopardizing the survival and future recovery of Saskatchewan – Nelson River populations. To achieve demographic sustainability (i.e., a self-sustaining population over the long term), under conditions with a 15% chance of catastrophic mortality event per generation and a quasi-extinction threshold of 50 adults, the adult Bull Trout abundance needs to be at least 1.9 million adult Bull Trout, requiring 510 km^2 of suitable habitat. Targets for alternative risk scenarios ranged from ~95 adults to ~30 million adults and ~14,000 m^2 to ~4,300 km^2 of suitable habitat and are highly sensitive to the extinction threshold, the probability of catastrophic mortality, and the ratio of individuals from small and large-bodied growth trajectories in the population.

Discussion

A participant asked if the presenter could clarify the type of MVP they were getting for the different life stages because the numbers looked high. The presenter responded that they were getting very high values for the MVP. This is typical of the analysis because of the estimates for survival and fecundity. Another participant asked if they had survival for small populations or only for large populations. The presenter only had survival estimates from populations deemed to be large growth curves based on growth trajectories, although they could have been mixed. The survival estimates are reliant on length at age which is used to estimate instantaneous mortality at unit size. That value is then re-estimated to achieve the desired population growth rate estimates of 1 for stable, maximum growth rate 0.75 and 0.95. So survival was changed to achieve the target population sizes. For MBP, lambda was set to 1. The participant noted that they were seeing similar growth trajectories for juveniles regardless of life history type. The author indicated that YOY and the youngest juveniles were similar sized for all life history types. Another author added that in part what they've done is assumed that there is some size-dependent mortality. This is consistent with some general fish information. It would be better to have survival estimates from these populations but this is how they filled in the data gaps.

A participant asked if the area required per individual was based on body size, not the actual area needed for the fish to carry out all life processes. The presenter responded that it was based on body size. Another other author added that they could think about this as an inverse density. Density is the number of individuals per m^2 and this would be how many m^2 needed per individual. It is based on a relationship of common density for different stream and river habitats developed across freshwater species. It is not particular to salmonids or territorial species. If there were data estimating territory sizes for Bull Trout, those values could be used instead of API estimates. So in theory the 176.4 m^2 is the area needed for an adult to carry out key life processes. Another participant asked if they would be able to integrate redd size into the model if they had an average redd size use for spawning. A participant responded that it would give an estimate of required spawning habitat but, that's only a portion of a life cycle and this number is incorporating all stages of the life cycle.

A participant commented that it was hard to apply this analysis to what they actually see. The Chair stated that these estimates are for the entire DU. They've got a range of what they might be looking at in terms of life history mixtures, the risk of catastrophe, and the life history types. It's presented as numbers based on the modelling to ensure that populations exist for another 100 years. It's not saying this is what the target will be. This is laying out a framework that the recovery teams can use to come up with a target. To improve the estimates they need more data specific to the populations.

A participant asked if the extinction threshold of 50 individuals is tied to effective population size. One of the authors indicated that it is used as a demonstration threshold based on literature values indicating the number of individuals you would need to maintain genetic diversity. There is evidence for populations have fewer individuals and not experience bottlenecks but 50 is a common rule with conservation genetics.

The author included all of the data that was used in the modelling and others can come up with their own estimates using different combinations or different values. The presenter added that equations can be changed around to see what the probability of extinction would be given different numbers of adults.

The Chair asked participants if they would like to see alternative scenarios presented in the research document. A participant thought that it would be useful to see additional scenarios. They will work out some scenarios to be explored and provide to the report author.

A participant asked if there was egg to fry survival in the model. The presenter indicated that the YOY is survival from egg to YOY. The estimates were taken from the literature and include fry survival and estimates from fry to YOY survival which resulted in the wide variety of estimates for YOY survival. It would be good to have an estimate of YOY for the population. A participant commented that they were looking at a recent paper that indicated variable egg to fry survival rate. The author has included values within that range in the modelling. Typically YOY survival would be assumed to be much lower than that. The participant asked whether the variation accounts for density dependence. The author indicated that was the hope. The model doesn't explicitly include the density and change in life history parameters in accordance with density.

A participant asked the presenter to walk them through the allowable harm, including both the allowable chronic harm table and the discussion of allowable transient harm. The presenter explained that the allowable chronic harm is based on the elasticity value from the equation. When they put the elasticity values from the previous graph into the equation it provides a value that when it is between -1 and 0, it gives you an estimate of maximum allowable reduction to that vital rate that would decrease the lambda to 1. Another participant added that this is assuming that you are only affecting the one vital rate. The elasticities are additive. The values may change if different population growth rates were considered. It only makes sense if it is a growing population. You can also use the elasticities in reverse to say how much you have to increase a vital rate, such as juvenile survival, in order to get a population growth rate for a declining population up to be in excess of 1. A participant wondered if the authors would be willing to provide values in a table if they provided some example scenarios. The authors agreed. The Chair commented that it is important to recognize that the modelling can provide a range of possibilities as information for recovery planning.

The Chair asked the group to send any comments on the working papers directly to the authors. The author's presentation will be sent out to the meeting participants.

The Chair asked if the modelling assumes there is complete movement within the DU when it comes up with recovery targets. The modelling report author responded that the assumption is that the DIU is a single population. The Chair then asked if they have barriers to movement (fragmentation) within the DU, technically, each of the areas where they are isolated would require the same target. The author responded that was correct in order to achieve that risk of extinction. In addition, say it there are five populations that each have their own risk of extinction, there would also be a risk of extinction for the entire DU which would be a composite result of the risk of losing all of those populations. In the case of Bull Trout, having multiple populations works in favour of the DU. If you have some locations with smaller populations, by themselves they have a higher risk of extinction but overall because of the combination of healthy growing populations with larger size and low risk of extinction, the overall risk of losing all populations is lower than the risk of losing any one of them.

The Chair then concluded that there is uncertainty in the recovery target information that has been developed in the model because we know they don't have complete mixing within the DU. There are isolated areas (from dams or barriers), but without knowing where the barriers are located, they aren't modelling recovery targets for each of the isolated populations. Multiple populations should be included and they are not. One participant noted that in Alberta they include all four basins as separate recovery units in their recovery plan. The Chair asked for something to be added to the modelling report about calculating the overall risk of extinction. If the watersheds are separate then you have a different extinction rate for the species as a whole and for the individual populations. It was noted that if there was some movement between populations there would be the potential for rescue effects. However the watersheds are considered to be separate. The modelling report author will update the research document and include information about this in their report. The Chair suggested leaving the four watersheds separate and discussing that issue in the uncertainties as well as the lack of detailed information on spawning populations, degree of isolation and any other necessary details for Bull Trout in DU4.

A participant noted that you start to see finer detail for the Bull Trout at the HUC10 level, where you see individual spawning units. Individual spawning streams are differentiated from one another genetically with little exchange being evident. Within HUC8s there are some isolated spawning populations and others not.

Element 3: The modelling research document includes estimates of the current or recent life-history parameters for Bull Trout that were used in the modelling.

Element 12: The RPA proposed potential abundance and distribution target(s) for recovery.

Element 13: There are insufficient data to provide meaningful population trajectories for Bull Trout in DU4.

Element 14: Modelling provides some 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 targets.

Element 15: The modelling research document assesses the probability that the potential recovery targets can be achieved to the extent possible.

Element 20: The modelling research document estimates the time to reach the potential recovery targets. Expected population trajectoriesy (and uncertainties) are not provided

Element 21: The range of parameter values used were based on the best information available.

BULL TROUT RPA SUMMARY BULLETS

The group discussed and revised the summary bullets beginning with those prepared following June 2014. Bullets would be updated to capture the HUCs now being used.

The Chair will work with the author of the modelling report to create summary bullets based on the conclusions in the research document. The bullets will need to include activities that have a moderate or higher probability of jeopardizing survival or recovery, mitigation measures, and the recovery goal. A participant asked if the recovery goal has to be based on number of individuals. The Chair responded that they have some criteria for setting goals and it's meant to be a quantitative target. In the RPA we are to provide abundance and habitat targets that are quantitative. The recovery team is able to use various inputs to determine targets, they are not restricted to only using the numbers provided in the RPA. They can also match the target with how the target will be measured (i.e., what metrics will be used to evaluate success).

One participant asked whether categorical targets could be used. An example would be to improve all watersheds to a minimum of FSI rank 3 taking into consideration natural limitations. FSIs are used by Alberta to evaluate success. The Chair asked if there was a description of the how FSIs are determined. The background document would be provided to help with understand the link between recovery targets based on the modelling and the recovery target based on a FSI scores.

SOURCES OF UNCERTAINTY

The Chair suggested that the uncertainties that were identified and discussed during the meetings, including those identified within the modelling report would be captured in the Science Advisory Report.

A participant suggested reinforcing the lack of stream temperature data, which is key to determining habitat and threats. The participant also identified that there is a lack of ground-truthed data in Alberta (i.e., stream crossing information). The Chair asked if culverts were barriers to movement. A participant responded that some definitely are barriers. At the moment they are relying on a predictive model and not on ground-truthed data which would be preferred. The model is based on a relationship between stream crossing age and slope around the crossing to estimate whether it is a barrier to movement. Older crossing and greater the slope the more likely the crossing is a barrier.

A participant added that there are major uncertainties which include the effect of angling because they do not have a handle on effort. They lack information on the effect of entrainment (from reservoirs and irrigation canals) and population level effects.

There is a new model being validated on sedimentation, looking at predicting source points of sedimentation that would be helpful in the Bull Trout range to understand and mitigate threats.

A participant suggested looking at the ability of populations to adapt to thermal regimes in the context of importance of temperature and impacts of climate change. Information on interannual variability in recruitment is also lacking.

A participant asked if it was worth the time and money to keep searching for hybridization across the species range. Another participant responded that there were several publications on this and they didn't think it was worth investing their resources on the topic.

NEXT STEPS

The working papers will be revised as research documents, distributed for participants for a final review, approved and submitted for posting on the CSAS website. The science advisory report and proceedings (based on discussions) will be drafted and send to participants for their review before approvals and submission to CSAS for posting.

Participants were thanked for their contributions and the meeting was adjourned.

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APPENDIX 1: TERMS OF REFERENCE

Recovery Potential Assessment of Bull Trout, *Salvelinus confluentus* (Saskatchewan – Nelson rivers populations)

Regional Peer Review Meeting – Central and Arctic Region

June 4–5, 2014, and June 15, 2016
Winnipeg, Manitoba (Teleconference and WebEx)

Chairperson: Kathleen Martin

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.

COSEWIC met in November 2012 and recommended that Bull Trout (Saskatchewan – Nelson rivers populations, Designatable Unit [DU] 4) be designated Threatened (COSEWIC 2012). This was their first assessment of Bull Trout.

In support of listing recommendations for Bull Trout (DU4) 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 SARA. It 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 Bull Trout (DU4).

Objective:

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

Biology, Abundance, Distribution and Life History Parameters

Element 1: Summarize the biology of Bull Trout.

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 Bull Trout (DU4).

Habitat and Residence Requirements

Element 4: Describe the habitat properties that Bull Trout needs for successful completion of all life-history stages. Describe the function(s), feature(s), and attribute(s) of the habitat, and quantify how 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 Bull Trout'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 Bull Trout (DU4)

Element 8: Assess and prioritize the threats to the survival and recovery of Bull Trout (DU4).

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 Bull Trout (DU4).

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 Bull Trout (DU4) population dynamics parameters.

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

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

Scenarios for Mitigation of Threats and Alternatives to Activities

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

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

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

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

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

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

Allowable Harm Assessment

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

Expected Publications

- Science Advisory Report
- Proceedings
- Research Documents

Participants

- Fisheries and Oceans Canada (DFO) (Science, Policy and Economics, and Ecosystems and Fisheries Management sectors)
- Government of Alberta
- Parks Canada Agency
- Other invited experts

References:

COSEWIC. 2012. COSEWIC assessment and status report on the Bull Trout *Salvelinus confluentus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 103 p.

APPENDIX 2: MEETING PARTICIPANTS

June 4–5, 2014 meeting

Name	Affiliation
Jeff Adam	Fisheries and Oceans Canada, Policy
Robert Al-Chokhachy	U.S. Geological Survey
Matthew Coombs	Alberta Environment and Sustainable Resource Development
Shelly Humphries	Parks Canada Agency
Lia Kruger (Rapporteur)	Fisheries and Oceans Canada, Science
Laura MacPherson	Alberta Environment and Sustainable Resource Development
Kathleen Martin (Chair)	Fisheries and Oceans Canada, Science
Neil Mochnacz	Fisheries and Oceans Canada, Science
Jim Reist	Fisheries and Oceans Canada, Science
Bruce Rieman	U.S. Fish and Wildlife Service, Retired.
Peter Rodger	Fisheries and Oceans Canada, Species at Risk
Mike Rodtka	Alberta Environment and Sustainable Resource Development
Chantelle Sawatzky	Fisheries and Oceans Canada, Science
Michael Sullivan	Alberta Environment and Sustainable Resource Development
Will Warnock	Canadian Columbia River Intertribal Fisheries Commission
Doug Watkinson	Fisheries and Oceans Canada, Science
Jennifer Young	Fisheries and Oceans Canada, Science

June 15, 2016 meeting

Name	Affiliation
Jeff Adam	Fisheries and Oceans Canada, Policy
Amanda Caskenette	Fisheries and Oceans Canada, Science
Shelley Humphries	Parks Canada Agency
Marten Koops	Fisheries and Oceans Canada, Science
Lia Kruger (Rapporteur)	Fisheries and Oceans Canada, Science
Kathleen Martin (Chair)	Fisheries and Oceans Canada, Science
Neil Mochnacz	Fisheries and Oceans Canada, Science
Jessica Reilly	Alberta Environment and Parks
Peter Rodger	Fisheries and Oceans Canada, Species at Risk
Chantelle Sawatzky	Fisheries and Oceans Canada, Science
Mark Taylor	Parks Canada Agency
Will Warnock	Canadian Columbia River Intertribal Fisheries Commission

APPENDIX 3: AGENDAS

Meeting 1: Recovery Potential Assessment – Bull Trout Saskatchewan-Nelson Rivers Populations (DU 4)

Regional Peer Review Meeting – Central and Arctic Region

Location: Science Boardroom

Date: June 4–5, 2014

Chair: Kathleen Martin

Day 1		**Presenter**
9:00	Welcome and Introductions	Kathleen Martin
9:10	Purpose of Meeting	Kathleen Martin
9:20	Species Description	Chantelle Sawatzky
9:25	Historic and Current Distribution and Abundance and Trends	Chantelle Sawatzky
9:35	Species Biology, Ecology, Habitat and Residence	Chantelle Sawatzky
10:15	*Health Break*	
10:30	Population Status	Chantelle Sawatzky
11:00	Habitat Functions, Features and Attributes	Chantelle Sawatzky
12:00	*Lunch*	
1:00	Threats to Survival and Recovery	Chantelle Sawatzky
3:15	Current and Candidate Mitigation Measures	Peter Rodger
	• including Works/Projects/Activities table	
4:00	End of Day 1	
Day 2		
9:00	Sources of Uncertainty	Chantelle Sawatzky
9:30	Summary Bullets for Science Advisory Report	Group
10:15	*Health Break*	
10:30	Review of Terms of Reference	Kathleen Martin
	Discussion of RPA modelling	Jennifer Young
12:00	Summary and Wrap-up	Kathleen Martin

Meeting 2: Recovery Potential Assessment – Bull Trout Saskatchewan-Nelson Rivers Populations (DU 4) (Second Meeting)

Regional Peer Review Meeting – Central and Arctic Region

Location: Small Seminar Room

Date: June 15, 2016

Chair: Kathleen Martin

9:00	Welcome and Introductions	Kathleen Martin
9:10	Purpose of Meeting / Terms of Reference	Kathleen Martin
9:20	SAR Recovery Planning Process	Peter Rodger
9:30	ALCES/STELLA Overview	Jessica Reilly
10:00	Overview of Threats Assessment Process	Chantelle Sawatzky
10:15	Health Break	
10:30	Threats Assessment Results and Discussion	Chantelle Sawatzky
12:00	*Lunch*	
1:00	Current and Candidate Mitigation Measures • including Works/Projects/Activities table	Chantelle Sawatzky
1:30	Modelling Presentation and Discussion	Amanda Caskenette
2:30	Recovery Targets and Allowable Harm	Amanda Caskenette
3:00	Health Break	
3:15	Sources of Uncertainty	Chantelle Sawatzky
3:45	Review Terms of Reference and Wrap-up	Kathleen Martin