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Ecosystems and Oceans Science / Sciences des écosystèmes et des océans

Ontario and Prairie Region
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Science Response 2020/052

ASSESSMENT OF THE ECOLOGICAL IMPACT OF THE GRASSY MOUNTAIN COAL PROJECT ON WESTSLOPE CUTTHROAT TROUT IN THE BLAIRMORE AND GOLD CREEK WATERSHEDS, ALBERTA

Context

The Grassy Mountain Coal Project (the Project) is an open-pit mine proposed along the eastern edge of the Rocky Mountain foothills approximately 200 km south of Calgary, AB, situated in the watersheds of Blairmore Creek (50 km²) and Gold Creek (63 km²) which are major drainages in the Crowsnest River watershed. The Gold Creek watershed contains watercourses identified as Critical Habitat (CH) for 99% genetically pure Westslope Cutthroat Trout (WCT, Saskatchewan-Nelson River Designatable Unit), which are listed as Threatened under the *Species at Risk Act* (SARA). Blairmore Creek contains watercourses with near-pure WCT populations (95–99%), which are considered areas of high potential to support the recovery of genetically pure WCT (The Alberta Westslope Cutthroat Trout Recovery Team 2013, DFO 2019). A Recovery Strategy and Action Plan (RS-AP) has been prepared and provides both the strategic direction for the recovery of the species, including the population and distribution objectives, and what is required to achieve those objectives (DFO 2019). The RS-AP guides federal and provincial governments to identify, maintain, and improve the distribution of pure populations in the province and to improve awareness of the species for their conservation and re-establish pure populations in sites within the original WCT distribution (DFO 2019).

Benga Mining Limited’s (the Proponent) Environmental Assessment (EA) has projected ecological impacts on pure and near-pure WCT and its habitat, and proposes preliminary mitigation, monitoring, and offsetting options. Fisheries and Oceans Canada (DFO) will be presenting their technical analysis of the Proponent’s Environmental Impact Statement (EIS) at the Joint Review Panel hearing for the EA of the Project. DFO Fish and Fish Habitat Protection Program (FFHPP) and Species at Risk Program (SARP) are concerned that alteration and destruction of habitat in the Gold Creek and Blairmore Creek watersheds will compromise the survival and recovery of Alberta WCT. More specifically, in order to authorize the destruction of CH (i.e., Gold Creek watershed), DFO requires robust scientific evidence that such destruction would not jeopardize the survival or recovery of the species. DFO FFHPP and the SARP are requesting DFO Science to provide science advice on the assessment of effects to WCT, including whether the proposed project impacts, mitigation, and offsetting measures would jeopardize survival or recovery of the species. While section 73 of the SARA preconditions are part of the regulatory phase, the sensitivity of WCT necessitates that DFO provides the Joint Review Panel with advice on the potential risks the Project poses to the survival or recovery of WCT for their consideration.

Based on the EA provided by the Proponent, the objectives of this review are to determine:

1. if there is sufficient information available to assess whether the proposed CH destruction or harmful alteration in Gold Creek would jeopardize the survival or recovery of a) the Gold Creek WCT population, and b) the potential survival or recovery of a near-pure population

and/or potential re-establishment of a pure population in Blairmore Creek as per the recovery objectives in the RS-AP;

2. if there are gaps in the proposed monitoring plans to ensure mitigation measures are effective and offsetting is functioning and effective, and if so, how can these gaps be addressed; and,
3. if the proposed draft monitoring plan is sufficient to demonstrate that the offsetting would meet its objective, as well as whether there is any supporting scientific information that demonstrates that offsetting for CH has been effective previously, and if so, whether those conditions met the current proposed offsetting plan (e.g., scope and scale) would effectively replace the lost habitat and populations.

This Science Response Report results from the Science Response Process of October 22, 2020 on Science Advice on Westslope Cutthroat Trout Critical Habitat Destruction and Jeopardy – Grassy Mountain Coal Project.

Background

Westslope Cutthroat Trout Status

The Saskatchewan-Nelson River populations of Westslope Cutthroat Trout (WCT; *Oncorhynchus clarkii lewisi*) historically occupied a native range in southwestern Alberta throughout a diversity of freshwater ecosystems in the Bow and Oldman drainages of the South Saskatchewan River, and potentially the headwaters of the Milk River (Figure 1A). However, over the past century major range contractions have occurred, and WCT now occupy < 20% of their historic range in Alberta (Figure 1B; COSEWIC 2016). Separated geographically from British Columbia populations, the Saskatchewan-Nelson River populations (Alberta) Designatable Unit (DU) was assessed as “Threatened” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in May 2005, re-examined and confirmed in November 2006, and again in November 2016. The WCT Saskatchewan-Nelson River DU was listed as Threatened on March 7, 2013 under Part 3 of Schedule 1 of the SARA. The species is also listed as Threatened under *Alberta’s Wildlife Act*.

The initial federal recovery strategy for this species was made publicly available in 2014 (DFO 2014) but was later updated and replaced with a combined RS-AP document titled “Recovery Strategy and Action Plan for the Westslope Cutthroat Trout [*Oncorhynchus clarkii lewisi*] Alberta Population [also known as Saskatchewan-Nelson River Populations] in Canada” (DFO 2019). The stated WCT population and distribution objectives in the RS-AP are to “*protect and maintain the existing distribution of ≥ 0.99 genetically pure populations of WCT, and re-establish genetically pure populations to self-sustaining levels, within the Saskatchewan – Nelson River watershed in Alberta*”. There are 51 known ≥ 99% genetically pure populations of WCT remaining in Alberta outside of national parks (DFO 2019). However, more than 50% of habitat patches are too small to support a viable population in the long term (100 years), and individuals cannot naturally disperse between the habitat patches (van der Lee and Koops 2020).

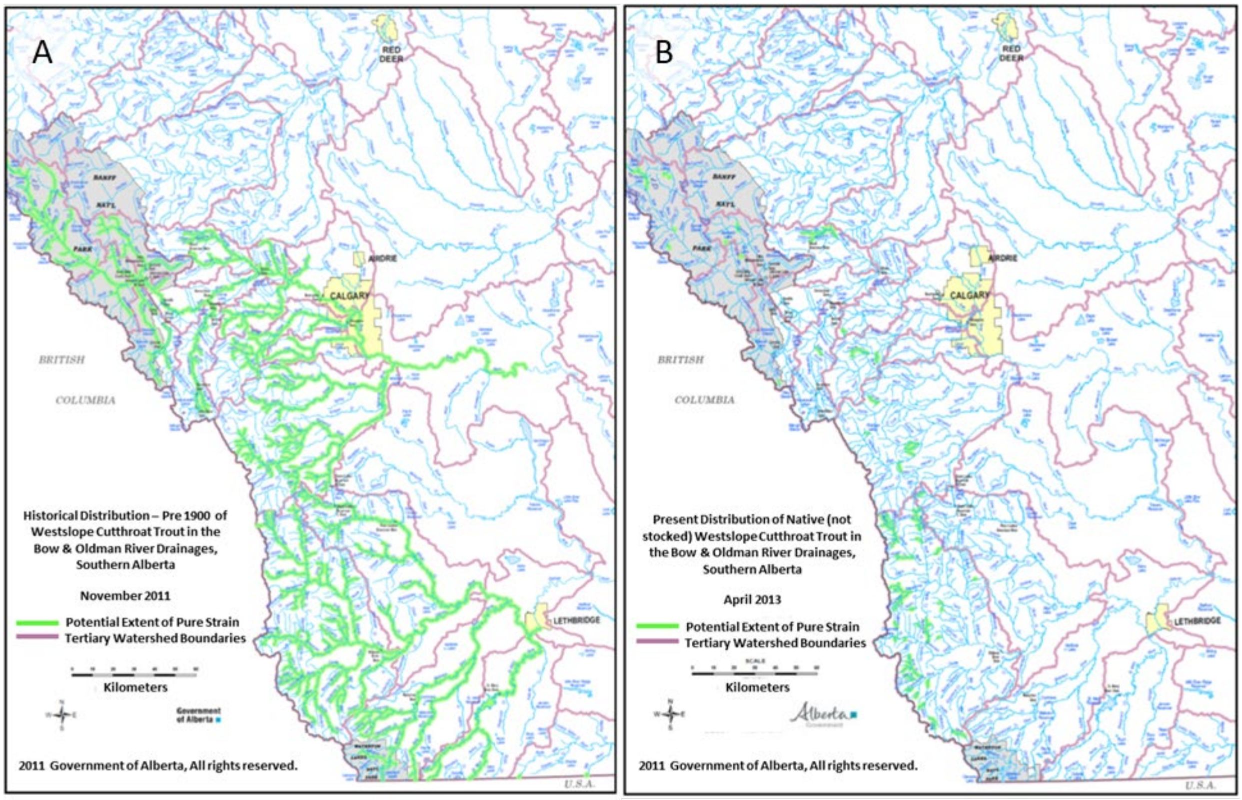

Figure 1. Historic (A; from Mayhood 2000) and current ranges (B; from COSEWIC 2016) of Westslope Cutthroat Trout (WCT) (courtesy of the Government of Alberta).

In addition to ≥ 99% genetically pure WCT, the RS-AP (DFO 2019) identifies ≥ 95% near-pure WCT as '*conservation populations*', which have the ability to contribute to the preservation of "*unique ecological and behavioural traits*" that represent "*the least introgressed populations within a geographic area*" and may represent opportunities to employ "genetic swamping" to increase genetic purity level. There is some uncertainty in the distribution of genetically pure populations of WCT due to hybridization with Rainbow Trout (*Oncorhynchus mykiss*) introduced to the region (COSEWIC 2016). Hence, a major tenant of the RS-AP was to assess the distribution of ≥ 99% genetically pure WCT CH through species sampling and genetic analyses, which is the focus of ongoing research conducted by Alberta Environment and Parks (AEP) and DFO. Therefore, a high level of precaution would be prudent in decision-making due to the uncertainties associated with the distribution and population status of pure WCT.

The Alberta Westslope Cutthroat Trout Recovery Team (2013) also recommended the use of the AEP Fish Sustainability Index (FSI) tool (MacPherson et al. 2014) to help guide the recovery of the species in Alberta. The FSI tool facilitates the creation of a series of maps using three broad criteria: population integrity, productive potential of habitat and threats and their mitigation. Based on 2013 adult density, most of remaining WCT populations were considered "low" or "very low" throughout Alberta (Figure 2A). A range of habitat protection need (i.e., very low to very high) was also mapped for areas where the adult densities still existed in Alberta, as of 2013, to help guide the Recovery Team (Figure 2B).

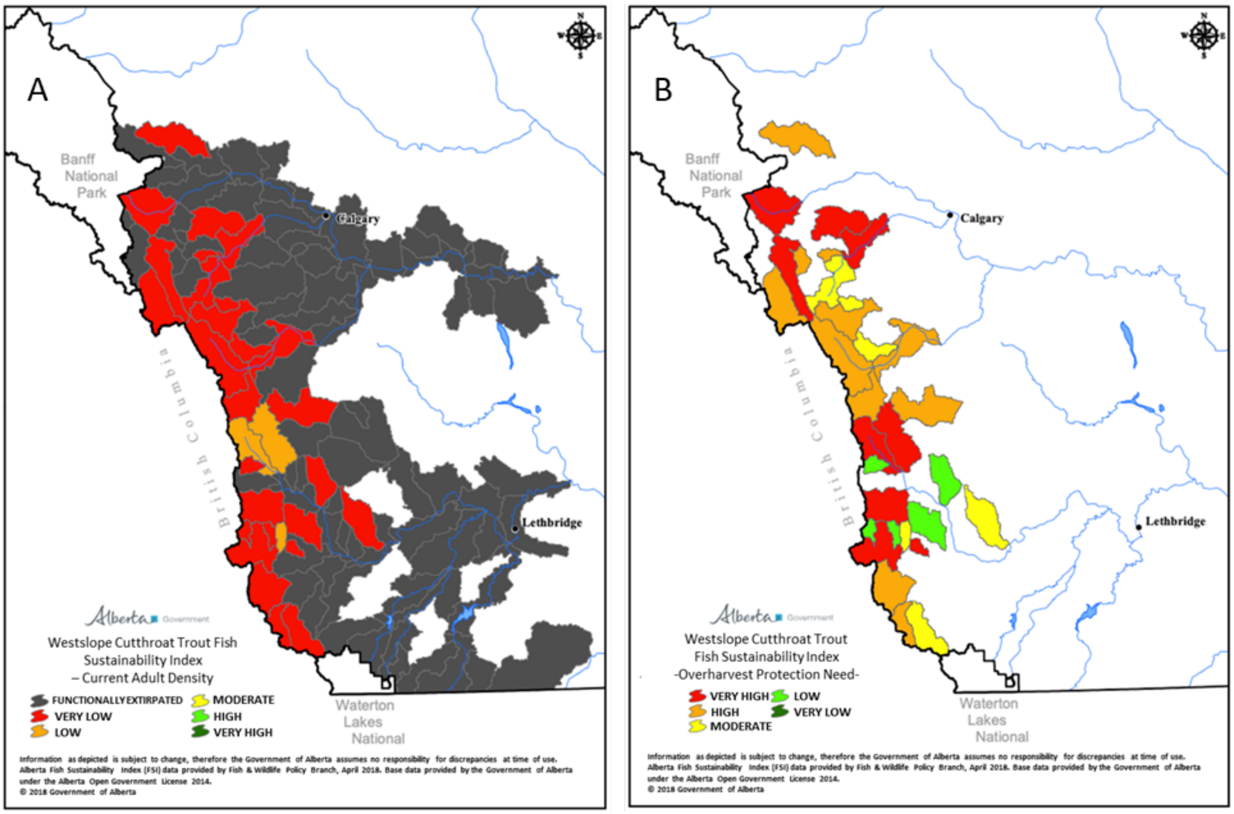

Figure 2. Alberta Environment and Parks WCT Fish Sustainability Index (2013) maps indicating adult density (A) and priority regions for habitat protection (B).

Status of Gold Creek and Blairmore Creek WCT

Due to uncertainty with WCT genetic purity throughout its remaining range, the status of WCT in these systems is the focus of ongoing research efforts and is often updated. As of 2016, Gold Creek contained an estimated 16.7 km of CH for 1,818 (788–3,257, 95% confidence interval) adult WCT (COSEWIC 2016). Gold Creek is one of ten populations that is estimated to have enough individuals to be considered viable (COSEWIC 2016). The Alberta Westslope Cutthroat Trout Recovery Team (2013) identifies the adult density (2013) in the Gold Creek watershed as “low”, which is higher than the majority of populations that are identified as “very low” (Figure 2A). Due to adult density and habitat degradation from various human activities, the Gold Creek watershed is identified as having a “very high” need for habitat protection (Figure 2B). Currently the extent of ≥ 99% genetically pure WCT CH includes the Gold Creek mainstem and tributaries (Figure 3). Blairmore Creek is known to contain ≥ 95% genetically near-pure WCT and is considered a ‘*conservation population’* that has high potential for population recovery. The EIS provided by the Proponent (Hatfield Consultants 2017) outlines the state of these ecosystems within the Local and Regional Study areas (LSA and RSA), which have been degraded due to a variety of factors including mining and forestry projects, human traffic, agriculture, man-made barriers, and flooding events.

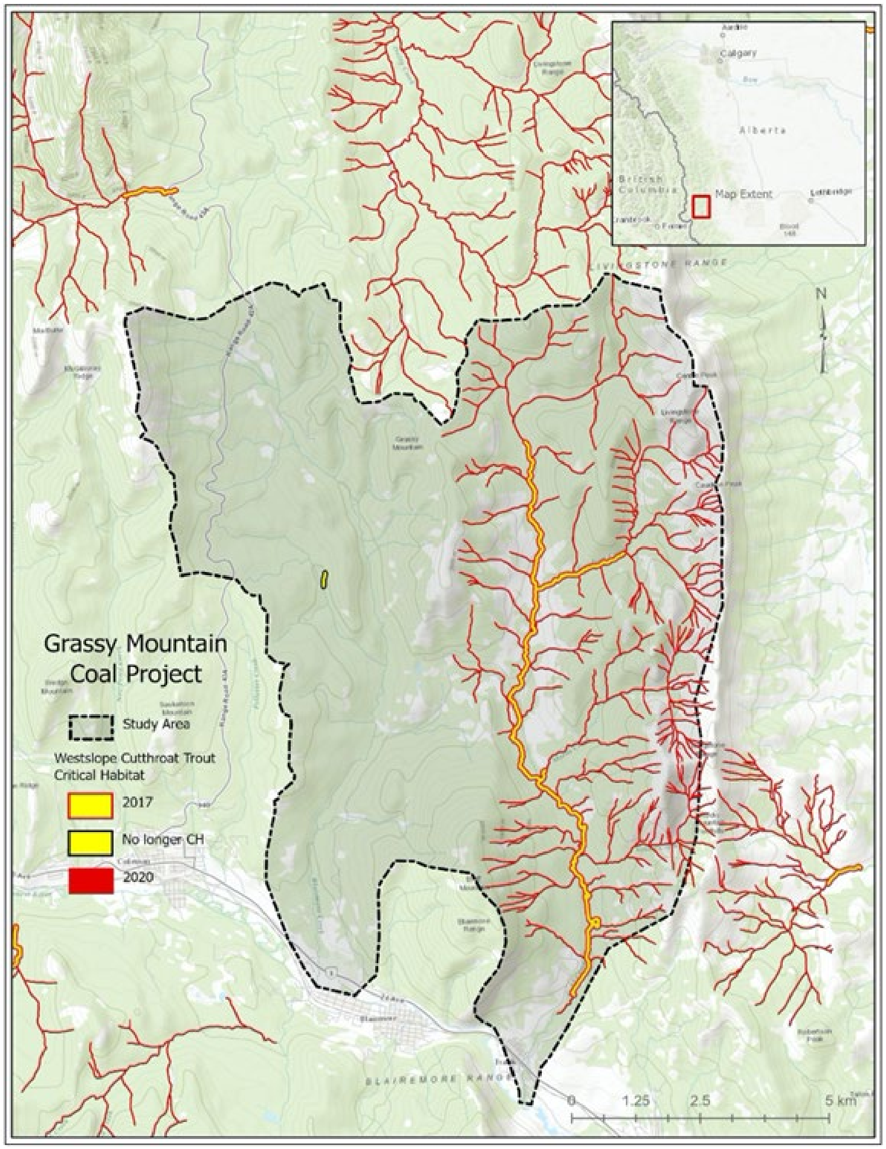

Figure 3. The current geographic extent of Critical Habitat within and near the local study area, contrasted with the extent of Critical Habitat that was defined at the time the Environmental Impact Statement for the Project was submitted (GOC 2020).

WCT Biology and Critical Habitat

Critical Habitat is defined in SARA s. 2. (1) as:

"*…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan*".

Aquatic habitat is defined in SARA s. 2. (1) as:

"*… spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced*".

The RS-AP (DFO 2019) states:

"*… critical habitat is identified to the extent possible, using the best available information, and provides the features and attributes necessary to support the species' life-cycle processes. This recovery strategy - action plan identifies critical habitat for Westslope Cutthroat Trout (Alberta populations), as all areas currently occupied by naturally-occurring pure-strain populations within the original Westslope Cutthroat Trout distribution, including the areas on which Westslope Cutthroat Trout depend indirectly (e.g., riparian areas) in order to carry out their life processes and areas where genetically pure populations of the species formerly occurred and has the potential to be reintroduced*".

Historically WCT existed throughout the Bow and Oldman drainages in Alberta in stream, river, and lake ecosystems (COSEWIC 2016). However, due to a combination of habitat degradation and loss, invasive species, hybridization, and overexploitation, the WCT Alberta DU is severely fragmented and constrained to limited segments of stream and river systems. WCT typically occupies small, steep, cold streams with low volume discharges (COSEWIC 2016). The species is thought to remain in small headwater streams due to "temperature/elevation refugia", where adaptations enable resistance to non-native species (Paul and Post 2001, COSEWIC 2016).

The habitat requirements of each life stage of WCT were outlined by COSEWIC (2016). The species is considered to have very specific habitat requirements, including a narrow optimal temperature range, necessary groundwater input and in-stream water flow regimes, in-stream structures and geomorphology, and riparian zone characteristics. In general, WCT requires relatively cold-water temperatures, with optimal ranges specific to different life stages. Specific spawning conditions within Alberta are not well known but thought to occur most commonly in May and June in small low-gradient streams as temperatures approach 10 ºC (DFO 2009). Survival of eggs relies on clean, un-silted gravels, with survival declining rapidly when sediments exceed 20% of substrate (Shepard et al. 1984). Eggs and alevins remain in gravel until July–August. Juveniles remain in headwater streams for 1–4 years and rely on groundwater inputs to maintain sufficiently deep water and cool temperatures. Adults are generally known to occupy deeper-water stream segments, moving into shallower tributaries to spawn. However, the small and highly fragmented systems that currently contain WCT in Alberta likely constrain adults to shallow headwater tributaries to a greater degree than would have occurred historically. Both juvenile and adult WCT are invertivores and rely heavily on allochthonous sources of invertebrate prey, which is supplied by riparian vegetation and sufficiently high-water flow.

WCT is known to exhibit highly variable genetics and phenotypic traits. The Canadian sub-populations are at the northern edge of the species' range and thought to retain a unique set of characteristics due to local adaptation (COSEWIC 2016). Hence, each isolated population of WCT may exhibit its own unique set of characteristics that represent adaptation to the local conditions. The presence of these unique characteristics means that lost populations within each system would be challenging to reintroduce. Furthermore, the ≥ 99% genetically pure populations may be the only potential source for re-establishing ≥ 95% pure *conservation populations* within Alberta due to their adaptive characteristics to local conditions.

Allowable Harm

Section 73(3)(c) of SARA states that an activity may only be permitted if "...*the competent minister is of the opinion that the activity will not jeopardize the survival or recovery of the species*". Therefore, some level of harm by an activity may be allowable if it is demonstrated to have a low likelihood of jeopardizing survival or recovery. To provide scientific advice for the species listing process, including allowable harm, DFO developed a Recovery Potential Assessment (RPA) framework (DFO 2007). It includes three components – species status assessment, scope for recovery, and scenarios for mitigation and alternatives to activities. van der Lee and Koops (2020) conducted RPA modelling for WCT Saskatchewan-Nelson River populations to support identification of recovery targets, conduct long term projections of population recovery, and assess impacts of harm. It was estimated that long-term self-sustaining populations (defined as 1% probability of quasi-extinction within 100 years with a 5–15% catastrophe rate per generation) could be achieved at population sizes of 1,600 to 4,200 adults (Figure 4), which would require 14–25 km of stream habitat as average model estimates. For a precautionary approach, the upper confidence interval estimates of 21–37 km are also provided (van der Lee and Koops 2020).

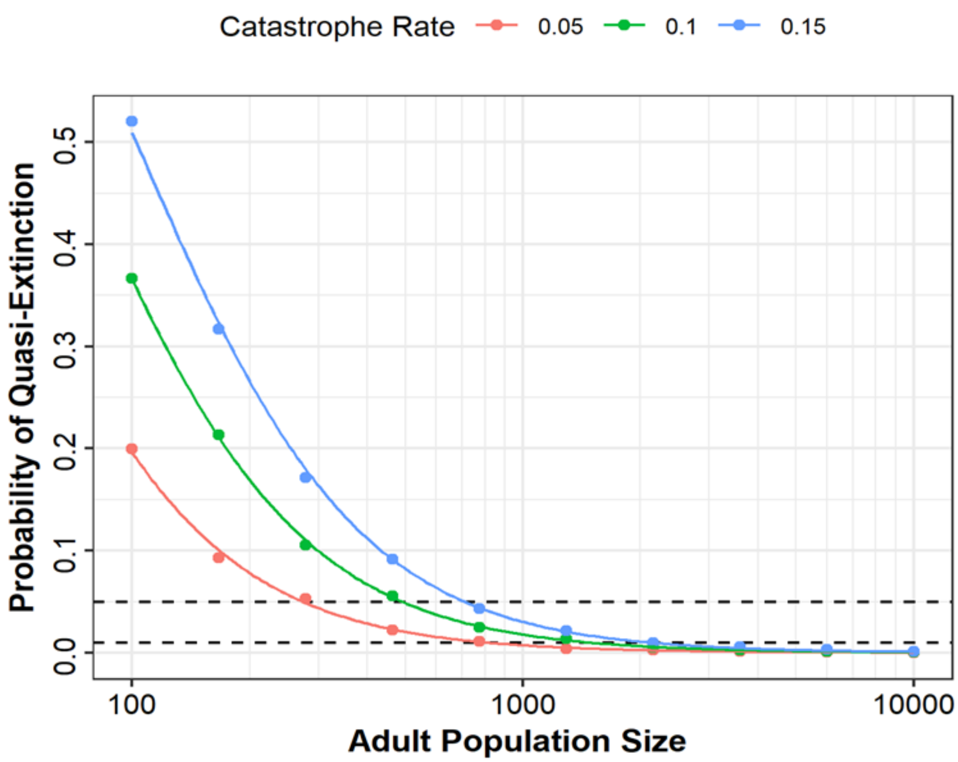

Figure 4. The probability of quasi-extinction (defined as fewer than 25 adult females) as a function of adult female population size and three rates of catastrophe; dashed reference lines represent 1% and 5% probability of quasi-extinction (from van der Lee and Koops 2020).

Based on the stream length estimates by van der Lee and Koops (2020), very few Alberta WCT populations are currently known to have sufficient population abundance and spatial extent of CH for long term population viability (see Table 4 in COSEWIC 2016). Gold Creek is recognized as one of the few populations with potential long-term viability. However, its size (1,818 adults, 788–3,257 range) is toward the low end of viability (1,600 to 4,200) and habitat extent (16.7 km). For populations below the abundance and habitat values needed for population viability, long-term survival is in jeopardy and would be exacerbated further with additional harm. Impacts of harm were estimated for a range of degrees and frequencies of harm amongst varied combinations of life stages (Figure 5; van der Lee and Koops 2020). Losses proportionate to initial population density (K) increased with the degree of harm and to the greatest extent when harm impacted all life stages simultaneously. When life stages were separated, harm to the juvenile life stage had the greatest impact on the population. Location-specific allowable harm can be estimated but will depend on both the initial condition of the population and the final state of the population considered acceptable.

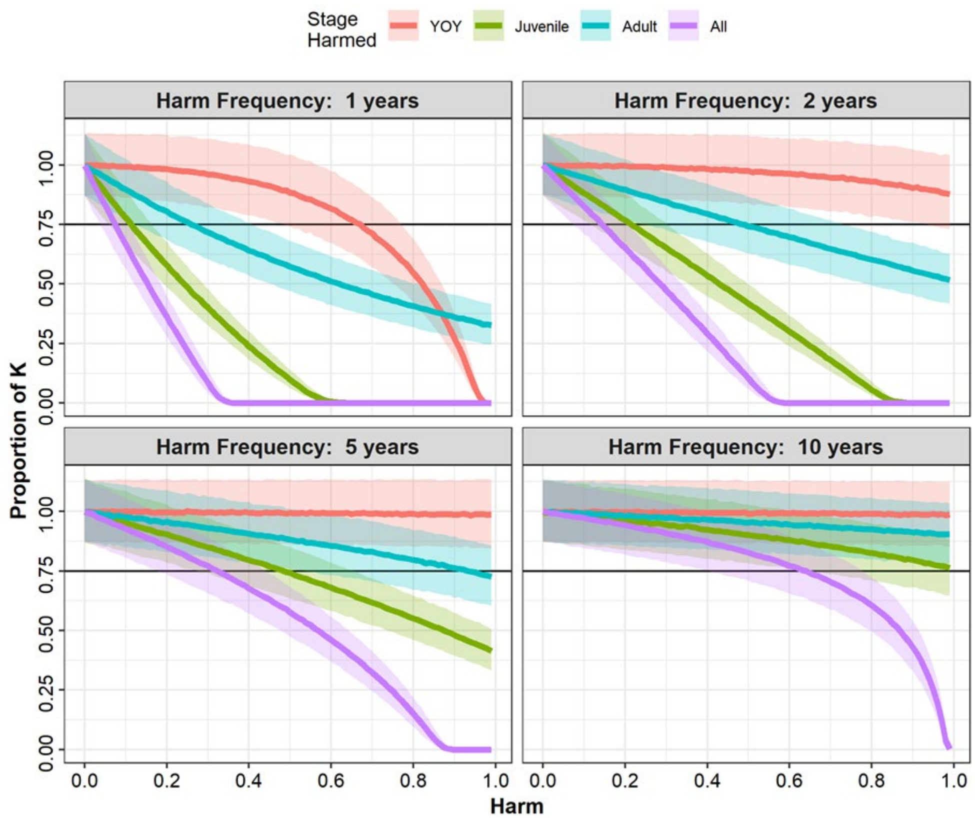

Figure 5. Results from the harm simulation analysis where harm is applied at different frequencies to specific life-stages. The x-axis represents the proportional harm (e.g., annual mortality) applied to the life-stage and the y-axis represents the proportional decrease in adult density over a 100-year simulation. The solid lines represent the mean impact, and the surrounding polygons represent 95% confidence intervals. The reference line indicates a 25% decline from initial density (from van der Lee and Koops 2020).

The Proposed Project

The proposed Grassy Mountain Coal Mine Project is in the Crowsnest River drainage within the Oldman River drainage, with an LSA defined within the EA (Figure 6) based on "*the Project footprint, boundaries of local watersheds* [Gold and Blairmore creek watersheds] *and the spatial extent of potential immediate direct and indirect effects of the Project on hydrogeology, surface water hydrology, water quality, and fisheries and aquatic resources*" (Hatfield Consultants 2017). The LSA is intended to comprise the downstream limit of potential impacts of the project on fish and fish habitat. The extent of WCT CH has changed since the initial assessment by Hatfield Consultants (2017) and is now considered to include 16.7 km of WCT CH in Gold Creek and 10 km of near-pure WCT habitat in Blairmore Creek.

The EA outlined numerous workings, undertakings, and activities (WUAs). These WUAs may cause the death of fish or harmful alteration, disruption, or destruction (HADD) through a range of Pathways of Effects (PoE) recognized by DFO. These pathways are currently under review and being updated through a forthcoming Canadian Science Advisory Secretariat (CSAS) peer-review process. The Proponent's EA utilized their own PoE analysis and recognized potential pathways impacting fish including noise, changes to water temperature, changes to food supply, changes to sediment supply and transport mechanisms, changes to hydrology, direct loss of aquatic and riparian habitat, and changes to recreational access to stream reaches.

The Proponent proposed to avoid impacts to fish and fish habitat using the following approaches (Hatfield Consultants 2017):

- Size of the project's physical footprint has been minimized through proactive mine design;
- Maintain appropriate riparian reserves and management zones from watercourses, where feasible;
- Project footprint will be minimized to the extent possible through storing of waste rock in existing disturbed locations and making best use of existing facilities, including through backfilling mined-out pits;
- Existing infrastructure, rather than new infrastructure, will be used or upgraded where feasible and sustainable;
- Redirection of non-affected surface water flows around rock drains, where feasible (i.e., clean water diversions);
- Implement erosion and sediment control based on industry standards.

The proposed project includes several WUAs that have the potential to impact fish and fish habitat, including within WCT CH and within its historical distribution (Hatfield Consultants 2017):

- Open pit development and resource extraction;
- Waste rock placement, reclamation and closure;
- Surface water management.

These WUAs have the potential to generate impacts to fish and fish habitat in Gold and Blairmore creeks and their tributaries including (Hatfield Consultants 2017):

- Destruction or harmful alteration of tributary or mainstem aquatic and/or riparian habitat;
- Change in hydrology resulting from the alteration of aquatic habitat;
- Potential death of fish resulting from blasting activities;
- Changes in water temperature;
- Changes to food supply;
- Changes to sediment supply and transport;
- Changes to surface or ground water quality;
- Change in recreational access;
- Calcite precipitation.

Project WUAs are projected to result in the destruction of 26,947 m^2 of aquatic habitat within the LSA. Of this total, 1,796 m^2 of destruction or harmful alteration is anticipated in fish-frequented aquatic habitat, and 25,151 m^2 of destruction or harmful alteration is anticipated in non-fish-frequented aquatic habitat (Hatfield Consultants 2017).

In order to calculate the impact of WUAs within riparian habitat, the Proponent has delineated riparian buffers of 50 m on the mainstem of Gold and Blairmore creeks, 30 m wide buffers on fish-frequented tributaries, and 20 m wide buffers on non-fish-frequented tributaries. The calculated footprint of proposed WUA impacts to riparian habitat is within these buffer zones and is estimated at 584,263 m^2 of destruction or harmful alteration. Of this total, 442,433 m^2 is in the Blairmore Creek watershed and 141,830 m^2 in the Gold Creek watershed (Hatfield Consultants 2017).

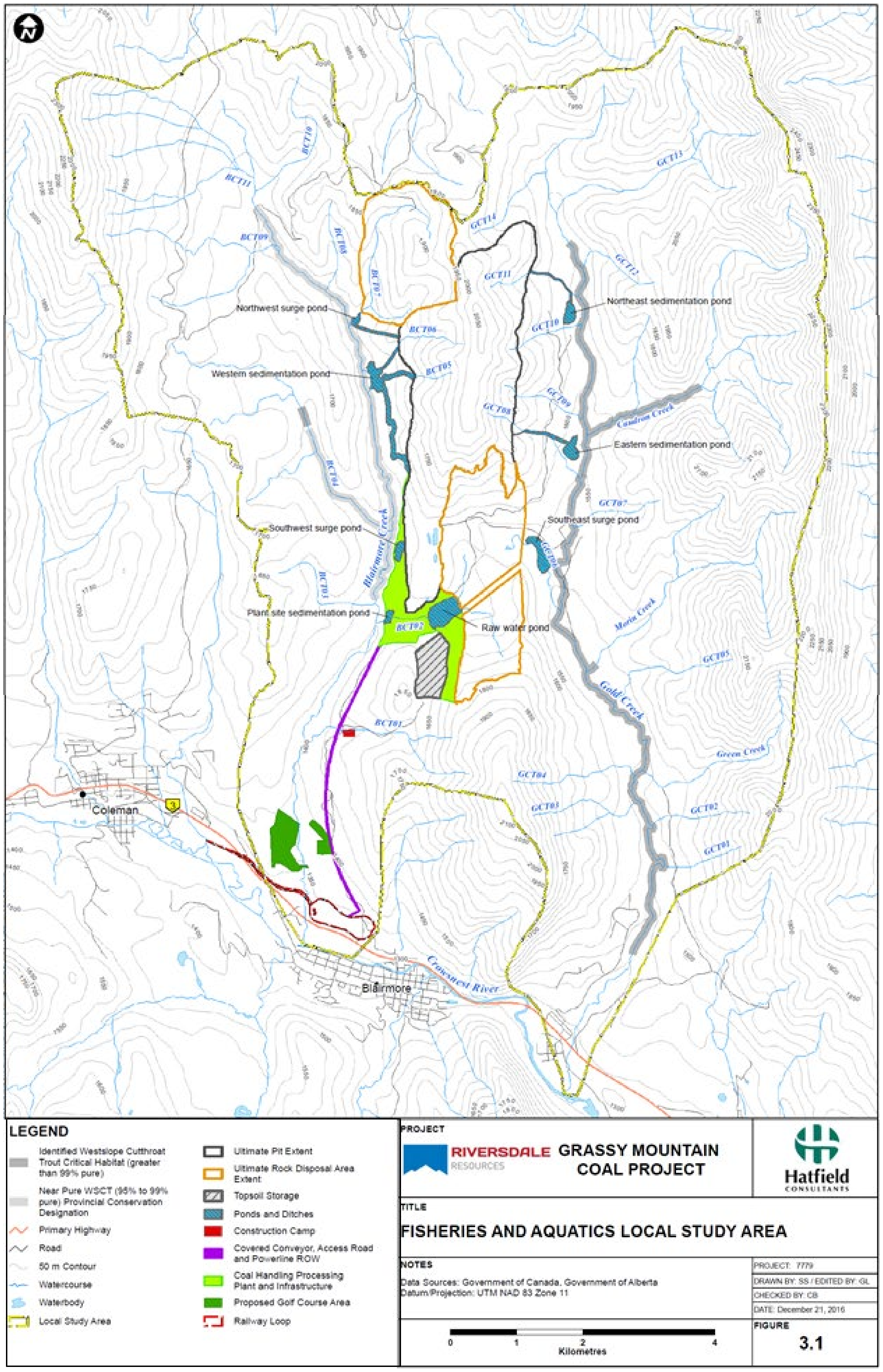

Figure 6. Map outlining the proposed local study area, including locations of mining-related activities and WCT habitat as outlined by Hatfield Consultants (2017).

Analysis and Response

Objective 1. Determine if there is sufficient information available to assess whether the proposed CH destruction in Gold Creek would jeopardize the survival or recovery of a) the Gold Creek WCT population, and b) the potential recovery of a near-pure population and/or potential re-establishment of a pure population in Blairmore Creek as per the recovery objectives in the RS-AP.

As discussed above in the Allowable Harm and Status of Gold Creek and Blairmore Creek WCT sections, the Gold Creek population size (1,818 adults, 788–3,257 range) is at the low end of viability (1,600 to 4,200 adults) and may be smaller when considering the range of uncertainty. Furthermore, the 16.7 km of CH is on the very low end of what is required for its long term viability. Therefore, to be allowable, any harm would need to be offset to achieve a net positive effect on the population with high certainty to avoid jeopardizing survival or recovery. DFO Science consider a net positive effect as the lower 95% confidence interval (modeled and measured when planning and monitoring, respectively) of adult population size is above the current value. Although estimates of population size for ≥ 95% pure WCT in Blairmore Creek are not readily available at this time, the 10 km of WCT habitat extent in this system indicates that any level of unmitigated harm on this population would also jeopardize its recovery. As stated in the RS-AP (DFO 2019), this population constitutes a '*conservation population'* with high potential for recovery through genetic swamping, and hence, its recovery is part of the objective of the WCT RS-AP.

To assess the extent of residual impacts and the effectiveness of offsetting, it is essential to have an accurate characterization of habitat quantity and quality prior to the proposed project and estimates of the extent and degree of project impacts. The DFO Submission to the Joint Review Panel (GoC 2020) outlines numerous ways in which the Proponent's EA fails to sufficiently establish the baseline conditions of WCT habitat, the full extent of impacts including the cumulative effects, and effective mitigation and offsetting measures (outlined in Table 1 below).

In addition to accurate characterization of individual impacts, consideration of cumulative effects is necessary to meet the requirements of the current *Fisheries Act*. Various project impacts are likely to generate cumulative effects. In addition, it is necessary to consider current and future system state due to other factors. Any previous activities within these systems may result in degraded conditions that may be compounded by impacts of the current project. Furthermore, the long project time frame necessitates consideration of factors such as the influence of climate change and other potential projects (e.g., other proposed mining activities) on the state of the watersheds that are likely to impact WCT populations.

Table 1: Summary of technical issues identified within the Environmental Impact Statement by Fisheries and Oceans Canada in the Government of Canada Submission to the Grassy Mountain Coal Project Joint Review Panel including reasons for concern and recommendations to address each concern (from GoC 2020). More extensive explanations of each issue are described in the Submission to the Joint Review Panel (GoC 2020).

Issue	Concern	Recommendations
WCT CH definition updated with 2019 RS-AP	• Full extent of habitat losses has not been characterized in relation to updated RS-AP.	• Conduct impact, mitigation, and offsetting assessments in the context of updated WCT habitat (RS-AP) including adjacent habitats (i.e., tributary streams and riparian habitat) to assess full effects.
Changes to recreational access	• High potential to lead to overexploitation of WCT populations and introduction of whirling disease.	• Develop an access management plan to ensure the public and employees do not have increased access to angling opportunities within the project area.
Impacts of blasting activities	• Potential for blasting plan to cause fish mortality across a range of life stages.	• Provide a site-specific blasting plan to quantify and effectively avoid and/or mitigate behavioural changes, destruction of CH, fish injury and/or mortality. The site-specific plan should include considerations for local habitat conditions (e.g., substrate type, water depth), fish life stage likely to be affected (e.g., body mass), frequency, timing, depth and setback distances of proposed blasting activities.
Changes in water temperature	• Proposed alterations to riparian habitat and surface water flows may result in increased water temperatures, to which WCT are highly sensitive.	• Perform a predictive analysis that includes all relevant variables that may affect the temperature of water entering Gold and Blairmore creeks, and their tributaries. Additional variables may include but not be limited to vegetation loss, increased temperature of water from water management structures, and effects of climate change on air/groundwater temperatures. • Prior to construction, identify adaptive management options (i.e., mitigation measures) to be implemented should monitoring indicate that stream temperatures approach trigger values, and perform an analysis of their likely effectiveness. Include consideration on the feasibility of implementing mitigation measures, particularly in the case of stream temperature changes being caused by widespread activities. • Update the Aquatic Monitoring Plan (AMP) to clarify how the temperature monitoring program will ensure changes to temperature are within the species’ tolerance or natural range or species’ tolerance throughout the available habitat.

Issue	Concern	Recommendations
Changes to food supply	• Impacts of lost riparian habitat and water flow on food supply have likely been underestimated and insufficiently assessed	• Perform a detailed assessment of areas where food drift may be reduced due to loss or alterations in aquatic or riparian habitat, or changes in flow, and cross reference with habitat suitability in those areas. Update the effects assessment, residual effect conclusions, and offsetting plan to reflect these issues. The assessment on anticipated food drift reduction should be based on a detailed project design understanding, a comprehensive literature review, and conservative assumptions to account for lack of site-specific data. Residual effects conclusions should take into account the sensitivity and lack of resiliency of the subpopulations in question. Align areas of potential loss with sampling locations defined in the AMP.
Changes to hydrology and flow characterization	• The provided quasi-monthly and peak return flow analysis do not adequately capture the potential changes to the components of the flow regime that may affect WCT. • Impacts of changes to flow are evaluated using habitat suitability curves, but the analysis does not account for uncertainty nor do monitoring plans demonstrate how suitability curves will be validated.	• Update the modelling analysis to assess the impact to the hydrologic regime at a temporal scale suitable to the assessment of fish and fish habitat, in particular WCT. Future modelling should simulate stream flows at a monthly timestep (as a minimum), incorporating monthly variability to better estimate both low and high flow periods. Hydrologic processes and components required to accurately capture the streamflow response to dry and extreme dry periods should be incorporated into the model. Analysis nodes should be included at key tributaries to allow project impacts to be assessed on low order, headwater streams. • Define low flow (ecosystem baseflow) thresholds that are required to maintain habitat functionality. The Proponent should describe how streamflow reductions below set thresholds will be mitigated, particularly under natural low flow conditions. A reference gauge approach to estimate the required augmentation under low flow conditions should be employed. • Include a sampling methodology that will verify the habitat suitability predictions in the AMP. • Update the changes in hydrology effects assessment to incorporate updated hydrologic modelling and instream flow needs. The analysis should be precautionary and conservative, incorporating DFO's Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (2013) and accounting for all habitat destruction and alterations associated with flow alterations. The offsetting, AMP, and Follow-Up Program should be updated, as required.

Issue	Concern	Recommendations
Changes to sediment supply and transport mechanisms	• The incremental effects assessment only considers potential impacts associated with alterations to part of the hydrologic regime and does not assess potential impacts associated with changes in sediment supply. Although sediment sources are inventoried in the existing conditions assessment, no analyses or discussion are provided assessing the potential impacts of reduced sediment supply to channel morphology or, correspondingly, fish habitat.	• The Proponent should assess the potential impacts to WCT, fish habitat, and critical habitat as a result of impacts to sediment supply associated with the overprinting of potential sediment sources in Gold and Blairmore creeks. This may include but not be limited to a sediment budget that considers baseline, operational, end of mine, and long-term closure conditions. Subsequently, the WCT effects assessment, mitigation measures, offsetting plan, and significance assessment should be updated, as required. The AMP and Follow-up Program should include monitoring to verify the accuracy of the predictions and effectiveness of mitigation. • The Proponent should incorporate hydrologic changes from the Water Management Plan , into the sediment transport analysis and evaluate potential impacts to the magnitude and frequency of sediment transport for the entire flow regime using daily flow data. The analysis should be used to assess potential impacts to channel-maintenance flows and the magnitude, frequency, and duration of spawning gravel transport, and to assess potential impacts to channel morphology and sediment transport for post-closure conditions. The WCT effects assessment, mitigation measures, offsetting, and significance assessment should be updated, as required.
Assessment and protection of riparian habitat	• Proponents suggested a range of riparian zone sizes (20, 30, 50 m) based on stream habitat type. • Proponent places value on each habitat type based on whether they fish-frequented, or adjacent to fish-frequented water, and based on their maturity (in the case of riparian).	• The Proponent should undertake a detailed analysis of the ability of the riparian areas in the vicinity of Gold Creek to support the functions, features, and attributes of critical habitat defined in the WCT RS-AP. A similar analysis should be applied to Blairmore Creek given the potential to support recovery objectives in the RS-AP. This analysis should consider the timescale of the Project such that potential future ability of riparian to support functions, features, and attributes are accounted for, including the potential for maturation of riparian areas, and the lateral migration of watercourses that may expand the range of vegetation that has the potential to contribute. Guidance on how to identify riparian habitat capable of supporting life history processes can be found in this recent publication: "Review of information to guide the identification of Critical Habitat in the riparian zone for listed freshwater fishes and mussels" (Caskenette *et al.* 2020).
Direct loss of aquatic and riparian habitat	• Loss of aquatic and riparian habitat does not consider updated WCT habitat definition in the RS-AP.	• Provide updated assessment of the extent of habitat impacted by proposed mining activities and update mitigation and offsetting approaches.

Issue	Concern	Recommendations
Calcite input	• Potential for waste rock storage to yield calcite formation in WCT habitat is underestimated.	• A quantitative assessment of the potential for calcite precipitation and its effects on WCT habitat should be completed. Based on the results of the analysis, a robust mitigation strategy should be developed, tested and proven effective prior to implementation. Any residual effects should be accounted for in the final assessment of impacts to WCT and offsetting required, and described in combination with other residual effects in the context of overall potential effects on WCT survival and recovery. A comprehensive monitoring and adaptive management program should be developed and in included in the AMP and Follow-up Program to define thresholds and triggers for action to prevent effects beyond those predicted.
Selenium input	• The assessment of impacts to food sources does not appear to account for changes in water quality due to effluent discharge.	• The final offsetting plan include an updated analysis of residual effects to food sources that accounts for potential long-term changes due to water quality specific to feeding habits and diet of WCT. The amount of offsetting required should then be updated to account for this, if required. • The follow-up monitoring program should be designed to verify the predictions related to benthic invertebrate communities and any consequential impacts on WCT food sources.
Consideration of cumulative effects	• Overall, the cumulative effects assessment does not have a quantitative basis and carries forward and compounds assumptions, gaps and uncertainties that DFO has identified in related effects analyses of the Project. The characterization of the potential cumulative effects on WCT are likely inaccurate and the effects underestimated.	• The Proponent should undertake a quantitative cumulative effects assessment. It should include consideration for the status of WCT; refined residual effects of the Project; appropriate consideration for other potential stressors including but not limited to whirling disease, timber operations, recreational use, grazing, and climate change; and reasonable predictions for the ability of the Proponent to effectively mitigate impacts in combination with other stressors.

Recommendation: The issues outlined in Table 1, discussed extensively in GoC (2020), would need to be assessed and addressed in mitigation and offsetting plans to provide a more accurate assessment of potential harm to WCT and its habitat in Gold and Blairmore creeks including consideration of project cumulative effects.

Recommendation: To be certain that mitigation measures are effective, population modelling would be required using methods such as those outlined in van der Lee and Koops (2020) on each system (Gold Creek and Blairmore Creek) separately. To do so, links between project impacts (PoE endpoints) and population vital rates need to be identified, including life-stage specific impacts. To achieve allowable harm, impacts would need to be mitigated. For impacts remaining after mitigation, offsetting measures need to be put in place such that population modelling indicates with high certainty that a net positive effect (lower 95% confidence interval of adult population size above the current value) could be achieved.

Objective 2: Determine if there are gaps in the proposed monitoring plans to ensure mitigation measures are effective and offsetting is functioning and effective, if so, how can these gaps be addressed.

DFO Science is not currently aware of a detailed proposed WCT monitoring plan for the project; however, an effective monitoring plan relies upon data collected prior to the beginning of the project to establish baseline system conditions and detect any changes. There is an established standardized framework for project monitoring (DFO 2012), which outlines the necessity to utilize a design before and after study design, and establishment of metrics and thresholds for monitoring, mitigation, and offsetting. The Proponent provided an initial assessment of stream biophysical characteristics, stream flow, fluvial geomorphology, benthic invertebrate densities, and fish densities within Gold and Blairmore creeks (Hatfield Consultants 2017). As discussed in GoC (2020), there are concerns with the Proponent's provided documentation (see Table 1 above), including how effectively these data can be used to validate predictions, or to set decision points for adaptive management:

- With the updated 2019 WCT RS-AP (DFO 2019), sampling proposed by the Proponent needs to be conducted in relation to the current extent of WCT habitat.
- Data were collected over a limited time period, creating challenges for before-after comparisons and generating uncertainty in effects predictions.
- The Proponent provided relative abundance estimates of fish or adults per m^2 of stream area but did not provide confidence intervals. This makes it difficult to determine how readily changes in the population could be detected post-impact.
- Recapture rates were low, and there appears to be high variability in the numbers of fish captured between survey methods (i.e., snorkeling, angling, and electrofishing) and stream reaches. It is unclear which values would be used to define the baseline condition, which is necessary to make post-impact comparisons. This high variability also decreases confidence that the survey methods are effective in generating useful estimates of relative abundance.
- Invertebrate drift sampling locations failed to align with key locations that would allow a before-after, control-impact study to determine if effects predictions are accurate (e.g., habitat that would be lost downstream of tributaries).
- Due to the small population sizes, it is especially important to ensure sampling related to monitoring efforts does not cause harm to WCT populations.

- No success targets or threshold values were established, which are required to determine if impacts exceed what was permitted and offset, and when to trigger mitigation measures.

Recommendation: Extensive sampling of WCT distribution and abundance, fish tissue contaminant concentrations, and invertebrate densities are required both spatially and temporally to effectively establish baseline conditions and monitor for project effects. To understand cause and effect relationships between environmental conditions and WCT, these measures would also need to be accompanied by ongoing sampling of water flow and quality (e.g., temperature, dissolved oxygen, contaminants) at a similar spatial-temporal sampling regime. Repeated measurements would be required to establish confidence intervals of relevant metrics to ensure no significant changes are occurring. Due to their small population sizes and limited, specific habitat requirements, sampling would need to occur among seasons using standardized approaches to monitor effectively. Further, sampling sites should extend spatially throughout the study systems in a systematic way to detect potential project effects, including downstream of project activities.

Recommendation: Specific thresholds need to be established, as well as specific plans of action for mitigation and offsetting need to be in place in case project impacts extend beyond thresholds.

Recommendation: Due to the small WCT population sizes, monitoring efforts have the potential to be a source of harm. Therefore, minimally invasive sampling methods should be used, especially for WCT. Some combination of literature synthesis, numerical modelling, experiments, and non-invasive techniques (e.g., environmental DNA) should be used to establish with high certainty that sampling approaches will not harm the populations.

Objective 3: Determine if the proposed draft monitoring plan is sufficient to demonstrate that the offsetting would meet its objective, as well as whether there is any supporting scientific information that demonstrates that offsetting for CH has been effective previously, and if so, whether those conditions met the current proposed offsetting plan (e.g., scope and scale) would to effectively replace the lost habitat and populations.

As described in Hatfield Consultants (2017), and as interpreted by GoC (2020), proposed offsetting measures include:

- Habitat gains associated with increased flows due to mine Water Management Plan in Blairmore Creek;
- Alteration within existing aquatic habitat to provide additional overwintering pools;
- Alteration within existing aquatic habitat (Gold Creek) to create a single channel where currently a braided channel exists, with the intent to provide increased fish passage and habitat connectivity;
- Riparian enhancement;
- Scientific research programme relating to genetic diversity within isolated subpopulations of WCT.

DFO’s current policy (2019) states under guiding principle three that “*the coincidental positive benefits of the works, undertakings, and activities being authorized should not be considered as measures to offset*”. Therefore, any additional habitat manifest in Blairmore Creek due to water management for the mine would not be eligible for consideration as an offsetting measure.

Different regulatory considerations apply to each of Gold and Blairmore creeks. Although fish in both systems are considered highly sensitive with low resilience to harm under the *Fisheries Act*, Gold Creek fish and fish habitat are further protected in specific ways under SARA. As such, it is necessary for the Proponent to differentiate between the impacts to each system, and clearly define how impacts to Gold Creek fish and fish habitat are being offset (including stage-specific effects of offsetting for WCT), and whether the final outcomes of that offset align with the goals identified in the RS-AP.

Offsetting measures are proposed to occur within the zone of influence of the project, which means that if any of the assumptions that led to “no residual effect” conclusions are inaccurate, the project has the potential to impact the offsetting. It is a typical condition of a *Fisheries Act* Authorization that the Proponent cannot cause the harmful alteration, disruption or destruction to the established offset. For these reasons, the proposed offsetting creates regulatory uncertainty.

The Proponent indicates “that a period of time of approximately ten years between the losses occurring and the offsetting measures becoming fully functional will likely occur”. Due to the small population sizes of WCT and limited habitat area in both Gold Creek and Blairmore Creek, this lag period is likely to jeopardize the survival and recovery of these populations. Moreover, offsets may fail to function as planned (Laitila et al. 2014), resulting in lasting and irreversible impacts of the project.

Overall, there is no empirical basis to support that the proposed offsetting plan is likely to be effective. Especially due to the vulnerability of these WCT populations, effective offsetting requires careful consideration of the timing, location, and degree of benefits in relation to specific project impacts.

Recommendation: To ensure offsetting measures will be effective at mitigating project impacts, population modelling would be required that integrates the frequency, timing, and degree of harm and the life stage-specific residual effects and offsetting benefits. This modelling exercise would present a useful guide for planning the extent of offsetting measures required to avoid jeopardizing survival or recovery of WCT. To accomplish this, offsetting and unmitigated project impacts combined should have a net positive effect, i.e., the projected lower 95% confidence interval of the population size should be above current levels.

Recommendation: To achieve allowable harm, an offsetting plan would need to have measures that can be implemented and verified as benefitting WCT and its habitat before any impact occurs to WCT subpopulations on a system-specific basis (i.e., Gold Creek and Blairmore Creek), and that offsets are not in the zone of influence of the project. Specifically, monitoring should indicate that offsetting measures had a net positive effect, i.e., the lower 95% confidence interval of measured adult abundance has increased to the extent required to offset projected losses.

Conclusions

Within the WCT Alberta population RS-AP, Gold Creek is considered CH, including its tributaries and watershed area. Gold Creek is one of only ten populations of WCT in Alberta that are considered likely to be viable in the long term. The system is degraded by human activities and is considered a high priority for habitat conservation for these reasons. Blairmore Creek is considered a *conservation population* within the RS-AP due to its recovery potential. Modelling exercises indicate, based on the population sizes and habitat extent for WCT in these systems, that any negative impacts through death of fish or HADD due to WUAs would jeopardize the survival or recovery of the Alberta DU. The proposed project has high potential to jeopardize Alberta WCT due to shortcomings in effects assessments, mitigation plans, monitoring protocols, and offsetting plans discussed above (Table 1; GOC 2020). Comprehensive monitoring of WCT populations and habitat conditions would be required to establish the system state prior to any project activity and carried on routinely in a standardized manner to detect ecological changes. This monitoring plan should consider spatial-temporal aspects of the system and project impacts and establish confidence intervals for key monitoring metrics. Careful consideration must be given to ensure that monitoring protocols are not a source of harm to the WCT populations. Given the different regulatory state of the two systems, monitoring, mitigation, and offsetting plans should be conducted on a system specific basis. In assessing project impacts and generating mitigation and offsetting plans, individual project effects cannot be considered in isolation; cumulative effects need to be considered. It is strongly recommended that population modelling be conducted in a manner similarly to van der Lee and Koops (2020) that integrates the timing, degree, and location of project impacts amongst WCT life stages on a system-specific basis, and integrates cumulative effects of this project and other factors (e.g., other projects, climate change) over the project duration. This modelling exercise would be highly useful and informative for the development of an offsetting plan by estimating the effectiveness of offsetting measures in counteracting any unmitigated project impacts for a net positive effect. Specifically, modelling should indicate that the lower 95% confidence interval of adult WCT abundance will be above current levels. Importantly, in assessing project effects and planning offsetting, functional habitat requirements amongst life stages, processes, and seasons should be considered beyond just habitat size. Because these WCT populations are small and disconnected, the proposed time delay between project impacts and offsetting benefits poses a major threat to these populations. If offsetting of habitat loss is to be used as a strategy, it will be critical to ensure that the benefits are validated as being effective in achieving the required adult population levels for a sustainable population (as predicted by modelling exercises) prior to any unmitigated project impacts occurring. Such requirements are necessary because WCT populations are known to be highly specialized to their local ecosystem; any loss of a population would be extremely difficult to reverse by stocking from another population.

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