Alberta Pygmy Whitefish (*Prosopium coulteri*) Recovery Plan

Alberta Species at Risk Recovery Plan

April, 2018

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Recovery Planning in Alberta

Albertans are fortunate to share their province with an impressive variety of wild species. Populations of most species of plants and animals are healthy and secure. However, a small number of species are either naturally rare or are now imperiled because of human activities. Alberta Species at Risk recovery plans establish a basis for cooperation among government, industry, conservation groups, landowners and other stakeholders to ensure that these species and populations are restored or maintained for future generations of Albertans.

Alberta's commitment to the federal/provincial Accord for the Protection of Species at Risk and the National Framework for the Conservation of Species at Risk, combined with requirements established under Alberta's *Wildlife Act* and the federal *Species at Risk Act*, have resulted in the development of a provincial recovery program. An overall goal of the recovery program is to restore species identified as Threatened or Endangered to viable, naturally self-sustaining populations within Alberta. The policy document: Alberta's Strategy for the Management of Species at Risk (2009–2014) provides broader program context for recovery activities.

Recovery Plans are developed with the involvement of affected stakeholders. The level and type of involvement depends on socio-economic and conservation issues. Draft recovery plans undergo review by the Fish and Wildlife Policy Branch and are then posted online for public comment for at least 30 days; additional opportunities for review by the public may be provided. Following public review, Alberta's Endangered Species Conservation Committee reviews draft plans and provides recommendations on their acceptability to the Minister of Environment and Parks (hereafter "the Minister"). Plans accepted and approved for implementation by the Minister are published as provincial government recovery plans. Approved plans are a summary of the Ministry of Environment and Park's commitment to work with involved stakeholders to coordinate and implement conservation actions necessary to restore or maintain vulnerable species.

Recovery plans include two main sections: (1) a situational analysis that highlights the species' distribution and population trends, threats, and conservation actions to date; and (2) a recovery section that outlines goals, objectives, associated broader strategies, and specific priority actions required to maintain or recover Threatened or Endangered species. Each approved recovery plan undergoes regular review, and at that time progress on implementation is evaluated. Implementation of each recovery plan is subject to the resource availability from both inside and outside of government.

Recovery plans will be systematically reviewed every 5 years. Where there are large changes in the goals, objectives or strategy sections due to a new understanding or circumstance, a plan may need to be redrafted, consulted on and reviewed by the Endangered Species Conservation Committee, and the changes approved by the Minister.

Table of Contents

List of Figures

List of Tables

Acknowledgments

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Executive Summary

Pygmy whitefish populations are found in only two locations in Alberta: deep in Waterton Lake and in a 46 km reach of the Athabasca River straddling the border with Jasper National Park. Because of this small and disjunct distribution, the species was classified by Alberta's Endangered Species Conservation Committee (2011) and under Alberta's *Wildlife Act* (2014) as *Threatened*. This extremely limited distribution also suggests that these fish have a correspondingly limited ability to colonize and, perhaps, adapt to changing conditions (e.g., move to other areas in response to spills of deleterious substances, or habitat degradation or loss).

Current habitat quality and range need to be maintained for pygmy whitefish. Most of pygmy whitefish habitat is protected in national parks, and active habitat improvement is not deemed necessary at this time. Habitat maintenance outside the national parks should be achieved through implementation of the Athabasca Rainbow Trout Recovery Plan, which encompasses the range of pygmy whitefish.

Although the populations have likely not declined within their known range, the potential human-caused threats to their sustainability are significant. These are primarily accidental spills of deleterious substances into the Athabasca River along the Yellowhead transportation corridor (highways, pipelines and railways), and to a lesser extent, potential sewage release from the townsite of Jasper. These threats could result in a population-level loss. Mitigation of these risks involves measures to prevent these threats, including identifying high risk sites (in terms of vulnerability to fish and likelihood of a spill) and implementing changes to reduce the severity of a spill and improve containment of deleterious substances. These strategies address maintenance of habitat quality and quantity. Climate change is also a significant threat, but direct mitigation is beyond the scope of this plan.

The goal of the plan is primarily maintenance and prevention (i.e., reducing risk of deleterious spills), rather than population recovery because the population is naturally small. If current populations are maintained, the potential for range expansion is also maintained. Planning for reintroductions in the event of a population-level loss should be conducted, including identifying potential sources of pygmy whitefish donor stocks with regards to genetic suitability and logistical practicality. Reintroduction protocols should be created with the partnership of the three levels of administration likely to be involved (i.e., Alberta government, Parks Canada, and British Columbia government).

1.0 Introduction

Pygmy whitefish appear to be a relic of a unique post-glacial dispersal and colonization in Alberta, being found only in two disjunct, small, isolated sub-populations along the eastern slope of the Rocky Mountains. Globally, they are also found in disjunct isolated sub-populations in lakes and rivers from Lake Superior to Siberia. Understanding more about their unusual distribution and population persistence has the potential to teach us much about post-glacial colonization, natural speciation, population dynamics, and the origins and maintenance of biodiversity. A complete description of the life history, sampling strategies, habitat requirements and conservation concerns for this species in Alberta is in the detailed pygmy whitefish status report (ASRD and ACA 2011).

The species was recommended as *Threatened* by Alberta's Endangered Species Conservation Committee in December 2011. This listing was approved by Environment and Sustainable Resource Development Minister Robin Campbell in July 2014.

2.0 Process for Plan Development

2.1 Recovery Team Composition

The plan was developed by a "core recovery team" (hereafter referred to as "the Team"), consisting of Dr. Michael Sullivan (Alberta Environment and Parks – fisheries scientist and species lead), Lisa Wilkinson (Alberta Environment and Parks – species at risk biologist), and Ward Hughson (Jasper National Park – aquatic ecologist; also representing Waterton Lakes National Park). Most of the range of the Athabasca pygmy whitefish falls within the park boundaries; the other population in Waterton Lakes National Park is less vulnerable.

The Initial Conservation Action Statement (ICAS) prepared by the Endangered Species Conservation Committee provided a list of potential team members. This list was reviewed and modified by the Team based on current land use issues, expertise and interest. In total, 18 organizations were invited to participate, including conservation groups, industry, government, and Indigenous people. Participation primarily took the form of providing comments and/or reviewing the draft recovery plan. All those who chose to participate and provide feedback were "Plan Contributors" (refer to Appendix A).

2.2 Recovery Plan Development

An initial draft of the recovery plan (hereafter referred to as "the Plan") was produced and circulated to Plan Contributors midway through development and consisted of the following components:

- Conservation actions to date
- Situational analysis
    - Species distribution, populations and trends
    - Limiting factors
    - Status
    - Analysis of population threats

Comments were addressed and a subsequent draft, including strategies and actions, was completed. After internal Alberta Environment and Parks (AEP) review, and additional opportunities for the Plan Contributors to review drafts and provide comments, the final draft was completed. No further changes were made to this version, but members were invited to identify any outstanding issues, and these were recorded and submitted to AEP. In circumstances under which an organization was invited to participate partway through plan

development (due to communication problems or new contact information), they were given equal opportunity to provide comments and review the draft(s). All Indigenous groups in or near the range of pygmy whitefish were invited to provide comments before and during the recovery planning process.

3.0 Situational Analysis

To date, no pygmy whitefish specific conservation actions have been implemented on habitat in pygmy whitefish waters. A brief discussion about fishing regulations appears below.

3.1 Species Distribution and Trends

Summarized from status report (ASRD and ACA 2011):

This species is represented in only two small and isolated populations in Alberta: a river-dwelling population in the Athabasca River between Jasper and Hinton (termed the Athabasca group), and a lake-dwelling population in Upper Waterton Lake (termed the Waterton group), see Figure 1. Little is known about their specific life history, but the general life history of this fish is somewhat understood (McPhail 2007). Spawning occurs in autumn to early winter, with eggs incubating throughout the winter and hatching in spring. Spawning locations are therefore likely in sites with good overwinter oxygen and protection from ice-scouring. These could be in protected side-channels of rivers, in areas with upwellings, or along submerged gravel beaches in lakes. Little is known about the early life history of this species after hatching, although immature fish were captured in the same habitat as adults in both Alberta populations. As with other whitefishes, we expect that all life history stages of pygmy whitefish are sensitive to changes in water quality, such as decreases in oxygen levels and increases in temperature, although to a lesser degree than trout (Behnke 2002).

Extensive fish sampling has been conducted in streams around the areas of both Alberta populations and no pygmy whitefish have been located far from either the mainstem Athabasca River or in Waterton area streams. It is unlikely that significant numbers of pygmy whitefish live in or migrate through small tributary streams in Alberta (ASRD and ACA 2011).

The approximate distributions of the two Alberta populations have been known for decades, but no detailed monitoring work on these two populations had been conducted until 2006. An extensive fisheries survey of the Athabasca River mainstem from Hinton to Whitecourt was conducted during 2014 with a specific goal to locate pygmy whitefish; however, none were found (AEP file data 2016). The Athabasca group exists in an area of riverine habitat approximately 9 km^2, and the Waterton group exists in an area of suitable lake habitat approximately 4 km^2 (ASRD and ACA 2011). Our assumption is that the two populations have naturally existed in Alberta for millennia, and have not had major changes in distribution since formal fisheries monitoring detected them in the 1970s. There is potential for earlier and more widespread distributions in Alberta, particularly in the Athabasca River system. It is possible that poor water quality (e.g., pulp mill and municipal sewage effluent) degraded pygmy whitefish populations prior to their discovery in the 1970s. As a precautionary measure, potential habitat adjacent to known pygmy whitefish distributions should also be considered for protection.

Protection of this fish in Alberta is facilitated by its limited distribution in Alberta and effective cooperation between Alberta Environment and Parks (AEP) and Parks Canada. The Upper

Waterton Lake population is found entirely within Waterton Lakes National Park. The Athabasca River population is found along approximately 46 km of the Athabasca River, approximately between Jasper town site and Hinton, of which 32 km (70%) are within Jasper National Park.

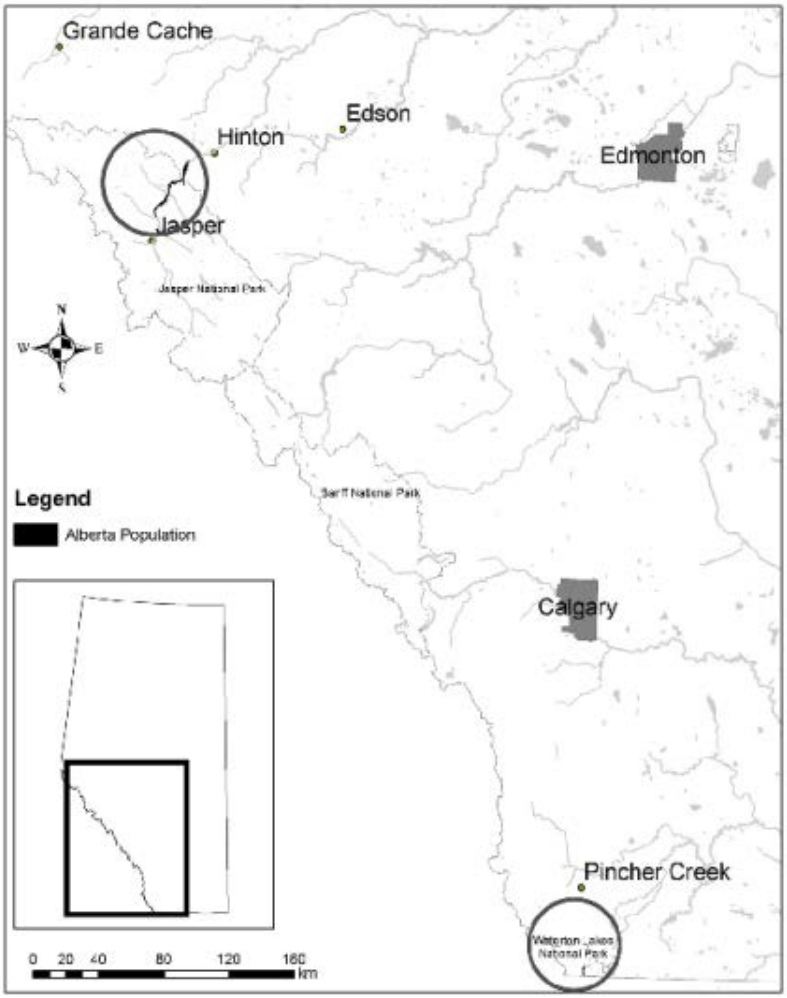

Figure 1. Pygmy whitefish distribution in Alberta.

3.2 Species Population and Trends

(Summarized from status report):

Limited data have been collected on the sizes of the two Alberta populations. The best available data suggest that the Athabasca group can be described as being composed of a few hundred mature fish while the Waterton group likely is represented by a few thousand mature fish. Central tendency estimates were: Athabasca group = 267 fish (95% CI of 50 to 450 mature fish); Waterton group = 1800 fish (95% CI of 750 to 3300 mature fish). Our assumptions

concerning these population numbers, similar to that of their distribution, is that these two groups have not had major changes in abundance.

3.3 Harvest

To our knowledge, no angler has yet reported catching a pygmy whitefish in Alberta. In Montana, however, ice-fishing for pygmy whitefish at a few Montana lakes has become a popular novelty fishery, as anglers vie to catch a new state-record fish (Flathead Beacon 2010). For the most part, fishing regulations in Alberta do not allow harvest of pygmy whitefish (except in Solomon Creek):

In Parks Canada-managed waters:

- Jasper National Park– Athabasca River section closed to angling in autumn (September and October) spawning season; no harvest of pygmy whitefish; bait ban
- Waterton National Park – Upper Waterton Lake closed to angling in autumn and winter (September to mid-May); no harvest of pygmy whitefish; bait ban

In Alberta Government-managed waters:

- Athabasca River section – open for angling from 01 April to 31 October, closed November to March (inclusive); no harvest of pygmy whitefish (all species 0 limit in this section); bait ban
- Solomon Creek (and other tributaries of Athabasca River) – open for angling 16 June to 31 October; bait ban; pygmy whitefish is not listed as sport fish, therefore there are no restrictions on the number kept during the open angling season. AEP is seeking a federal amendment to Section 1 of the *Alberta Fisheries Regulations* (1998) to have pygmy whitefish added to the list of game fish so that restrictions on harvest may be implemented. This action, however, is not expected to result in any loss of sport fishing opportunities, or to increase pygmy whitefish populations.

We found no information on traditional use of pygmy whitefish by Indigenous peoples. These fish are likely too small, too uncommon, and too difficult to catch to have been an important fish for Indigenous peoples. Overharvest by Indigenous peoples should not be considered a plausible threat to this species.

3.4 Rescue Effects

Both Alberta populations are effectively isolated from other pygmy whitefish and have no realistic opportunity of natural re-colonization in the event of a population-level collapse. The Athabasca group may have a tentative connection to another population in the Saskatchewan portion of Lake Athabasca. This connection, however, is over 1300 km in distance and despite very intensive fisheries sampling in the intervening river and lake systems (i.e., much of this system is monitored as part of Alberta's oil sands environmental monitoring), only two pygmy whitefish have been ever captured (near Whitecourt), leading the Endangered Species Conservation Scientific Sub-Committee (2011) to consider these as vagrant fish and not likely representing a population. The Waterton group is not connected to any other pygmy whitefish

populations, and is in fact the only known population in the entire Churchill-Nelson continental watershed (ASRD and ACA 2011). In addition, it's possible that each population is locally adapted to its respective environment, adding further challenges associated with natural recolonization and/or rescue efforts.

The nearest pygmy whitefish populations are found in Yellowhead Lake, British Columbia (Fraser River-Pacific drainage), 45 km from Alberta's Athabasca population (Mackenzie River – Arctic drainage), and in Montana's Macdonald Lake (Columbia River – Pacific drainage), 40 km from Alberta's Waterton Lake fish (Nelson River – Hudson Bay drainage). We therefore assume the Alberta fish are somewhat genetically distinct from these adjacent populations, reducing the value of artificial rescue effects; however, this assumption of genetic distinction should be quantified. It is important that the genetic attributes of these fish be quantified soon, and prior to a potential population-level collapse, for the obvious reason that it is impossible to measure genetic attributes without samples.

3.5 Life History Limiting Factors

Both populations of pygmy whitefish in Alberta are found in cold, clean, well-oxygenated water. We can assume these are life history requirements. Additionally, although spawning sites in Alberta are undocumented, other whitefish species require clean gravel with oxygenated upwelling. These factors restrict whitefish to select lakes and rivers along Alberta's east slopes, as is observed with the similar and related mountain whitefish (*P. williamsoni*). However, the extremely limited distribution of Alberta's pygmy whitefish, with only two small populations along the entire east slopes, suggests some additional but unknown limiting factors. Potential factors might include narrow tolerances for water quality (e.g., salinity, temperature, oxygen), an inability to disperse outside or through this tolerance window, inability to compete with certain species of fish, morphological adaptations to local habitats (e.g., lake or river), or other factors resulting in a statistically low colonization success over time.

The limited distribution of pygmy whitefish suggests that they are not adaptable to a wide variety of environmental conditions and it is likely that any change in conditions such as habitat loss or degradation will be detrimental. For example, pygmy whitefish are currently not found upstream of the Miette River or the Jasper townsite, so would be unlikely to move upstream if there was a spill of a deleterious substance. Moreover, we lack an understanding of limiting factors to the specific populations. This highlights the need to be precautionary in planning for the protection of this species.

Of these two isolated populations, the Athabasca River group has the lowest numbers, and the Waterton Lake group has the smallest distribution. The main conservation concerns for this species in Alberta were based primarily on their small population sizes, limited distributions and lack of any potential natural re-colonization from adjacent or connected populations. The key threats for the Athabasca group are primarily risks of potential spills of deleterious substances along the Athabasca Yellowhead Pass transportation corridor, and to a lesser extent, potential sewage release from the Jasper townsite. Both population groups could be affected by introduction of exotic fishes and extreme weather events related to climate change.

3.6 Analysis of Population-level Threats

The population-level threats for this species (within the foreseeable future, i.e., five years) are presented in Table 1, based on the rationale of threats described in the following sections. Detailed explanations for threats assessments follow after the table. We used the following definitions for the threat analysis:

Probability: high >1 /yr, moderate once every 1 – 10 yr, low < every 10 yr; only considers probability of a threat to pygmy whitefish, e.g., a highway accident releasing no fuel into the river is no threat.

Consequences: severe = single incident very likely to affect entire population, high = single incident potentially affecting entire population, moderate = single incident unlikely to affect entire population, but locally high consequences, low = single incident may have local, short-term effects.

Vulnerability: high = limited ability to escape or avoid incidents; moderate = some ability to avoid or escape incidents; low = ample ability and opportunity to avoid incidents.

Exposure: increasing = risk to population of being exposed to a spill is increasing over time; low = no change in risk over time; very low = negligible risk and not expected to increase.

Probability of Mitigation: this considers two components: 1. efficacy of preventative actions to minimize the likelihood and/or impact of a spill, and 2. ability to minimize damage to habitat after a spill (based on similar situations and/or expert opinion; considers volume of spill). High = will greatly reduce potential of spill (low volume); moderate = will help to reduce potential of spill but habitat will still be affected due to volume of spill.

Table 1. Population-level threats for pygmy whitefish in Alberta.

Threat	Probability	Consequence	Vulnerability	Exposure	Probability of Mitigation
Athabasca population					
Highway spills	high	low	moderate	increasing	high
Pipeline spills	very low	high	moderate	increasing	moderate
Railway spills	moderate	high	moderate	increasing	moderate
Sewage spills	very low	low	moderate	low	high
Waterton population					high
Spills (all kinds)	low	very low	very low	very low	high
Both populations					
Overharvest	insignificant	insignificant	insignificant	insignificant	not necessary

Exotic species	low	moderate	low	low	not addressed in this plan
Climate change	high	high	high	increasing	out-of-scope

3.6.1 Athabasca Group

Most of the Athabasca group habitat is in Jasper National Park, and as such is protected from industrial disturbance. The habitat outside of the park boundary (approximately 14 km) is small and there are currently no industrial activities in that stretch of the Athabasca River, nor or any planned in the near future. For this reason, there is no threats analysis for potential industrial activities. However, pygmy whitefish habitat will need to be identified to potential industrial proponents and other developers, who must confer with AEP about activity restrictions as per riparian habitat protection for listed fish (see the *Alberta Athabasca Rainbow Trout Recovery Plan 2009-2014*; Alberta Athabasca Rainbow Trout Recovery Team 2014).

The primary threat to habitat is the potential spill of deleterious materials. The entire 46 km reach of river habitat of the Athabasca group is closely paralleled by a major highway, a twinned pipeline and a railway corridor. The Athabasca / Yellowhead corridor is a major transportation route between Alberta and the Pacific Coast. This transportation corridor extends upstream for a total watershed distance of 85 km, and a spill of deleterious substances into the water anywhere along this corridor (upstream of, or within, pygmy whitefish range) could threaten the fish and the occupied habitat. The impact of the spill varies with location, type and volume of substance, and time of year.

For the purposes of this report, a deleterious substance is, as defined by Canada's federal *Fisheries Act*, Section 34(1a): "any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water" (also see Dudley and Walden 2005). Considering previous *Fisheries Act* investigations in Alberta, deleterious substances have included grain, fertilizer, oil, coal, petrochemicals, industrial chemicals, ores, and agricultural and municipal waste.

Spills of deleterious substances are of significant concern and a major spill could be catastrophic to the pygmy whitefish population. Large quantities of potentially deleterious substances, such as grain and oil, are shipped by rail and pipeline through this corridor. The river reach of pygmy whitefish habitat is also immediately downstream from the town of Jasper sewage treatment plant.

Highway Spill Threat Analysis

Probability: Parks Canada data show 0.12 billion vehicle-km/yr on this route (Parks Canada 2010). Alberta Transportation (2014) indicates the probability of an injury or fatality of 342

accidents/billion vehicle-km. Therefore, there is a probability of 41 vehicle accidents/yr or a high probability.

Consequences: Parks Canada staff report very few accidents resulting in significant fuel or transport truck spills into the river. The volumes of transport trucks are relatively small, likely resulting in local effects, therefore low to moderate consequences to the population.

Vulnerability: Pygmy whitefish may be more vulnerable during winter, when potentially concentrated into small overwintering pools with low winter river flows. Overwintering eggs of these autumn-spawning/spring-hatching fish would be especially vulnerable. Winter also has a higher probability of vehicle accidents. If a low-volume spill occurs during summer, vulnerability would be much lower as fish could escape up tributaries or into side-channels. Overall year-round vulnerability is moderate.

Exposure: Vehicle traffic increased by approximately 15% during the period of 1997 to 2008. This trend is expected to continue as human populations in Alberta and British Columbia increase. The exposure to these types of accidents is therefore increasing.

Mitigation: The probability of effective preventative mitigation (i.e., identify high-risk accident zones and implement structural and/or maintenance improvements) would appear to be high, also taking into account the low volume of spill expected, refer to details in Strategy 2.

Highway Threat Analysis Summary: This type of spill may have a high probability, but low consequence because of the small volumes (unless spills are chronic). Preventative mitigation in the probable locations of higher vulnerability and exposure would minimize this threat.

Pipeline Spill Threat Analysis

Probability: The Trans Mountain Pipeline (operated by Kinder Morgan Canada) corridor extends along the known pygmy whitefish habitat and upstream along the Miette River. Currently a single pipeline is in use, but this will be an operational twinned pipeline in about 2-3 years. The average number of all pipeline incidents in Alberta, of which ruptures and spills account for approximately 90%, has remained steady at approximately 1.5 incidents per 1000 km/yr (Alberta Energy Regulator 2013). Therefore, the annual spill/rupture probability in the known habitat and upstream reaches (85 km) is approximately 0.15 spills/yr. However, Trans Mountain (2014) reports a total of 82 spills along their pipeline from Edmonton (through Jasper) to Vancouver since 1961 (a rate of 1.5/yr), and only one spill was reported in Jasper during this 53 year period (near Pocahontas during the 1970s). This is lower than the provincially expected average of 8 spills over this period. Pipeline spills with a population-level effect within whitefish range in Jasper therefore appear to have a very low probability of occurrence. Once operating as a twinned pipeline this probability will increase slightly due to the increased volume of oil being transported.

Consequences: Pipeline volume is currently 300,000 barrels/day (bpd; 0.55 m^3/s; Trans Mountain 2015). This is in comparison to Athabasca River winter river flows of approximately 20m^3/s, and summer flows of 200m^3/s. During low winter flows, a pipeline break could result in a spill of 3% of the river volume for as long as the break flows. The amount of time taken to detect

and shut down the spill influences the volume released. With a spill of heavy, low-viscosity bitumen or diluted bitumen (i.e., sinking and directly affecting incubating eggs and fry; Dollhpof *et al*. 2014; Walker *et al*. 2016), this could have a severe population-level consequence.

Vulnerability: Very few pygmy whitefish have been found in tributary streams, suggesting that the mainstem Athabasca is a key habitat. The two lakes along the mainstem Athabasca River (Jasper Lake and Brule Lake) would slow the transport of oil to reaches further downstream. Pygmy whitefish may be more vulnerable during winter, when concentrated in shallow pools with low flow. Moreover, under conditions of partial or total ice cover, spill containment can be complex and difficult with enhanced human safety concerns, so mitigation should be preventative (Andrishak and Hicks 2011).

The vulnerability of the entire population of pygmy whitefish to a single oil spill is low, but major portions of the population could exhibit severe vulnerability. The overall vulnerability of this sub-group would be moderate, interpreted as a mix of severe in some segments and low in others.

Exposure: Trans Mountain (2015) proposes to increase capacity from 300,000 bpd to 890,000 bpd (1.6m^3/s), or up to 8% of winter river flows when the twinned pipeline is operational. Additionally, oil being transported is expected to be heavier than current oil, increasing the risk of exposure to severe population-level effects (Dollhopf *et al*. 2014). Although a low-volume spill may affect only one bank of the Athabasca River and allow fish to escape initial effects, whole-river mixing and long-term habitat loss may be a consequence of large-volume spills (Dollhopf *et al*. 2014). If a pipeline spill were to occur and enter the river anywhere along or upstream of pygmy whitefish habitat, the entire river habitat reach could be affected within a few hours.

Mitigation: Pipelines are equipped with check valves to stop flow when a rupture/spill is detected, and emergency spill response protocols are in place. The amount of oil that could be released into the river is dependent on the time until detection of a spill, and the efficacy of clean-up is dependent on response time and local conditions, such as ice cover. Even with a short response time, fish and fish habitat will be affected. Preventative mitigation is key (i.e., identify high-risk accident zones and implement structural and/or maintenance improvements). The probability of mitigation is rated as moderate based on the likelihood of successful preventative actions to reduce the occurrence and impact of a spill, while taking into account that a spill of deleterious substances into the water will affect fish habitat in some capacity. Refer to details in Strategy 2.

Pipeline Threat Analysis Summary: This type of spill has a low probability, but with potentially severe consequences that could include the loss of the pygmy whitefish population, especially with proposed increases to higher volumes of oil being transported. If the oil gets into the river, it would be difficult or impossible to remove before polluting significant portions of pygmy whitefish range. In winter a spill would be difficult to contain or clean. This type of spill could potentially be reduced by identifying high-probability spill locations and implementing preventative mitigation (e.g., engineering solutions).

Railroad Spill Threat Analysis

Probability: The Canadian National Railway Company (CN) operates track alongside the Athabasca and Miette Rivers, for a distance of 85 km, including track adjacent to, and upstream of, the Athabasca pygmy whitefish reach. For the period of August 2015-August 2016, CN reports an average of 29.4 trains/day (K. Graf, CN; pers. comm.) within Jasper National Park. Based on 2014 statistics, freight traffic in Canada continues to increase (Transportation Canada 2014). The rail accident frequency in Canada involving dangerous goods was 1.4/million train-km/yr (1999-2008; Transportation Safety Board 2009), suggesting that the frequency of train accidents involving deleterious substances in the Jasper corridor could be 1.5 accidents/year. However, these statistics may not represent traffic or collision rates in the Yellowhead corridor.

Consequences: The consequences to pygmy whitefish of a derailment releasing deleterious material depends on the location, material and volume spilled. For example, a rail derailment of 43 cars spilled 149,500 L of oil into Wabamun Lake in 2005 (DeBruyn *et al*. 2007; McDonald *et al*. 2007). Approximately 82 km^2 of fish habitat were affected and the fishery remains closed. For perspective, the entire habitat area of pygmy whitefish in the Athabasca River is only 9 km^2.

Many goods carried by railways in Canada are substances considered by the *Fisheries Act* (2016) as deleterious (e.g., grain, fertilizer, oil, coal, petrochemicals, industrial chemicals, ores and minerals). The most common item carried by rail in Canada is coal, followed by wheat and petroleum products (Railway Association of Canada 2015). The consequences of a significant derailment or railway spill of deleterious substances on fish and fish habitat may be high.

Vulnerability: If spills were to occur in or upstream of the pygmy whitefish habitat, the whitefish would be fully exposed to the spill, with little opportunity to escape (refer to Pipeline Spill Threat Analysis for details). Pygmy whitefish may be more vulnerable during winter (refer to Highway Spill Threat Analysis for details). Depending on the toxicity and volume of the material, and time of year, whitefish could be highly vulnerable to a spill. A railway spill of oil would likely be a lower volume than a pipeline spill, but would still have severe consequences. Spills allowing algae growth, such as from grain and fertilizers, can result in eutrophication and subsequent oxygen depletion (review by Smith and Schindler 2009). Eutrophication (winterkill) has resulted in the loss of fishes in several rivers in Alberta (Norris 2012). The vulnerability of the entire population of pygmy whitefish to a single oil spill is low, but major portions of the population could have severe vulnerability. The overall vulnerability of this sub-group would be moderate, interpreted as a mix of severe in some segments and low in others.

Exposure: Train traffic volumes fluctuate with market demand, but in general, oil by rail is increasing (CAPP 2014a). CAPP (2014b) estimated that oil-by-rail would increase from approximately 200,000 bpd in late 2013 to 700,000 bdp by 2016. The National Energy Board of Canada, however, showed that actual transport of oil by rail increased even more, to 1 054 679 bpd in 2016 (National Energy Board 2017) . Although these figures are for continent-wide increases, it is reasonable to conclude that rail transport of all products moving through the Yellowhead Pass may increase.

Mitigation: Location of spill, type and volume of substance and time of year will influence the success of mitigation. Even with a short response time, fish and fish habitat will be affected, so

preventative mitigation is key. The probability of mitigation is rated as moderate based on the likelihood of successful preventative actions to reduce the occurrence and impact of a spill, while taking into account that a spill of deleterious substances into the water will affect fish habitat in some capacity. Refer to details in Strategy 2.

Railroad Spill Threat Analysis Summary: The probability of a train derailment releasing deleterious substances into pygmy whitefish habitat is likely moderate, and the potential of related population-level effects of spills of deleterious substances appears both high and potentially increasing. Although after-spill mitigation of certain spills (e.g., petrochemical, all spills in winter) is difficult, preventative mitigation is possible and should be investigated.

Municipal Sewage Spill Threat Analysis

Probability: The Jasper sewage treatment plant uses large-volume in-line filtration rather than settling ponds. If this system fails, it will not suddenly release a large volume of sewage as would a breached or failed settling pond system. A back-up pond system (four ponds) is in place, and a sequential failure of both systems (i.e., the in-line system failing resulting in the back-up series of ponds filling, with all four then failing and spilling) would be highly unlikely. The sewage treatment involves primary and secondary treatment, followed by UV treatment, then exfiltration to a settling and filtration pond. Probability of a spill is very low.

Consequences: Large volume municipal sewage pond spills in Alberta have resulted in major fish kills (e.g., Battle River, June 2009; Conjuring Creek, May 2014). Without a storage pond creating the potential for a single spill, however, the large volume of flow in the Athabasca River (100-300 cms (cubic metres per second) during summer, >10 cms winter) compared to the flow of the in-line filtration system (0.06 cms) would reduce the severity and consequences of sewage release in the Jasper area. The overall consequence is low.

Vulnerability: No specific studies on oxygen requirement in pygmy whitefish have been conducted, but the con-generic mountain whitefish generally require moderately high levels (>6 ppm) of oxygen (Siefert *et al*. 1974). One study of pygmy whitefish in an unusually shallow and eutrophic lake in British Columbia found that these fish were able to tolerate low levels of oxygen, but the authors cautioned against extrapolating these findings to other populations of pygmy whitefish (Zemlak and McPhail 2006). As a precaution, we assume that the vulnerability of pygmy whitefish to eutrophication and low oxygen levels is moderate. In other foothills Alberta streams (in the Grande Prairie area), eutrophication has resulted in the complete loss of the entire resident fish community (Norris 2012). The overall vulnerability is moderate.

Exposure: Pygmy whitefish habitat, identified to date, commences approximately 15 km downstream of the Jasper sewage treatment plant outflow, with much open-water and aeration during winter. The risk of exposure of pygmy whitefish to oxygen-depletion caused by sewage release is very low.

Mitigation: Reducing the already-low likelihood of a sewage release is high, refer to Strategy 2 for details.

Sewage Threat Analysis Summary: The threat of a sewage release causing a kill of pygmy whitefish appears to have a low probability, with low consequences. Preventative mitigation would be effective, hence low risk to fish.

3.6.2 Waterton Lake Group

No significant human development or transportation corridors occur in the upper watershed draining into Upper Waterton Lake other than the development associated with the Hamlet of Waterton Park. Few people reside in Waterton Park (e.g., the 2011 Canada Federal census listed a population of 88 people), but tourist visitation can be high (e.g., 2013 visitation of 420,000). The potential threat of spills from vehicles or sewage systems near the Hamlet should be recognized and discussed with stakeholders. The current municipal sewage system would appear to be no threat, as the lagoons are located well downstream of Upper Waterton Lake. Moreover, the deep-water dwelling pygmy whitefish are not particularly vulnerable to surface spills near the development, which is both near the lake outlet and at the downwind end of the lake. The threat of deleterious substances both spilling into and affecting pygmy whitefish habitat in Upper Waterton Lake is lower than the threats to habitat and populations in the Athabasca River.

3.6.3 Threats to Both Populations

Overharvest

There are no recorded instances of anglers catching pygmy whitefish from either Alberta population. The ice fishery that has developed in Montana for pygmy whitefish is unlikely to develop in Alberta, as Waterton Lake is closed to angling during the winter and no lake–dwelling pygmy whitefish have been found in the Athabasca area. Additionally, in both national parks, and in the mainstem Athabasca River, angling harvest of pygmy whitefish is prohibited. Harvest is permitted in the tributaries of the Athabasca River in Alberta, but few if any pygmy whitefish are assumed to be resident in these streams (based on extensive and intensive stream sampling). The threat to pygmy whitefish from overharvest appears to be insignificant.

Threat of Exotic Species Introductions

Exotic species such as stocked trout, including lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis)*, brown trout (*Salmo trutta)*, and tiger trout (brook trout x brown trout) can have harmful effects on pygmy whitefish, through either competition or predation (Hansen *et al*. 2008), but pygmy whitefish have also shown their ability to co-exist with exotic fishes (Zemlak and McPhail 2006), including in the Athabasca River in Jasper. Stocking of exotic fishes by both Parks Canada and the provincial government has been stopped in the ranges of pygmy whitefish. Intentional stocking or illegal introductions of fish is a potential threat, and effects on pygmy whitefish should be considered if planning introductions. Mitigation of illegal stocking has typically used publicity and education programs, and even boat inspections (ASRD 2014), but illegal stocking of fish has continued to occur in Alberta (Elgin *et al*. 2014, Rezansoff *et al*. 2015). A realistic “if harmful exotics are found, what will we do?” plan would be a responsible action (IUCN 2013). Another potential source of exotic introductions is the use of live bait by anglers. Bait bans for anglers are already in place for both Alberta watersheds with pygmy

whitefish and may also be a useful legislative measure to prevent exotic introductions from use of live bait in adjacent downstream watersheds.

No specific mitigation strategies to deal with exotic species are included in this plan because the threat is low and there are already provincial strategies in place to deal with exotic species.

Climate Change

Climate change predictions for pygmy whitefish ranges in Alberta are alarming (Barrow and Yu 2005; Sullivan *et al*. 2013). The Athabasca River population could experience considerable increases in mean annual temperatures (2˚C to 6˚C), with mean warmest month temperatures increasing from 14.6˚C to over 19˚C (Western North America Climate scenarios up to year 2080, Wang *et al*. 2012). These temperatures are well above those in current core distributions of pygmy whitefish ranges in British Columbia. Athabasca River pygmy whitefish would be unable to migrate much further upstream in the mainstem because of the natural barrier of Athabasca Falls (approximately 40 km upstream of the known distribution of pygmy whitefish). This small potential movement also assumes there is no other barrier to current movement (this is uncertain, as there are no pygmy whitefish found upstream of Jasper townsite now). Reductions in glacier-melt source flow would further increase water temperatures.

For the Waterton group, pygmy whitefish may be able to find thermal refuges by using deeper water, although increases in water temperature would certainly reduce the amount of habitat available to this population. The climate change predictions for the Waterton area are particularly severe in terms of increases in growing degree-days (GDD>5^0C). This is a metric widely used by ecologists and agriculturalists to measure the heat accumulation in a region (Neuheimer and Taggart 2007). In the Waterton area, the GDD>5^0C will rise from the current value of 1039 (mean decade 2000–2010), to an estimated GDD>5^0C = 1807 by the year 2055 (Climate WNA 2015, using CGM model “CanESM2 rcp45_2055”, Wang *et al*. 2012; using software updated to 2015). This is considerably warmer than current-day Medicine Hat. Potential thermal refuges must also align with appropriate prey.

Mitigation of most potential climate change effects are beyond the scope of this plan. Maintaining a healthy population of pygmy whitefish, however, provides resilience for effects of climate change. In addition, maintaining natural groundwater flows and riparian habitat through effective land use practices and regulations will mitigate certain effects of climate change.

4.0 Recovery Goal and Indicators

Some Threatened and Endangered species within Alberta are designated as such because of factors that cause them to be naturally rare on the landscape, such as existing at the northern periphery of their range in North America. In such cases, a recovery goal is not warranted; rather, a maintenance goal is more appropriate. Such is the case for pygmy whitefish. While the terms “recovery” and “maintenance” will both be used herein, it is important to clarify that the goal for this species has a maintenance intent.

4.1 Goal

To maintain current pygmy whitefish population size and range in Alberta with minimal risk of loss of populations or habitat, particularly from the accidental spill of deleterious substances.

4.2 Indicators

Population estimates calculated as density-approximated catch rates as per the following:

a. Athabasca River: percentage of 2-km reaches in which pygmy whitefish are detected (10% detection rate) using autumn electrofishing sampling from boats (Scheik 2014)
   Target: pygmy whitefish detected in at least 10% of sampled reaches with no negative trend.
b. Upper Waterton Lake: percentage of pygmy whitefish captured in autumn net sets (100% detection rate; nets = 33m Nordic-style multi-mesh nets, set for 24h, at depths greater than 30m in Upper Waterton Lake; Rasmussen *et al*. 2009).
   Target: pygmy whitefish detected in 100% of described net-sets with no negative trend.

5.0 Habitat Needed To Support Recovery

Although specific details about the life history of pygmy whitefish are lacking, we assume that all life stages are sensitive to changes in water quality, such as decreases in oxygen levels and increases in temperature; immature fish have been captured in the same places as adults. Their narrow range suggests that pygmy whitefish may have limited tolerance for certain environmental factors. We expect that specific features are needed for spawning and overwintering habitat, such as protected side channels (refer to Species Distribution and Trends). Some of these types of sites have been identified, but not all are known and habitat features in river systems are not static. Therefore, all habitat within the current range is considered essential for pygmy whitefish and needs to be maintained in a natural state (see Figure 1).

Currently occupied habitat (Athabasca River: from Maligne River confluence to Solomon Creek confluence; and Upper Waterton Lake: in entire lake, at appropriate depth strata (>30m depth)) is adequate to support known pygmy whitefish populations.

Habitat used by pygmy whitefish in the Athabasca River is shared by several fish species, including the “at risk” species bull trout and Athabasca rainbow trout, with which they share general habitat requirements. The *Alberta Athabasca Rainbow Trout Recovery Plan 2014-2019* (Alberta Athabasca Rainbow Trout Recovery Team 2014) provides actions to maintain and improve fish habitat upstream and downstream of Hinton (the latter would also support potential pygmy whitefish range expansion). Implementation of the Athabasca Rainbow Trout Recovery Plan will therefore maintain habitat for pygmy whitefish, so actions are not duplicated in this plan. Actions include:

- Develop Regional Access Plans (RAP) to identify and address problematic stream crossings and linear disturbances
- Maintain natural stream flow regimes.
- Identify and decrease the number of point sources contributing to sedimentation.
- Identify and decrease the number of point sources contributing to water quality degradation and reverse the trends of degradation from non-point sources.

In the event of proposed development in pygmy whitefish habitat, the conditions for habitat protection outlined in the *Alberta Athabasca Rainbow Trout Recovery Plan 2014-2019* (Alberta Athabasca Rainbow Trout Recovery Team 2014) should be consulted and applied.

6.0 Recovery Strategies and Actions

6.1 Strategy 1: Track population distribution and density through inventory and monitoring

Currently, a systematic monitoring program does not exist and is needed to effectively evaluate whether the current population and distribution are being maintained. A maximum interval of five years is recommended unless the habitat conditions (e.g., fragmentation, flow, water quality) appear to be deteriorating. Water quality is monitored regularly by AEP and some monitoring occurs in the national parks.

Desired outcome

Sufficient monitoring data are collected so that the population objective can be evaluated at least every five years.

Performance measures

1. Completion of a monitoring plan within first year of recovery implementation.
2. The proportion of the survey identified in the monitoring plan has been completed within five years.
3. Monitoring data have been provided to Parks Canada and AEP database applications.

6.1.1 Recovery Actions

1. Work with Parks Canada to develop a monitoring plan that identifies when and where (i.e., Athabasca River from upstream of Maligne River confluence to below Solomon Creek confluence; Upper Waterton Lake in >30m depth strata) surveys will occur.
    a. Monitoring plan should be developed by biologists from Parks Canada and AEP and be compatible with previous monitoring;
    b. Plan should include changes to monitoring regime based on occurrence of negative impacts, new threats to the population, and population decline (based on monitoring results); and
    c. Monitoring should include careful attention to identification of small whitefish, especially beyond the currently known range. This may lead to the potential discovery of new populations (e.g., Rock Lake, lakes in lower Athabasca watershed) or understanding of any expansion of the current range.
2. Athabasca population monitoring: follow large-river monitoring protocols of boat electrofishing during autumn, using 2-km reaches as sampling units (Scheik 2014).
3. Waterton population monitoring: follow index-netting protocols developed by Parks Canada, using Nordic nets at greater than 30 m depth strata (Rasmussen *et al*. 2009). Careful consideration must be given before gill netting because it is a lethal monitoring technique, but the only one available for Waterton Lake. At this time there is no immediate threat to the Waterton group.

4. Ensure that pygmy whitefish status, range and associated conditions are incorporated into AEP mapping layers (e.g., Land Analysis Tool – LAT), Fish Sustainability Index (FSI), and relevant land use policies; notify local biologists and other stakeholders, as appropriate.

6.2 Strategy 2: Develop and implement effective prevention plans (including potential mitigation) to reduce risk of population-level effects on the Athabasca River group.

There are three potential types/sources of transportation corridor spills: 1. Highway, 2. Pipeline and 3. Railway. Mitigation for each type of spill has the same fundamental principles, so they have been grouped together below. Development and implementation of these strategies will vary according to the stakeholder involved, and these differences are noted.

Desired outcome

All high-risk site structural additions and/or improved maintenance practices are implemented within five years of the plan being approved. Milestone: At least one high-risk site has been improved within the second year of recovery plan implementation.

Performance measure(s)

The percentage of identified structural and improved maintenance practices that have been implemented.

6.2.1 Recovery Actions

The following should be done in consultation with AEP biologists, Parks Canada (for range in National Parks), and the relevant stakeholder/agency (Ministry of Transportation/CN/Trans Mountain):

1. Create a plan to identify and implement prevention actions. The plan should include the following three steps:
    a. Identify high-risk sites. Risk is evaluated on two criteria: 1. the likelihood of a spill where deleterious substances could quickly enter flowing waters; and 2. vulnerability of fish populations, (e.g., overwintering pools). Locations of the former will vary depending on the method of transport. Sites should be prioritized to guide implementation. High-risk sites would be characterized as follows:
        i. Highway - High-risk accident zones adjacent to flowing water, especially overwintering pools (some pool locations are known, but change semi-annually as flow and beds shift). These might include Highway 16 bridges over Snaring and Athabasca River, Disaster Point, Rocky River Highway 16 bridges, and the Highway 40 bridge over the Athabasca River.

ii. Pipeline - Areas of potential pipeline breaks such as landslide and avalanche zones, as well as those close to highways, areas of flooding and ice-jams.
iii. Railway - Areas where track runs near water and there is potential for derailments. A potential site is along the Athabasca River shoreline near Bedson Ridge, where two derailments have recently occurred, and near where fish are expected to overwinter.

b. Review current structural and maintenance practices around high-risk sites and determine where improvements are needed. Improvements (i.e., preventative mitigation options) could include, but are not limited to:
   i. Highway - Enhanced highway maintenance at high-risk accident zones (e.g. more attention to sanding and sweeping), emergency vehicle access-point construction, guardrails, and spill deflection berms and ditches.
   ii. Pipeline - Spill deflection berms and ditches, catchment ponds, and possibly pipeline strengthening. Ensure check valves are well placed in regards to high-risk locations.
   iii. Railway - Spill deflection berms or holding/catchment ponds. Spill mitigation equipment, especially vacuum pumps capable of removing large volumes of grain, and equipment to allow safe working conditions on river ice, should be readily accessible.
c. Mitigation options for response to a spill, including techniques for under-ice cleans-up, should be reviewed and enhanced if possible. Discussions should involve emergency responders who have received training to understand the types of deleterious substances of concern to fish. Mitigation options include, but are not limited to the following:
   i. All - Ready access to emergency response equipment, including containment and removal equipment as well as gear for safe working conditions on ice.
   ii. Railway - Vacuum pumps capable of removing large volumes of grain.

6.3 Strategy 3: Mitigate for major sewage release

Athabasca group: Reducing the already-low likelihood of a sewage release from the town of Jasper is plausible. Discussions could be held with the sewage treatment plant operators to make them aware of the consequences of a major sewage release and ensure they have a back-up to divert sewage into the emergency holding pond, and that the holding pond is adequately maintained for that purpose.

Waterton group: With no development on the Upper Waterton Lake, the risk of a sewage spill is negligible.

Desired outcome

Adequate back-up system to deal with major sewage release within five years of plan approval.

Performance measure(s)

Percentage of identified safety protocols that have been implemented.

6.3.1 Recovery Actions

Meet with sewage treatment plant operators to:

1. Ensure awareness of consequences of a major sewage release, (i.e., sensitivity of fish and fish habitat).
2. Determine presence of a back-up system to divert sewage into a suitable and adequately maintained emergency holding pond.
3. If a back-up system is lacking or insufficient, recommend ways to improve.

6.4 Strategy 4: Have the ability to reintroduce a population in the event of a catastrophic population loss

Planning for reintroductions in the event of a near- or complete population loss should be done, including identifying potential sources of pygmy whitefish donor stocks with appropriate genetic suitability and logistical practicality.

This must be approached cautiously, as clear risks are associated with transfers of organisms (IUCN 2013; Anderson *et al*. 2014). In particular, two assumptions must be tested before accepting this as a conservation option: 1) are nearby populations of pygmy whitefish genetically similar to existing Alberta populations, and 2) are nearby populations robust enough to support fish transfers? Potential nearby sources to be studied for genetic relationships include pygmy whitefish populations in Yellowhead Lake and Moose Lake in Mount Robson Provincial Park in BC (for the Athabasca group) and McDonald Lake, Glacier National Park, Montana (for the Waterton group).

As described in the IUCN (2013) guidelines for reintroductions, prior to any reintroduction, the cause for the near- or complete loss must be known and removed. Implementation of prevention plans (see 6.2) will help to minimize risks to the population. This planning and survey work should be conducted reasonably soon. The risk of a population-level loss will likely increase over time (i.e., cumulative risk), and genetic samples will be difficult, if not impossible to obtain from lost populations. In addition, depensatory ecosystem changes may occur in response to the loss of fish species (Post *et al*. 2002; Daskalov *et al*. 2007). Potential changes after the loss of pygmy whitefish could reduce the potential of a successful reintroduction.

It is important to note that planning and survey work that is conducted now would critically reduce the time needed to plan and conduct a reintroduction after a population loss. Appropriate genetic information could also be used to monitor population sizes and evolutionary potential.

Desired outcome(s)

The ability to rapidly source and distribute appropriate genetic stock in the event that a local population is extirpated.

Performance measure(s)

A. Field sampling and genetic analyses completed by 2018.
B. Completion of a reintroduction plan (if suitable genetic stocks exist within three years of recovery plan implementation).

6.4.1 Recovery Actions

Develop a team (committee) with representatives from the Government of Alberta, Parks Canada and Government of British Columbia to:

1. Identify sampling locations to better determine genetic relationships from potential source populations (potential sites include: Yellowhead Lake and Moose Lake in Mount Robson Provincial Park, BC, and McDonald Lake in Glacier National Park, Montana).
2. Identify responsibilities and timelines for conducting sampling and genetic analyses.
3. Conduct sampling as per methods cited earlier in this plan.
4. Determine if suitable genetic stock is available and, if so,
5. Develop a reintroduction plan that addresses all considerations and is endorsed by all affected jurisdictions.

7.0 Implementation Plan

7.1 Implementation timetable and costs

Table 2 outlines the priorities, partners, timing and costs for implementation of actions. Implementation will be led by AEP, in collaboration with Parks Canada. The total estimated cost for five years of implementation is $28,600.00. This cost includes staff time ($4 800), with the remaining amount for field costs and genetic analyses ($23 800).

7.2 Plan progress review, evaluation and amendment

Progress and evaluation of preventative measures and mitigation plans, along with a reintroduction plan, will be reviewed on an annual basis. If there is a lack of progress on implementation, reasons will be identified and addressed. Evaluation of actions will be based on performance measures and, pending results of the evaluation, adjustments may be required to better define and/or achieve performance measures.

Evaluation of population density and distribution will be made on a five-year interval, as per the monitoring cycle in the recovery plan. If there are perceived changes and/or increased risks to the pygmy whitefish distribution and density, or to habitat quality, the monitoring interval will be shortened and plan amendments may be required. The Team will be responsible for amendments, consulting plan contributors as required and informing the Executive Director of the Fish and Wildlife Policy Branch.

Annual progress updates will be prepared by the Team and submitted to the Fish and Wildlife Policy Branch.

7.3 Implementation opportunities and barriers

The success of this plan is based in large part on successful partnerships. Parks Canada is one of the primary partners and collaborated on preparation of the plan. Most other potential partners (i.e., industry, municipalities and other government agencies) were consulted during plan preparation and contributed comments. However, when mitigation plans are developed, there could be differing opinions on the necessity and timing of some actions (due to cost, resources, etc.). Developing a reintroduction plan and conducting genetic sampling requires cooperation from other jurisdictions (i.e., government of British Columbia), and no issues are anticipated because this information will be valuable to both jurisdictions.

Table 2. Timetable for implementation

Priorities have been identified based on need. Items that are considered 'necessary' may be implemented and completed before 'urgent' items if they can be achieved relatively quickly.

Item	Action	Priority*	Lead/Partners**	Year and Associated Cost					Comments
				2018	2019	2020	2021	2022	
1	Develop population monitoring plan	N	AEP, NPC	X					2 person weeks, target completion: May 2018
	Incorporate spatial data and associated information into relevant processes, (e.g. LAT)		AEP	X					Work with GOA staff, target completion: May 2018
	Conduct monitoring		AEP, NPC		x				Athabasca group -part of regular fisheries monitoring program for AEP and Parks Canada
2	Spill plans and implementation	U							
2.1	Highway spill plan		AEP, NPC - Work with Highways	X	x				1 person week, meetings and field visit. Target completion: January 2019
	Highway spill mitigation				x	x	x	x	Implementation
2.2	Pipeline spill plan		AEP, NPC - Work with Trans Mountain (possibly others)	X	x				2 person weeks, meetings and field visit. Target completion: January 2019
	Pipeline spill mitigation				x	x	x	x	Implementation
2.3	Railway spill plan		AEP, NPC - Work with CN	X	x				2 person weeks, meetings and field visit. Target completion: January 2019
	Railway spill mitigation				x	x	x	x	Implementation
3	Sewage release plan and implementation	N							
	Sewage spill plan		AEP, NPC – work with municipality of Jasper	X					1 person week, meetings and field visit. Target completion: October 2019
	Sewage spill mitigation				x	x			

4	Ability to reintroduce populations	N	AEP, NPC – work with BC government	X	x	X			2018-2 person weeks, meetings and field visit. Target completion: Dec 2018 2019-4 person weeks Lab costs and field expenses. Target completion Dec 2019 (lab analysis may take longer) 2020-2 person weeks, meetings and travel. Target completion: Oct 2020

***Prioritization**: Urgent = high priority for immediate species conservation, initiates as soon as possible; Necessary = medium priority for long term species conservation; Beneficial = lower priority, primarily directed at potential future activities.

****Lead agencies**: Alberta Environment and Parks (AEP), National Parks Canada (NPC), relevant industry or agency, i.e., proponents of development projects (Project Proponent).

8.0 Social and Economic Scan

Social and economic impacts are expected to be negligible based on the limited range and distribution of the pygmy whitefish. There are no known impacts to Indigenous people or the public (at this time, there are no recommendations to change *Alberta Fisheries Regulations* (1998)). The prevention and mitigation recommendations are considered relatively small in scale and costs to industry should be minimal. Minimizing risk of spills would help to avoid expensive clean-up efforts. Table 3 summarizes the social and economic considerations associated with actions in the plan.

Table 3. Social and Economic Considerations.

Strategy	Action	Socioeconomic Impacts (-) is a cost (+) is a benefit
Track population, distribution and density though inventory and monitoring	Develop a monitoring plan that identifies when and where surveys will occur.	(+) increased efficiency and coordination
	Monitoring of Athabasca & Waterton groups	(+) improved efficiency if combined with other fish species (+) will not interfere with recreational fishing opportunities for the public (-) costs of inventory and monitoring
	Ensure that pygmy whitefish status, range and associated conditions are incorporated into AEP mapping layers (e.g., LAT), the FSI, and relevant land use policies.	(+) improved access to information for industrial proponents (+) improved permitting efficiency (-) costs of adjusting development plans (e.g., setback distances, timing)
Develop and implement effective prevention plans to reduce risk of population-level effects on the Athabasca River group	Develop plans to identify high-risk sites, determine where structural and maintenance improvements are needed, and develop mitigation options for response to a spill.	(-) stakeholders will incur costs in implementing structural or procedural changes; however (+) changes could lead to cost savings in the long term in terms of improved spill prevention and containment (+) improved collaborative relationships between provincial government, federal government, and relevant stakeholders and agencies (-) coordination costs
Mitigate for sewage release	Meet with sewage treatment plant operators to discuss a back-up system in the event of a major sewage release.	(+) improved non-use values (existence, bequest, altruism, etc.) (-) potential costs for structural changes

Strategy	Action	Socioeconomic Impacts (-) is a cost (+) is a benefit
Have the ability to reintroduce a population in the event of a catastrophic population loss	Develop a team (committee) with representatives from the Government of Alberta, Parks Canada and Government of British Columbia to identify sampling locations, conduct sampling and genetic analyses, determine availability of genetic stock, and develop a reintroduction plan that is endorsed by all affected jurisdictions.	(+) improved collaborative relationships between provincial government, federal government, and counties (+) benefits both Alberta and British Columbia fish

9.0 Effects on Other Species at Risk

Other provincially and federally listed at-risk fish in the Athabasca area (bull trout, Athabasca rainbow trout) and in the Waterton area (bull trout, westslope cutthroat trout) will benefit from the preventative measures outlined in the plan. No negative effects are expected for any species.

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Appendices

Appendix A: Plan Contributors

Plan Contributors included:

- Department of Fisheries and Oceans (DFO) – Peter Rodger
- University of Calgary – Dr. Sean Rogers, Evolutionary Biologist and Geneticist
- Hinton Wood Products (a Division of West Fraser Ltd) – Laura Trout
- Canadian National Railway
- Kinder Morgan Canada (Trans Mountain Pipeline)
- Athabasca Bioregional Society – Carl Hunt
- Alberta Transportation
- Canadian Association of Petroleum Producers (CAPP) *
- Confederacy of Treaty Six*
- Asini Wachi Nehiyawak (Mountain Cree)*

*These organizations initially expressed interest in participating but, for varying reasons, did not provide comments.