FWCP
Fish & Wildlife
COMPENSATION PROGRAM
fwcp.ca

PEACE REGION
RIVERS, LAKES, & RESERVOIRS
ACTION PLAN

August 11, 2020

The Fish & Wildlife Compensation Program is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, Indigenous Nations, and public stakeholders to conserve and enhance fish and wildlife in watersheds impacted by BC Hydro dams.

BC Hydro Power smart
BRITISH COLUMBIA
Fisheries and Oceans Canada

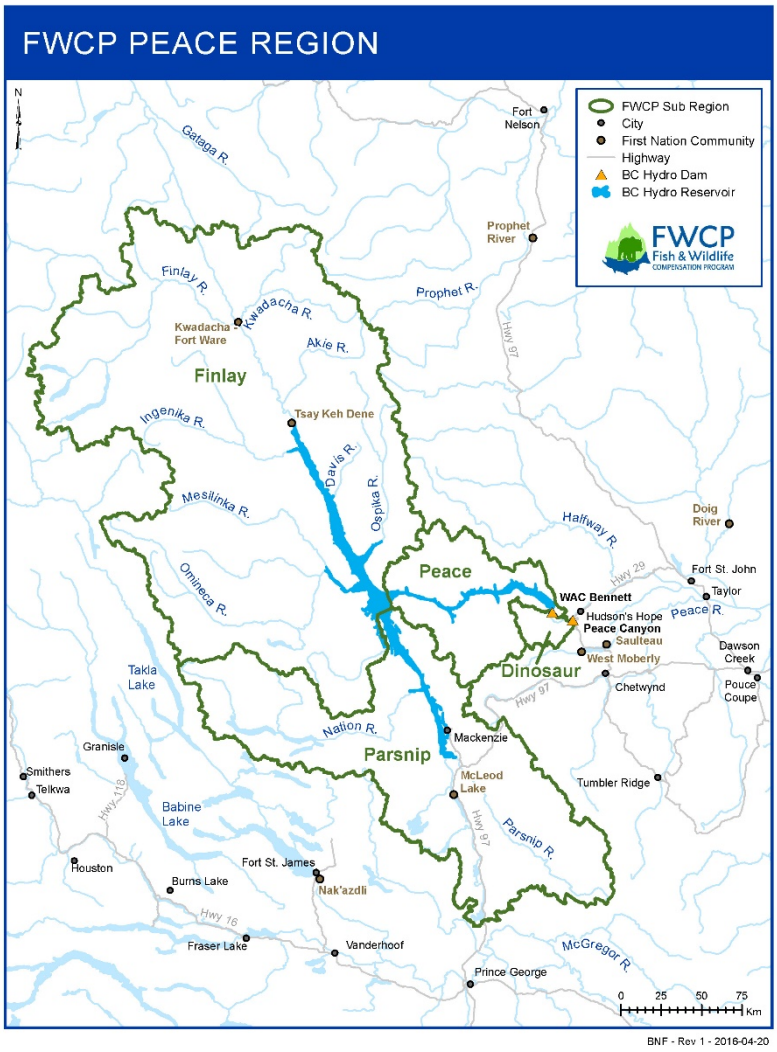

Figure 1. The Fish & Wildlife Compensation Program Peace Region boundary includes the Upper Peace River Basin, which consists of the Finlay, Parsnip, Peace, and Dinosaur sub-regions.

Cover photos clockwise from top left: Quentin Lake, R. Zemlak; arctic grayling, iStock mlharing; kokanee, Ben Meunier; bull trout, Steve Rooke; reservoir, Abe Swanson.

The Fish & Wildlife Compensation Program (FWCP) is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, Indigenous Nations, and public stakeholders to conserve and enhance fish and wildlife in watersheds impacted by BC Hydro dams (W.A.C. Bennett and Peace Canyon dams). The FWCP funds projects within its mandate to conserve and enhance fish and wildlife in Upper Peace River Basin ecosystems.

Learn more about the FWCP, projects underway, and how you can apply for a grant at fwcp.ca. Subscribe to our free email updates and annual newsletter at fwcp.ca/subscribe. Contact us anytime at fwcp@bchydro.com. Connect with us on LinkedIn and follow us on Instagram.

EXECUTIVE SUMMARY

Rivers, Lakes, & Reservoirs Action Plan

The Fish & Wildlife Compensation Program (FWCP) is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada (DFO), Indigenous Nations, and public stakeholders to conserve and enhance fish and wildlife impacted by BC Hydro dams. The Rivers, Lakes, & Reservoirs Action Plan builds on the FWCP's strategic objectives and is an update to the 2014 FWCP Lakes Action Plan, Reservoirs Action Plan, and the Streams Action Plan. This updated 2020 action plan merges aquatic ecosystems (e.g., rivers, lakes, and reservoirs) and our priority actions for those ecosystems into a single action plan.

The action plan was developed with input from BC Hydro, the Province of B.C., participating Indigenous Nations, and local communities. It specifies priority actions that will conserve, restore, and enhance fish and aquatic species in river, lake, and reservoir habitats in the Upper Peace River Basin. Priority actions are in the action tables at the end of this document. The priority actions are intended to support the FWCP's strategic objectives of conservation, sustainable use, and community engagement and related sub-objectives. Actions fall into one of five action types funded by the FWCP:

1. **Research and information acquisition** – These actions will collect information necessary to evaluate, review, and implement subsequent conservation, restoration, and enhancement actions. Examples include gathering Indigenous knowledge and values, a limiting factor assessment, and other activities to address data gaps and information needs to complete other actions.
2. **Monitoring and evaluation** – These actions will monitor and evaluate river, lake, and reservoir projects supported by the FWCP to understand the effectiveness of habitat- or species-based actions.
3. **Habitat-based actions –** These actions will conserve, restore, and enhance river, lake, and reservoir habitats. Examples include habitat creation, restoration, and enhancement; enhancing habitat connectivity; nutrient restoration; and invasive species prevention.
4. **Species-based actions** – These actions will alleviate limiting factors for river, lake, and reservoir species. Examples include restoration planning and species-specific habitat restoration and initiatives.
5. **Land securement** – These actions will contribute to investigating and prioritizing land securement and stewardship opportunities for conservation purposes.

The Rivers, Lakes, & Reservoirs Action Plan sets out priority actions for the FWCP that will guide funding decisions for FWCP projects in aquatic habitats of the Upper Peace River Basin. The focus of the priority actions over the next five-year period will be to prioritize aquatic habitats for conservation, enhancement, and/or restoration and to implement high-priority habitat-based and species-based actions. High-priority issues include addressing potential impacts of climate change and cumulative effects to aquatic ecosystems, understanding reservoir productivity and relationships to priority species, increasing the population viability of priority species, addressing fish passage, and enhancing sustenance and recreational resources, including culturally important species to Indigenous Nations, Bands, and groups.

This action plan identifies priority aquatic species associated with rivers, lakes, and reservoirs (i.e., priority species have been merged into the appropriate updated 2020 ecosystem-based action plan). Priority species for aquatic ecosystems include the focal species of Arctic grayling, bull trout, native and introduced kokanee, and lake trout, as well as many inventory species such as rainbow trout, northern pikeminnow, and freshwater invertebrates. All priority species are identified in the Cross-Ecosystem Plan, while terrestrial and semi-aquatic wildlife species are identified in the Riparian & Wetlands Action Plan and the Uplands Action Plan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION AND BACKGROUND

FWCP introduction

The FWCP action plans provide strategic direction for each region based on the unique priorities, compensation opportunities, and commitments in the region, and how they reflect the FWCP's vision and mission. The action plans describe the objectives, sub-objectives, and priority actions to support the FWCP's strategic objectives of conservation, sustainable use, and community engagement. Please refer to the Peace Region: Overview & Action Plans document for more information on the process that was followed to develop the updated 2020 action plans.

There are four updated 2020 action plans for the FWCP's Peace Region representing the ecosystems in the Upper Peace River Basin:

- Cross-Ecosystem Action Plan
- Rivers, Lakes, & Reservoirs Action Plan
- Riparian & Wetlands Action Plan
- Uplands Action Plan

This Rivers, Lakes, & Reservoirs Action Plan builds on the FWCP's strategic objectives by setting out priorities for the FWCP to guide projects within the FWCP's Peace Region to support fish and aquatic ecosystems.

The objectives and priority actions described herein have been developed with input from the Province of B.C., BC Hydro, Indigenous Nations, provincial and regional stakeholders, and local communities.

Planning priorities within action plans may not translate immediately into funded projects. Limited funding requires that priority setting be developed across the FWCP as a whole, not just within action plans. The process of selecting which actions will be implemented in any given year will occur during the annual implementation planning cycle.

Rivers, Lakes, & Reservoirs Action Plan introduction

Setting

The Rivers, Lakes, & Reservoirs Action Plan addresses the area within the Upper Peace River Basin above the Peace Canyon Dam within the watersheds of the Williston and Dinosaur reservoirs (Figure 1). The Upper Peace River Basin includes the Williston Reservoir, Dinosaur Reservoir, and consists of the Finlay (Figure 2), Parsnip (Figure 3), Peace (Figure 4), and Dinosaur (Figure 5) sub-regions. In the Williston Watershed, there are 10 major rivers (drainage >1,500 km^2), seven large rivers (400–1,500 km^2), 49 medium rivers (50–400 km^2), and 262 small rivers (<50 km^2) (Langston and Blackman 1993); however, detailed habitat assessments have been completed for only some of these. Of the five tributaries that flow into Dinosaur Reservoir, only two creeks (Johnson and Gething creeks) provide spawning and rearing areas for fish (Hammond 1987). The FWCP's Peace Region also contains 20 large lakes (>1,000 ha), 91 medium lakes (>100–<1,000 ha), and 2,547 small lakes (<100 ha) (Blackman et al. 1990). There are no natural lakes larger than 10,000 ha within the watershed (Schiefer and Klinkenberg 2004). Williston Reservoir has a large annual drawdown and Dinosaur Reservoir has fast throughput of water, making both reservoirs very different ecologically relative to natural lakes in the region. The Williston Reservoir is the largest reservoir in B.C., and the seventh largest in the world by volume, with a surface area of 1,779 km^2.

The Rivers, Lakes, & Reservoirs Action Plan addresses all tributaries within the Upper Peace River Basin, including those connected to creeks or rivers that flow directly into the Williston and Dinosaur reservoirs. There is a large diversity of streams within the Upper Peace River Basin, ranging from small creeks to major river systems. The creation of the reservoirs drastically altered these systems within the basin by inundating a sizable proportion of streams, which rapidly limited the habitat available for species that rely on stream habitats to carry out all or portions of their life history. The number of Upper Peace River Basin lakes inundated by reservoirs is unknown; however, natural lakes decreased in

number, and there were effects on many aquatic species (e.g., Stockner et al. 2000, Blackman 2001). There are also indirect impacts of reservoir creation, such as increased interactions with native and introduced lake-dwelling species whose abundances were favoured by reservoir creation (e.g., kokanee) and that use streams for parts of their lifecycle, such as spawning. Human access created by the reservoir and associated roads has partly enabled other land uses, such as forestry, mining, and gas development, which have resulted in direct habitat impacts.

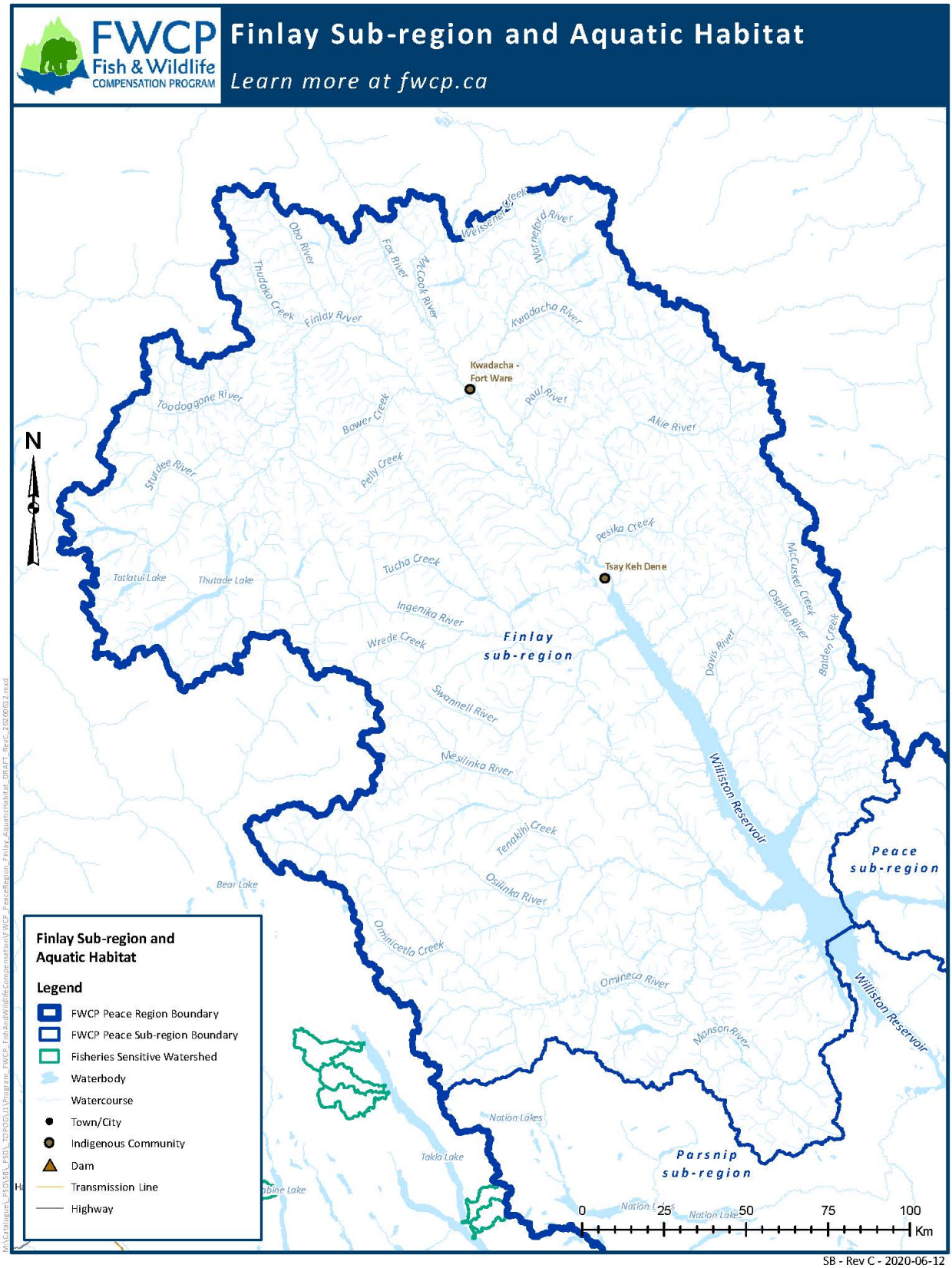

Figure 2. Aquatic habitat in the Finlay sub-region.

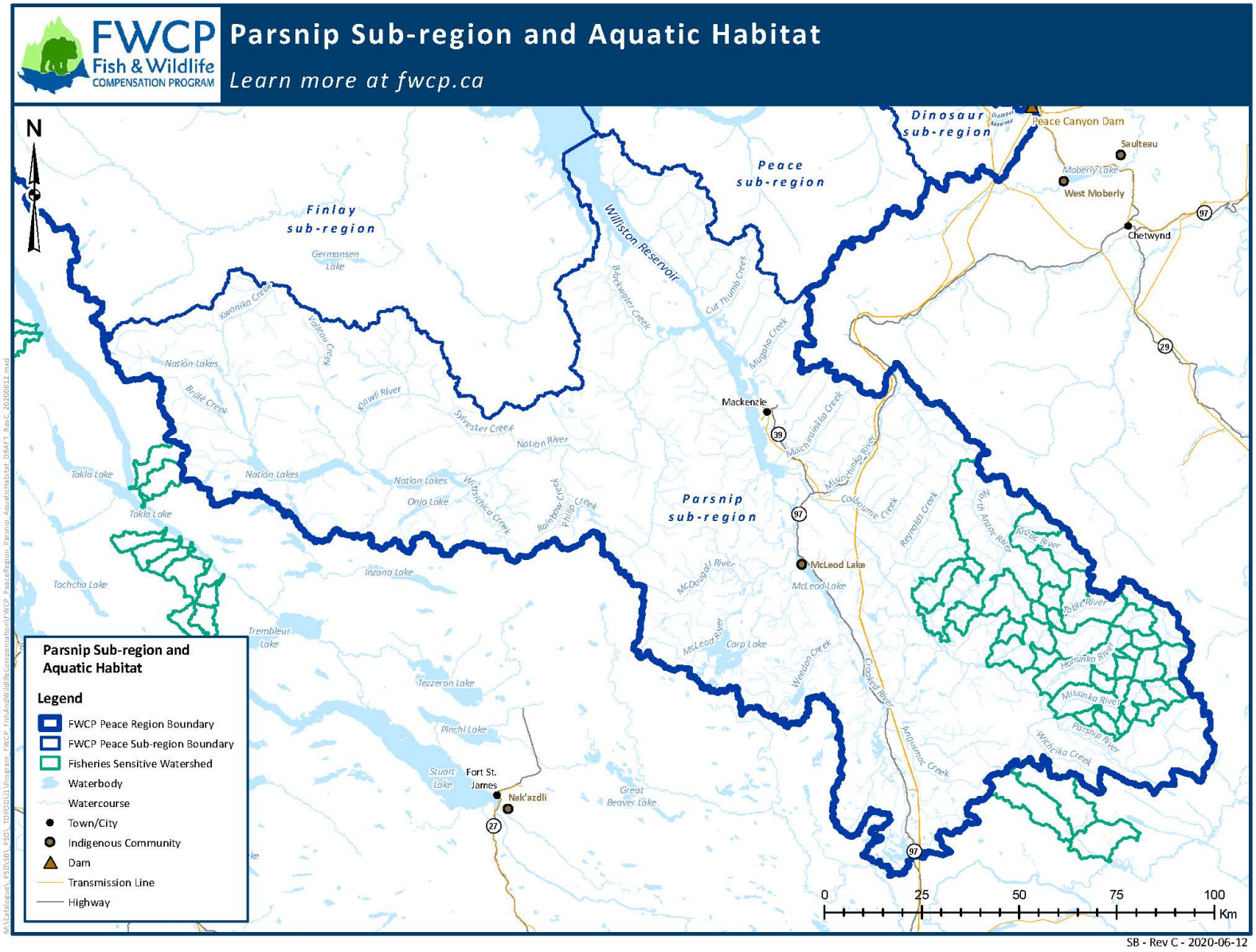

Figure 3. Aquatic habitat in the Parsnip sub-region.

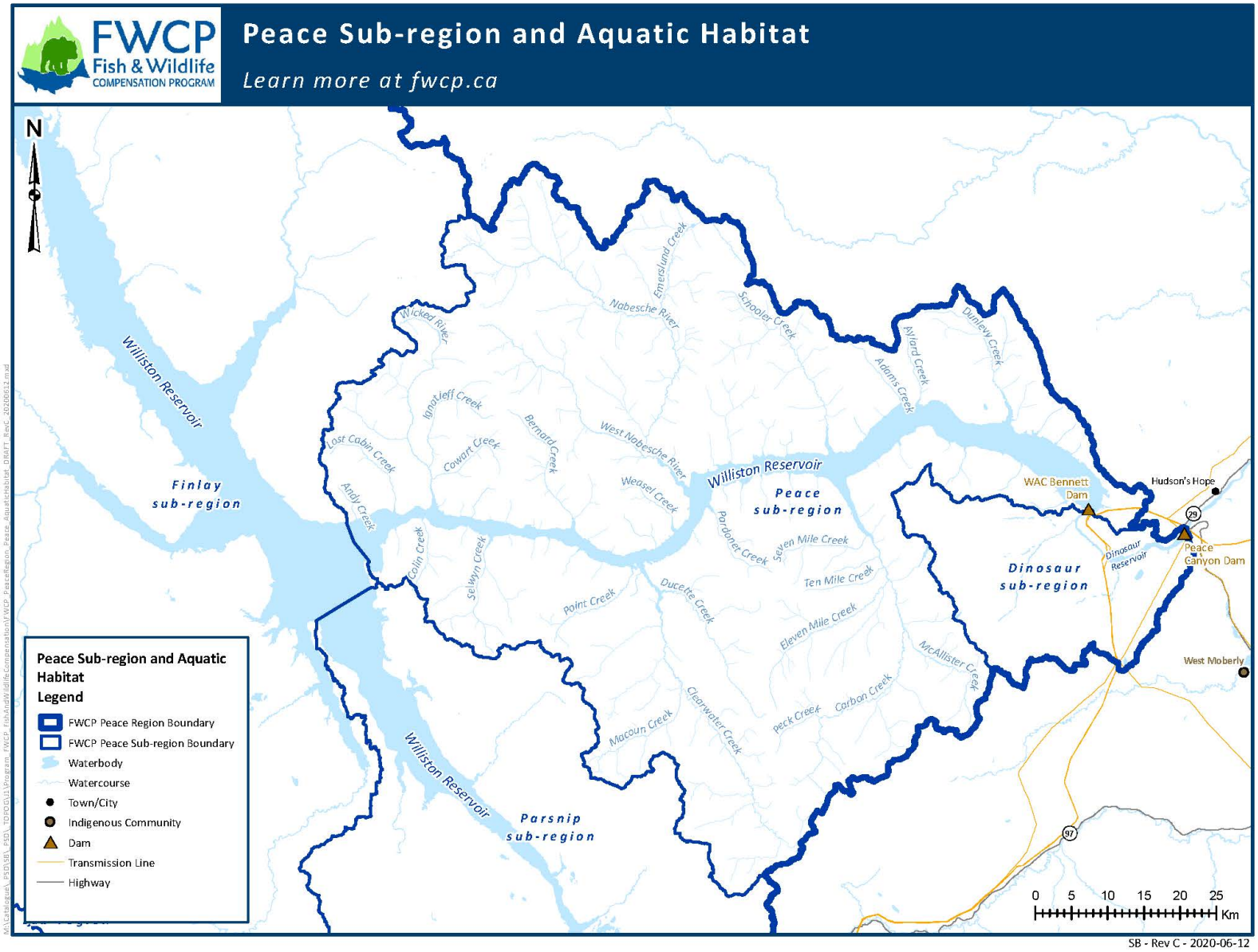

Figure 4. Aquatic habitat in the Peace sub-region.

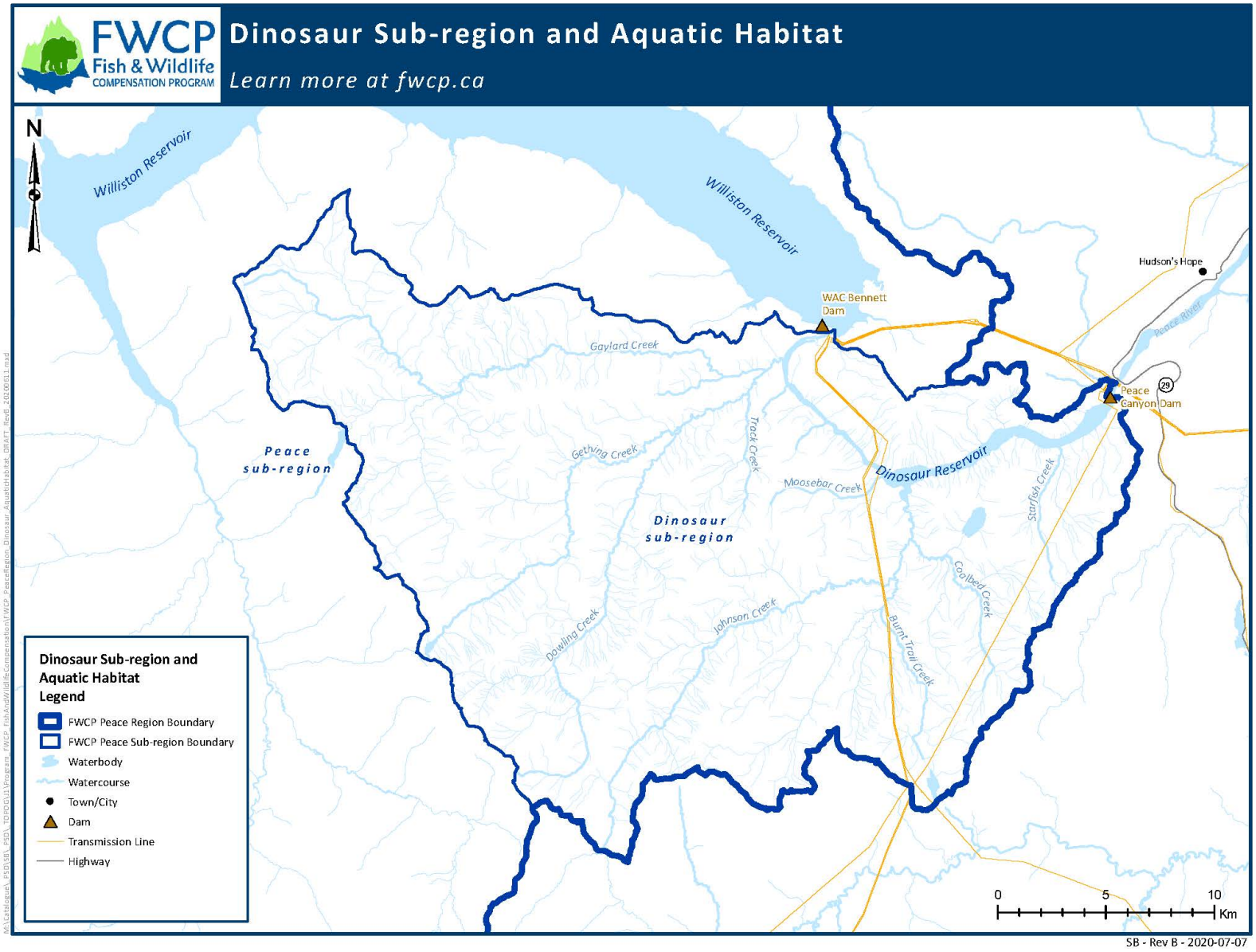

Figure 5. Aquatic habitat in the Dinosaur sub-region.

Footprint impacts and threats

The FWCP blends its obligation to address dam impacts with a forward-looking approach that recognizes continual adaptation will be required in a dynamic natural environment in order to achieve the FWCP's vision of thriving fish and wildlife populations in watersheds that are functioning and sustainable. The actions in this plan were developed to address footprint impacts of the Williston and Dinosaur reservoirs, as well as other existing and foreseeable threats to priority species and aquatic habitats in the Upper Peace River Basin, in a way that reflects the FWCP's forward-looking approach. These footprint impacts and threats, including cumulative effects and emerging issues such as other industrial land uses, climate change, and invasive species, are summarized below.

Hydro-related impacts

The creation of the Williston Reservoir resulted in large-scale habitat change, including a reduction of river habitat and the formation of reservoir habitat. In general, this change has favoured lake-dwelling species and impacted stream species (Blackman et al. 1990). Changes in aquatic species abundance and distribution have likely influenced inter-specific competition and predation patterns (Plate et al. 2012), which has likely had a positive effect on some species and a negative effect on others. For example, declines in Arctic grayling within the basin are attributed primarily to reductions in stream habitats, and there is speculation that more abundant longnose sucker, largescale sucker, rainbow trout, and slimy sculpin are outcompeting Arctic grayling.

Additional hydro-related impacts include migration barriers for fish, losses in primary productivity, alterations in water quality, entrainment, and bioaccumulations of methyl mercury. For example, impaired access to traditional spawning and rearing areas through the reservoirs has affected the genetic diversity of some fish populations. The large fluctuations in water levels of the Williston Reservoir also has seasonal impacts to stream and littoral habitat productivity. This may reduce the food supply for species that rely on littoral habitat, such as lake whitefish (Blackman et al. 1990). An increase in pelagic area and stocking kokanee that thrive in this habitat may have increased the abundance of large predators like lake trout.

Cumulative effects

Compounding the impacts to fish and their habitats, the FWCP's Peace Region continues to experience growth in many natural resource sectors, including increased development for forestry, mining, agriculture, and oil and gas exploration and extraction. These developments contribute to the cumulative impacts on aquatic ecosystems. For example, poor land- and water-use practices from logging, oil and gas activities, mining, pipelines, transmission lines, railways, and roads can all adversely affect fish habitat (Doyle and Havlick 2009). In the FWCP's Peace Region, these activities have resulted in habitat loss and degradation, such as the siltation of streambeds, which reduces egg survival, food production, and habitat suitability for fish. Drainage structures (e.g., culverts) that are poorly engineered or have exceeded their life expectancy can inhibit or completely block fish passage. The loss of streambank vegetation can also lead to reduced habitat quality from increased water temperatures, reduced cover, reduced nutrient input for food production, reduced bank stability, and increased water velocities due to loss of stream complexity (Wesche et al. 1987). This may negatively impact reservoir species that use stream habitats for part of their life cycle (e.g., bull trout). Highly sought-after game fish (e.g., rainbow trout) are vulnerable to overharvesting (Fausch 2007), and longer-living, top-predatory species (e.g., lake trout) are vulnerable to pollution (e.g., Luxon et al. 1987). Non-native species (e.g., kokanee, brook trout) have been introduced and native species (e.g., rainbow trout) have been stocked in the Dinosaur Reservoir and in lakes connected to the Williston Reservoir. Hybridization, competition, and predation can negatively impact native species and populations (Beauchamp et al. 1995).

Climate change is also a key and emerging issue for the FWCP's Peace Region. Climate model projections predict that the region can expect to experience overall increased precipitation, with warmer summers and winters, more extreme storm events, increased risk of forest fires, changes in snowpack, and decreased summer stream flow in all basins (Fraser Basin Council 2019). For aquatic ecosystems, shifts in stream flow and increasing summer water temperatures are predicted to have effects for temperature-sensitive species such as Arctic grayling and bull trout.

Limiting factors

Factors limiting the abundance and distribution of aquatic species in the FWCP's Peace Region fall into three broad categories, including habitat extent, distribution, and productivity:

Habitat extent

A large amount of stream and lake habitat has been lost through inundation, which has been replaced by reservoir habitat. There are many kilometres of remaining tributary habitat, but often only short sections are accessible due to the presence of barriers, both between the reservoir and tributaries and in the tributaries themselves. The presence of barriers is generally considered one of the most important limiting factors for fish populations in streams.

Distribution

Connectivity among habitats is important for the dispersal of fish and aquatic animals and for the seasonal movements of some species. Connectivity among stream habitats has been affected by reservoir creation; for example, aquatic habitats that were formerly continuous stream habitat are now only connected via the reservoir, which may prevent or reduce movements of some fish species among these streams (Clarke et al. 2007). Barriers within streams also restrict fish movement. Lakes that are isolated from the rest of the Upper Peace River system by barriers have lower diversity of native species compared to connected lakes (Zemlak and Cowie 2003).

Productivity

The productivity of an ecosystem is defined as its ability to grow or yield native plants and animals. Even where the extent and distribution of habitats is relatively intact, the productivity of ecosystems can be eroded by pressures such as invasive species, mechanical disturbance, soil erosion, changes in drainage patterns, as well as forest harvesting, livestock grazing, and other extractive activities. The biological productivity of the reservoirs is limited by low nutrient levels, as compared to the lakes they replaced, which were less extensive but more productive (Slaney and Lewynsky 1991, Harris et al. 2006).

Overall, aquatic productivity is limited by fluctuations in stream flow, nutrient levels, changes in temperature and turbidity, and alterations to physical spawning habitats, among other factors. For example, the natural flow regime maintains high-quality habitat for rearing fish and invertebrates, flushes sediment from interstitial spaces, and influences the recruitment of large wood debris, which provides habitat for stream species. Flow rates and timing provide important ecological cues to many species at times during their lifecycle (Poff et al. 1997).

Knowledge status and gaps

There have been many studies of the ecology, productivity, and enhancement potential of aquatic habitats in the Upper Peace River Basin (e.g., Langston 1992, Slaney 1992, Northcote 1993, Zemlak and Langston 1998, Harris et al. 2006, Langston and Murphy 2008, Plate et al. 2012), but there remain substantial knowledge gaps, particularly with respect to critical habitat (e.g., spawning habitat locations and quality), trends in abundance of species (e.g., bull trout, rainbow trout, mountain whitefish), and the understanding of the ecological impacts of the shifts in species compositions that accompanied reservoir creation. In general, species that prefer stream habitats (e.g., Arctic grayling, mountain whitefish) have declined in abundance since reservoir creation due to a substantial reduction in stream habitat (Blackman et al. 1990). Overall, there is limited available information on historical fish abundance within the Upper Peace River Basin streams. Some detailed species inventories and life history studies have been conducted in streams (e.g., Slaney 1992, Hohndorf et al. 1993, Langston and Blackman 1993, Zemlak and Langston 1998, DWB 2019), but knowledge of current status and trends is limited. Recent work to synthesize existing information in the Arctic grayling and bull trout information syntheses and monitoring frameworks (Hagen and Stamford 2017, Stamford et al. 2017, Hagen and Weber 2019), for example, have greatly increased our understanding of these high-priority species of conservation concern. However, there is a need to synthesize existing data for many species, determine conservation status and key limiting factors, and use this to inform future actions.

There have been several studies on the ecology of the Williston Reservoir (e.g., Wilson and Langston 2000, Stockner et al. 2001, Harris et al. 2006, Plate et al. 2012, Culling and Euchner 2019), but there remain substantial knowledge gaps. Species composition has changed from a community dominated by riverine species to one dominated by lacustrine species. Lacustrine species assemblages may also shift toward planktivores and piscivores rather than insectivores, whose food source is limited by degraded littoral habitats (Blackman 1992).

The small lakes and streams within the Upper Peace River Basin have a long history of fish introductions through stocking (Langston and Murphy 2008). This has provided a benefit for angling opportunities but has also resulted in the introductions of new species, notably kokanee. A summary of stocking in 47 lakes in the FWCP's Peace Region from 1976 to 2005 is presented in Langston and Murphy (2008). Rainbow trout and bull trout were the most common fish species stocked.

Previously implemented FWCP projects

The FWCP has invested in a diversity of projects in river, lake, and reservoir habitats. Most of these projects have been focused on priority species such as Arctic grayling, bull trout, and kokanee, while others have addressed aquatic ecosystems via habitat assessments and enhancements. Previous project highlights include:

- Carbon Creek side channel enhancement (Morgan 1995, Triton 2012);
- Williston Reservoir productivity assessments (Langston and Wilson 2000, Stockner et al. 2001, Harris et al. 2006);
- Williston Reservoir Stocked Kokanee Spawning Assessment (Langston and Zemlak 1998);
- Dinosaur Reservoir littoral fish population and habitat enhancement assessments (Blackman et al. 2004);
- Pygmy whitefish studies on Dina Lake and other lakes (Zemlak and McPhail 2004);
- Mesilinka River multi-year fertilization trial (Wilson et al. 2008);
- Orphaned Culvert Assessment Project (Ecofor 2016);
- Arctic grayling and bull trout information syntheses (Hagen and Stamford 2017, Stamford et al. 2017, Hagen and Weber 2019);
- Indigenous Nations information gathering on kokanee, bull trout, and Arctic grayling (Pearce et al. 2019a-e);
- Williston-Dinosaur Watershed Fish Mercury Investigation (Azimuth 2019);
- Williston Watershed Kokanee Spawner Distribution and Aerial Enumeration Surveys project (DWB 2019); and
- Williston Reservoir Peace Reach Lake Trout Movements Study (Culling and Euchner 2019).

RIVERS, LAKES, & RESERVOIRS ACTION PLAN OBJECTIVES

Clear and realistic objectives are necessary to guide and prioritize actions. Priority actions will change as progress is made and information is gained. The current action plans reflect the progress made to date, information available and values expressed by FWCP partners, including Indigenous Nations and stakeholders.

The FWCP has the following overarching strategic objectives:

1. Conservation – maintain or improve the integrity and productivity of ecosystems and habitats
2. Conservation – maintain or improve the status of species or ecosystems of concern
3. Sustainable use – maintain or improve opportunities for sustainable use, including harvesting and other uses
4. Community engagement – build and maintain relationships with Indigenous and stakeholder communities

The Rivers, Lakes, & Reservoirs Action Plan has nine sub-objectives, which are high-level statements of desired future conditions (goals) that are nested within the FWCP's strategic objectives (Figure 6). While the sub-objectives provide specific direction on desired future conditions for ecosystems and priority species, priority actions in the action tables are the "means" to achieve each sub-objectives and often occur in a sequence under each sub-objective.

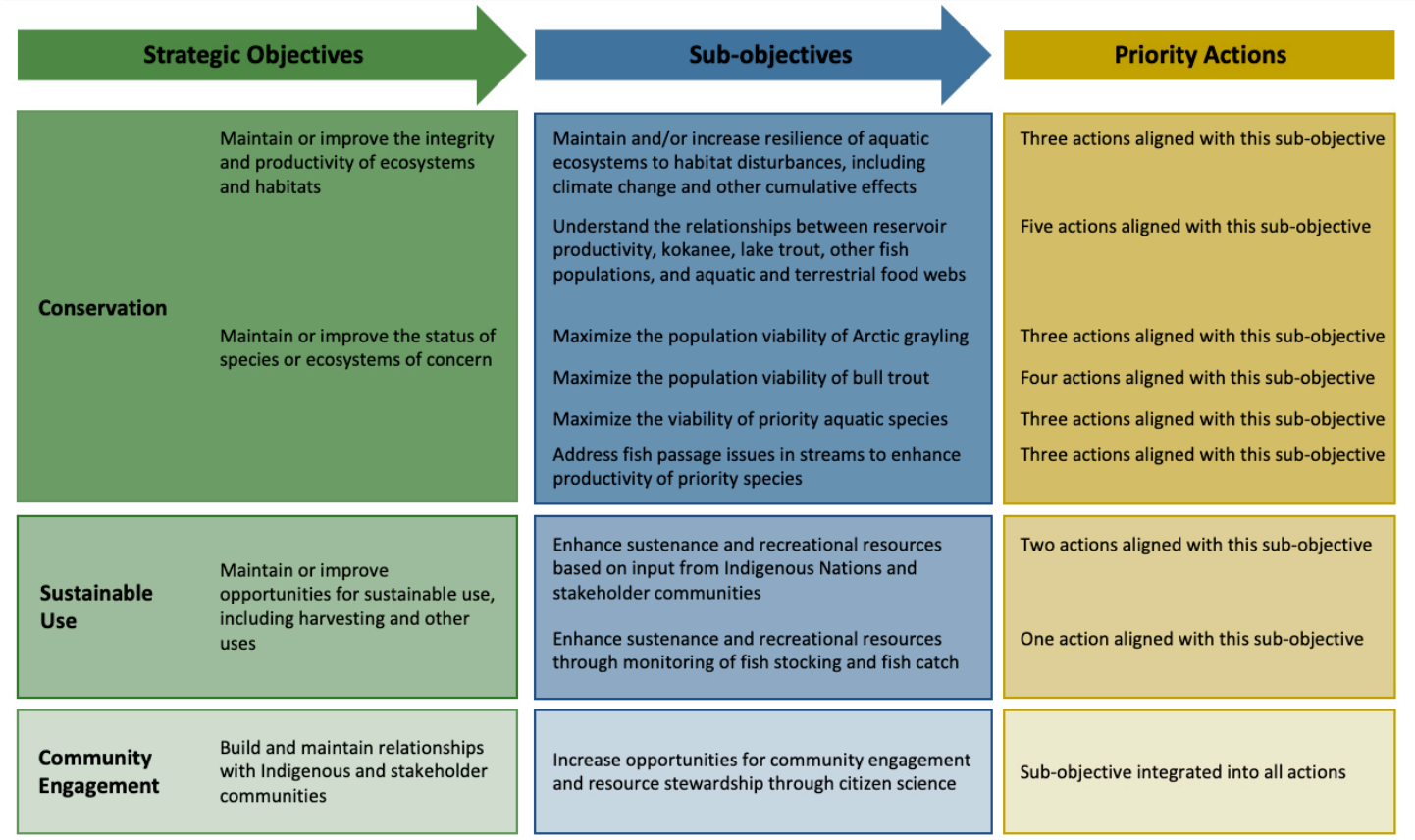

Figure 6. Objective hierarchy for the Rivers, Lakes, & Reservoirs Action Plan.

Conservation

Strategic objective: maintain or improve the integrity and productivity of ecosystems and habitats

Sub-objective 1: maintain and/or increase the resilience of aquatic ecosystems to habitat disturbances, including climate change and other cumulative effects

Resilient ecosystems can maintain or recover key functions, such as primary production, nutrient cycling, and water management, during or following disturbances, such as fire or flooding. The function, connectivity, and species diversity of ecosystems are often good indicators of potential ecosystem resilience. Adjacent undisturbed species populations will provide source populations for the recolonization of areas subjected to habitat disturbance in well-connected ecosystems. The sub-objective to maintain and/or increase the resilience of aquatic ecosystems to habitat disturbances, including climate change and other cumulative effects, focuses on broad conservation goals for aquatic ecosystems and associated priority species.

In addition to effects of inundation by the formation of the reservoirs, climate change and cumulative effects are placing increased pressure on aquatic species and ecosystems in the FWCP's Peace Region. These pressures may also limit the success of habitat- or species-based actions supported by the FWCP if they are not well understood or accounted for in future planning. The Province of B.C. has developed the Provincial Cumulative Effects Framework to begin to address

potential cumulative effects to aquatic ecosystems and priority fish species (e.g., Lewis et al. 2016, Interim Assessment Protocol for Aquatic Ecosystems in British Columbia 2019). The approach generally involves several steps including a GIS-based tier-one assessment of risks, followed by ground-based tier-two assessment of watershed condition and the development of restoration opportunities (Pickard et al. 2018, West et al. 2020).

Three actions were developed under the sub-objective to maintain and/or increase the resilience of aquatic ecosystems to habitat disturbances, including climate change and other cumulative effects:

- Action #1 to implement an approach to document cumulative effects to aquatic ecosystems.
- Action #2 to implement a ground-based assessment of watershed condition and develop restoration opportunities.
- Action #3 to implement conservation, restoration, and/or enhancement actions.

Actions to maintain or increase resilience to climate change and cumulative effects can also cross multiple ecosystem types. Four actions are housed under sub-objective 1 in the Cross-Ecosystem Action Plan that link to these actions in the Rivers, Lakes, & Reservoirs Action Plan. Actions #1 and #2 of the Cross-Ecosystem Action Plan involve developing a framework for incorporating climate change and cumulative effects into priority actions and should inform the habitat cumulative effects assessment approach taken in action #1 of the Rivers, Lakes, & Reservoirs Plan, as well as similar actions (action #1) in the Riparian & Wetlands Action Plan and Uplands Action Plan.

Land securement is another related action in the Cross-Ecosystem Action Plan (actions #3 and #4) that could be a conservation outcome of actions #1 and #2 in the Rivers, Lakes, & Reservoirs Action Plan for priority aquatic habitats.

Sub-objective 2: understand the relationships between reservoir productivity, kokanee, lake trout and other fish populations, and aquatic and terrestrial food webs

The Williston Reservoir is characterized as ultra-oligotrophic and is limited by low nutrient levels, likely due in part to the high drawdown, which reduces littoral productivity and inputs of terrestrial nutrients to the reservoir (Stockner et al. 2001, Harris et al. 2006). In contrast, Dinosaur Reservoir is limited by the flow-through rate of the water. Measures of productivity have been assessed for the Williston Reservoir in the past (e.g., Wilson and Langston 2000) and several studies have monitored fish populations and trends. For example, historical fish monitoring has suggested a shift in species composition from dominated by lake whitefish to kokanee (Plate et al. 2012). The decline in number of spawning kokanee for some locations within the three years of the Ecosystem Impact of Kokanee Study (Coxson et al. 2019) and the recent kokanee spawning census (DWB 2019) indicate some uncertainty regarding the status of kokanee in the reservoir. In comparison, the populations of piscivorous lake trout may be increasing, which may be having adverse effects on species such as bull trout (Culling and Euchner 2019).

Five actions were developed under the sub-objective to understand relationships between reservoir productivity, kokanee, lake trout, and other fish populations, and aquatic and terrestrial food webs:

- Action #4 to assess Williston Reservoir productivity, including relationships to historical reservoir productivity and kokanee, lake trout, and/or other fish species productivity.
- Action #5 to assess the distribution and abundance of kokanee spawners in tributaries of the Williston Reservoir using aerial surveys.
- Action #6 to assess the distribution, abundance, and habitat preferences of kokanee spawners in tributaries of the Williston Reservoir that are not currently covered with aerial surveys (action #5).
- Action #7 to assess the effects of kokanee introductions to spawning tributaries, including potential competitive effects of kokanee spawning to other fish and to nutrient dynamics of spawning tributaries.
- Action #8 to develop a cost-effective method for monitoring lake trout populations in the Williston Reservoir.

There are no directly associated actions in the Cross-Ecosystem Action Plan or the other ecosystem-based action plans with this sub-objective. However, the monitoring of productivity and fish populations could be completed in association with Indigenous Nation land guardian programs (see action #22 in this action plan) and/or through the use of citizen science (see sub-objective 9 in this action plan).

Strategic objective: maintain or improve the status of species or ecosystems of concern

This objective addresses the concepts of ecosystem integrity, resiliency, and the functional elements of ecosystems, including efforts to improve or optimize productive capacity for priority species. Priority aquatic species for the FWCP's Peace Region are identified in the priority species section of this action plan.

Sub-objective 3: maximize the population viability of Arctic grayling

Prior to the creation of the reservoirs, Arctic grayling (*Thymallus arcticus*) were widespread and abundant in the FWCP's Peace Region. Afterward, however, Arctic grayling were essentially extirpated from the flooded lower reaches of the Parsnip and Finlay rivers, the upper reach of the Peace River, and from most of the tributary streams to these reaches, where they had formerly thrived (Northcote 1993, Stamford et al. 2015, Stamford et al. 2017). Conservation status has been delineated in eight core areas for the Upper Peace Basin upstream of the W.A.C. Bennett Dam, including the Parsnip, Nation, Omineca, Ingenika, Williston, Upper Peace, Lower Finlay, and Upper Finlay/Toodoggone areas. Assessed levels of risk ranged from *potential risk* in the relatively pristine Upper Finlay core area to *high risk* for the Ingenika, Williston, and Upper Peace core areas. High-risk areas are where Arctic grayling populations may be largely extirpated or exist only as remnants. The remaining four core areas (Parsnip, Nation, Omineca, Lower Finlay) are considered *at risk*, largely because of major habitat loss, diminished connectivity, and population declines over the scale of decades. Relative to pre-impoundment conditions, the most significant factors limiting potential Arctic grayling productivity in the FWCP's Peace Region have likely been physical habitat and ecological changes, along with interrupted connectivity among populations, resulting from the flooding of critical habitats.

Arctic grayling is a focal priority species of conservation concern in the FWCP's Peace Region. Three actions were developed under the sub-objective to maximize the population viability of Arctic grayling. Action #9 includes steps 1–3 of the Arctic grayling monitoring framework, while action #10 is step 4 of the monitoring framework (Hagen & Stamford 2017).

- Action #9 to conduct research and monitoring of Arctic grayling to obtain data related to conservation status, critical habitats, and key limiting factors.
- Action #10 to implement high-priority conservation, restoration, and/or enhancement options for Arctic grayling.
- Action #11 to assess the success of actions associated with Arctic grayling.

Assessing the success of actions associated with Arctic grayling could include an update to the Arctic grayling monitoring framework (Hagen & Stamford 2017). An assessment of performance of the progress made on all activities under the monitoring framework is required after at least five years of implementing studies.

Additional actions that could relate to Arctic grayling conservation include actions #1–4 in the Cross-Ecosystem Action Plan and actions #1–3 and #17–23 in this action plan.

Sub-objective 4: maximize the population viability of bull trout

Bull trout (*Salvelinus confluentus*) is one of the most highly valued fish species in the Upper Peace River Basin and is also one of British Columbia's most sensitive species. Migratory bull trout, which grow to sizes of 80 cm or more on a piscivorous diet, provide the only opportunity to catch big fish in streams of the Upper Peace River Basin and are targeted in both subsistence and recreational fisheries. Bull trout are in serious decline in some parts of its range and are currently Blue-listed in British Columbia, meaning the species is of special concern and considered sensitive to human

activities or natural events (Cannings and Ptolemy 1998). Bull trout in the Peace Watershed are part of the Western Arctic population assessed as Special Concern by COSEWIC (COSEWIC 2012).

Conservation status has been delineated in eight core areas for the Upper Peace River Basin via completion of the bull trout information synthesis and monitoring framework (Hagen and Weber 2019). *Low-risk* core areas have been identified in the pristine Upper Finlay and the Finlay Reach, which are home to major bull trout populations in the Davis and Ingenika watersheds. *Potential-risk* core areas include the Lower Finlay and Omineca, which have relatively low habitat threats. The Parsnip, Parsnip Reach, and Peace Reach core areas are all estimated to be *at risk*, with the most important factor affecting the ranking being small adult population size. The Dinosaur core area is at *high risk* of extirpation due to limited habitat availability and a small, declining population. The remnant bull trout population isolated between the Peace Canyon and W.A.C Bennett dams may not be self-supporting and may depend on entrainment through the W.A.C. Bennett Dam for viability.

Bull trout is a focal priority species of conservation concern in the FWCP's Peace Region. Four actions were developed under the sub-objective to maximize the population viability of bull trout. Action #13 includes steps 1–3 of the bull trout monitoring framework, while action #14 is step 4 of the monitoring framework (Hagen & Weber 2019).

- Action #12 to conduct a population genetic structure study for bull trout.
- Action #13 to conduct research and monitoring of bull trout to obtain data related to conservation status, critical habitats, and key limiting factors.
- Action #14 to implement high-priority conservation, restoration, and/or enhancement options for bull trout.
- Action #15 to assess the success of actions associated with bull trout.

Additional actions that could relate to bull trout conservation include actions #1–4 in the Cross-Ecosystem Action Plan and actions #1–3 and #17–23 in this action plan.

Sub-objective 5: maximize the population viability of priority aquatic species

There have been many studies of the ecology and abundance of fish species in the Upper Peace River Basin (e.g., Slaney 1992, Langston and Zemlak 1998, Zemlak and Langston 1998, Langston and Murphy 2008, Plate et al. 2012, DWB 2019), but there remain substantial knowledge gaps, particularly with respect to critical habitat, trends in abundance of species, and key limiting factors. Recent work has focused largely on several high-priority species, such as Arctic grayling, bull trout, kokanee, and lake trout (Stamford et al. 2017, Coxson et al. 2018, DWB 2019, Hagen and Weber 2019, Culling and Euchner 2020), which has greatly increased our understanding of these species of regional concern. However, there is a need to collect additional data for many lesser-known fish species related to conservation status, critical habitats, and key limiting factors and use this to inform of future actions. For example, 17 lakes in the Upper Peace River Basin are known to contain pygmy whitefish (Zemlak and McPhail 2004), but relatively little is known of trends.

Three actions were developed under the sub-objective to maximize the population viability of priority aquatic species:

- Action #16 to conduct research on priority, but lesser-known, fish populations related to conservation status, critical habitats, and key limiting factors.
- Action #17 to develop a habitat restoration and protection plan for priority fish species.
- Action #18 to implement high-priority conservation, restoration, and/or enhancement options for priority fish species.

The list of priority fish and aquatic species is provided in the priority species section of this action plan. Work related to pygmy whitefish, mountain whitefish, burbot, brassy minnow, and northern pikeminnow may be of interest. Additional actions that could relate to maximizing the population viability of priority fish species include actions #1–4 in the Cross-Ecosystem Action Plan and actions #1–3 and #17–23 in this action plan.

Sub-objective 6: address fish passage issues in streams to enhance productivity of priority species

There are many kilometres of remaining tributary habitat, but often only short sections are accessible due to the presence of barriers, both between the reservoir and tributaries and within the tributaries themselves. For example, past road construction and associated stream crossings have caused barriers to fish passage. Poorly engineered drainage structures (e.g., culverts) or structures that have exceeded their life expectancy can inhibit or completely block fish passage. The presence of barriers is generally considered one of the most important limiting factors for fish populations in streams.

The need to replace these structures to restore fish passage is often complicated by issues of current responsibility or the tenure of the associated road. The current road permit holder may not be required to replace the structures and restore fish habitat, as the crossings were "built to the standards of the day," and many funding agencies are not interested in assessing and potentially replacing these structures due to the underlying accountability for the road, which is held by the road permit holder (SERNbc 2015). The FWCP has recently adjusted its approach to fish passage with the recognition of this issue as a key limiting factor. The FWCP is interested in supporting the improvement of fish access when there are significant habitat gains possible and there is an opportunity for partner financial support in implementing habitat-based actions to improve fish passage.

Three actions were developed under the sub-objective to address fish passage issues in streams to enhance the population viability of priority species:

- Action #19 to conduct research to support fish passage issues in streams and locations for fish passage enhancement.
- Action #20 to conduct engagement with FWCP partners and stakeholders to prioritize locations for fish passage enhancement.
- Action #21 to conduct habitat improvements that restore fish access to streams.

Work under this sub-objective should build upon, where appropriate, results of the Fish Passage Planning project (SERNbc 2015), the Orphaned Culvert project (Ecofor 2016), and the Fish Passage Assessments and Habitat Confirmations (SERNbc 2020) project. Actions to assess the success of habitat-based actions related to fish passage occur in the Cross-Ecosystem Action Plan.

Sustainable use

Strategic objective: maintain or improve opportunities for sustainable use, including harvesting and other uses

Sub-objective 7: enhance sustenance and recreational resources based on input from Indigenous Nations and stakeholder communities

This objective focuses on the FWCP's role in restoring or enhancing the abundance of priority species and in providing information to resource-management decision-makers related to providing opportunities for harvesting and other uses. Sustenance and recreational harvesters include Indigenous Peoples, licensed hunters and anglers, and commercial harvesters. Other uses may include cultural, medicinal, or non-consumptive uses.

There are two actions under the sub-objective to enhance sustenance and recreational resources based on input from Indigenous Nations and stakeholder communities:

- Action #22 to work with Indigenous Nations and stakeholder communities to characterize culturally important fish species in priority freshwater habitat locations.
- Action #23 to implement conservation, restoration, or enhancement actions.

Work under action #22 should include the incorporation of Indigenous knowledge to document priority species and habitats for further action and could be informed by action #10 in the Cross-Ecosystem Action Plan or existing surveys of Indigenous knowledge (e.g., Pearce et al. 2019a-e). See also actions #13 and #14 in the Riparian & Wetlands Action Plan, and actions #15 and #16 in the Uplands Action Plan for similar actions for culturally important species in those ecosystem types.

Sub-objective 8: enhance sustenance and recreational resources through the monitoring of fish stocking and fish catch

In British Columbia, about 800 lakes and streams are stocked annually with salmonids produced from the five facilities operated by the Freshwater Fisheries Society of BC. Provincial policy that considers the risk and benefits related to introducing fish into any given waterbody guide decisions of where and when to stock fish. Stocking is typically concentrated in small lake habitats because risks (e.g., the spread of introduced species, hybridization with wild fish) are most easily managed in this environment. Provincial policy gives highest priority to the conservation of wild indigenous fish species. Currently, 15 lakes within the FWCP's Peace Region are regularly stocked, primarily with rainbow trout.

A summary of stocking in 47 lakes in the area from 1976 to 2005 is presented in Langston and Murphy (2008).

There is one action under the sub-objective to enhance sustenance and recreational resources through the monitoring of fish stocking and fish catch:

- Action #24 to monitor species-based enhancements in lakes to support the regional stocking program and maximize opportunities for sustenance and the recreational use of fish.

Monitoring work undertaken in this action needs to occur in partnership with the Freshwater Fisheries Society of BC and the Province of B.C. to support evaluation of stocking effectiveness. Work could include monitoring of fish populations and fisheries catch (creel surveys). Projects that involve citizen science are also encouraged.

Community engagement

Strategic objective: build and maintain relationships with Indigenous and stakeholder communities

Sub-objective 9: increase opportunities for community engagement and resource stewardship through citizen science

The FWCP's overarching strategic objective of community engagement stems from BC Hydro's social responsibility policy, the Province of B.C.'s shared stewardship goal, and the approach of the DFO's Stewardship and Community Involvement Program. This recognizes the importance of engaging Indigenous Nations, Bands, and groups; local stakeholders; and other interest groups to contribute to making good decisions and delivering effective projects.

In the previous iteration of the FWCP's Peace Region action plans, the Peace Basin Plan (FWCP 2014) highlighted community-based projects under a separate category of "stewardship and education" to better facilitate projects not (necessarily) directly aligned with the objectives of the action plans but consistent with the FWCP's overarching strategic objective for community engagement. During the 2020 action plan update process, it was decided that these community engagement actions should be more directly integrated into the action plans.

Stewardship and education actions are housed in the Cross-Ecosystem Action Plan and do not appear in the ecosystem-based action plans; however, stewardship and education are encouraged to be incorporated into relevant projects in the ecosystem-based action plans.

PRIORITY SPECIES

A list of priority species was developed for aquatic ecosystems as an outcome of the action plan engagement process, which focuses the action plans toward species of conservation concern and those most likely affected by the creation of the reservoirs. The full list of priority species across all ecosystems is available in the Peace Region: Overview & Action Plans document. The approach to identifying priority species includes all vertebrate species at risk that breed in the

FWCP's Peace Region, as well as additional sustenance species and species of conservation concern that are not federally or provincially listed as a species at risk due to observed declines or current/imminent threats. An open category of culturally important species is also included in the list of priority species to provide flexibility for Indigenous Nations, Bands, and groups to develop a project on a culturally important species that does not appear on the list of priority species. As conservation status may change during the period that this action plan is in place, action #5 in the Cross-Ecosystem Action Plan has been developed to allow for emerging species of conservation concern to be considered if necessary.

The FWCP uses three general categories of priority species: recovery, focal, and inventory. Recovery, focal, and inventory categories are an indication of the state of knowledge for each species and not an indication of the priority level for each species (Table 1). The list of priority species for the Rivers, Lakes, & Reservoirs Action Plan is shown in Table 2.

Table 1. Category definitions for the FWCP's Peace Region priority species.

Category	Priority Species Category Definitions
Recovery	Recovery species are a high priority and conservation concern and have likely been adversely impacted by dam construction. These species have formally been classified as either Threatened or Endangered by Canada or B.C., and recovery and/or management plans are in place by federal or provincial management agencies. Actions for recovery species align with recovery strategies and plans.
Focal	Focal species have a strong linkage to dam footprint impacts and are of high priority. At least some information related to population status, critical habitats, and key limiting factors have been defined for focal species based on previous FWCP projects (e.g., through the development of a monitoring framework), and therefore specific follow-up actions have already been developed. Actions for focal species should build upon previous FWCP projects with an aim to conserve, restore, and/or enhance suitable habitats in the relevant ecosystems.
Inventory	Inventory species have also been affected by dams and are a high priority, but detailed inventory and/or trend monitoring is required to better understand population status, critical habitats, and key limiting factors. Actions for inventory species should aim to provide the basis for future compensation actions, if required.

Table 2. Priority species list for the FWCP's Peace Region Rivers, Lakes, & Reservoirs Action Plan.

The FWCP's Peace Region priority species for rivers, lakes, and reservoirs							
Species Group	**Species**	**Provincial Listing**	**Federal Designation**	**Species Category**	**Applicable Ecosystem-based Action Plan**		
					Rivers, Lakes, & Reservoirs	**Riparian & Wetlands**	**Uplands**
Fish	Bull trout	Blue	-	Focal	√		
	Arctic grayling	-	-	Focal	√		
	Kokanee (native)	-	-	Focal	√		
	Kokanee (introduced)	-	-	Focal	√		
	Lake trout	-	-	Focal	√		
	Rainbow trout	-	-	Inventory	√		
	Burbot	-	-	Inventory	√		
	Dolly Varden	-	-	Inventory	√		
	Lake whitefish	-	-	Inventory	√		
	Mountain whitefish	-	-	Inventory	√		
	Pygmy whitefish	-	-	Inventory	√		
	Brassy minnow	-	-	Inventory	√		
	Northern pikeminnow	-	-	Inventory	√		
	Minnow spp.	-	-	Inventory	√		
	Sculpin spp.	-	-	Inventory	√		
	Sucker spp.	-	-	Inventory	√		
Aquatic Invertebrates	Freshwater mussels	-	-	Inventory	√		
	Freshwater clams	-	-	Inventory	√		
	Freshwater insects	-	-	Inventory	√		
	Apatania comosa: Trichoptera	-	-	Inventory	√		
	Zooplankton	-	-	Inventory	√		
Culturally Important Species		-	-	Inventory, Recovery, or Focal	√	√	√

ACTION TABLES

The action tables in this document identify FWCP priority actions to conserve and enhance fish and aquatic ecosystems in river, lake, and reservoir habitats in the FWCP's Peace Region. See the Peace Region: Overview & Action Plans document for additional information on action table format and the funding application process.

Priority actions are organized by ecosystem (or cross-ecosystem actions), species, and action type (research and information acquisition, monitoring and evaluation, land securement, habitat-based actions, and species-based actions) and are assigned a priority ranking from 1 (highest priority) to 3 (lowest priority). The priority ranking does not account for potential project sequencing.

Priority – The action plans identify the importance and urgency of each priority action (i.e., priority 1, 2, or 3). When grant applications are evaluated, a priority 1 action will score higher than a priority 2 or 3 action. See Table 3 below for additional information on priority setting.

Table 3. Priority rating definitions for actions in the FWCP's Peace Region.

Priority	Definition of FWCP Priorities
1	Required urgently due to current/imminent threats, highest priority for FWCP partners and stakeholders, and/or provide a significant benefit relative to cost.
2	Required due to current/imminent threats, high priority for FWCP partners and stakeholders, and/or provide good benefit relative to cost.
3	Identified due to possible threats, high priority for some FWCP partners and stakeholders, and/or benefit relative to cost may not be known.

Cross-ecosystem actions

Several broad actions are relevant to all ecosystem-based action plans and will require the consideration of multiple ecosystem types and values. These actions were not suited to any single ecosystem-based action plan and have been grouped into a stand-alone Cross-Ecosystem Action Plan. All grant seekers are encouraged to review the Cross-Ecosystem Action Plan as your proposed project may address actions in both the Rivers, Lakes and Reservoirs Action Plan and the Cross-Ecosystem Plan. During the online application process, grant seekers are asked to define primary and secondary actions that their proposed project may address. These primary and secondary priority actions can occur in more than one action plan. For example, actions to assess the success of habitat and species-based actions are housed in the Cross-Ecosystem Action Plan.

Rivers, lakes, and reservoirs ecosystem actions

These action tables identify the FWCP's priority actions to conserve and enhance upland species and ecosystems impacted by BC Hydro dams in the FWCP's Peace Region. Actions identified as **open** (see delivery approach column) **are eligible for a grant**. When completing your online grant application, you will be required to identify a priority action(s) that your project intends to address. A high-quality grant application will clearly demonstrate alignment with a priority action(s) in an action table. Actions identified as **directed only** are not eligible for a grant. These are projects that our regional boards will direct through the appropriate procurement process (e.g., a request for proposal). Please **do not** submit a grant application for a **directed only** project. Actions identified as **directed/open are eligible for a grant** or may be projects that our regional boards will direct through the appropriate procurement process. Contact us if you are unsure.

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Conservation sub-objective 1: maintain and/or increase the resilience of aquatic ecosystems to habitat disturbances, including climate change and other cumulative effects							
1	Research & information acquisition	**PEA.RLR.S01.RI.01 Assess cumulative effects on aquatic ecosystems-P1**	1	Fish and aquatic invertebrates	Assess cumulative effects to aquatic ecosystems based on outcomes of action #2 in the Cross-Ecosystem Action Plan. The assessment may also consider outcomes of action #1 in the Cross-Ecosystem Action Plan related to climate change and include predictions of effects of climate change to aquatic ecosystems and priority fish species. Cumulative effects should include human developments on the landscape, including BC Hydro footprints and additional developments such as linear development features, forestry operations, and water licenses. The deliverable will include identification of priority areas for conservation, monitoring and restoration actions.	Prioritization of aquatic and riparian habitats to monitor, conserve and/or enhance, based on cumulative effects.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
2	Research & information acquisition	**PEA.RLR.S01. RI.02 Conduct ground-based assessments of watershed condition-P1**	1	Fish and aquatic invertebrates	Conduct ground-based assessments of watershed condition to follow work undertaken in action #1. Ground-based assessments should use standard inventory methods (e.g., existing Forest and Range Evaluation Program [FREP] protocols; Pickard et al. 2018), but should be tailored to develop specific restoration and enhancement opportunities for priority fish species and/or aquatic habitats (e.g., West et al. 2020). This action should identify limiting factors for enhancement opportunities and validate the cumulative effects assessments undertaken in action #1. The deliverable for this action includes an assessment of watershed health and a list of prioritized conservation, enhancement, and/or restoration opportunities for aquatic and riparian habitats. Prioritization of opportunities should consider future land use through engagement with industrial land users and provincial agencies responsible for permitting.	Prioritization of aquatic and riparian habitat conservation, restoration, and enhancement opportunities to address issues related watershed condition or to sustain critical fish habitat.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
3	Habitat-based action	**PEA.RLR.S01.HB.03 Implement stream conservation, restoration, and/or enhancement actions-P1**	1	Fish and aquatic invertebrates	Implement conservation, restoration, and/or enhancement actions based on the findings of the assessments in actions #1 and #2 and engagement with Indigenous Nations and other stakeholders. Actions could include on-the-ground stream restoration projects such as riparian planting, building groundwater channels, or land securement actions such as defining new fisheries-sensitive watersheds to protect priority fish species. See actions #3 and #4 in the Cross-Ecosystem Action Plan for actions related to land securement.	Implementation of restoration and/or enhancement actions to maintain and/or increase the productivity and resilience of key fish species and aquatic ecosystems.	Open/ Directed
	Species-based action		1				

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Conservation sub-objective 2: understand the relationships between reservoir productivity, kokanee, lake trout, and other fish populations, and aquatic and terrestrial food webs							
4	Research & information acquisition	**PEA.RLR.S02.RI.04 Assess Williston Reservoir productivity and relationships to fish productivity-P1**	1	Kokanee, lake trout, and other fish	Assess Williston Reservoir productivity, including relationships to historical reservoir productivity and kokanee, lake trout, and/or other fish species productivity. Measures of productivity have been assessed for the Williston Reservoir in the past. Historical fish monitoring also suggested a shift in species composition from lake whitefish to kokanee dominated (Plate et al. 2012). Kokanee are pelagic feeders in reservoirs and are likely to be limited by the ultra-oligotrophic Williston Reservoir. The decline in number of spawning kokanee for some locations within the three years of the Ecosystem Impact of Kokanee Study (Coxson et al. 2018) and the recent Williston Watershed Kokanee Spawner Distribution and Aerial Enumeration Surveys project (DWB 2019) indicate some uncertainty as to the status of kokanee in the reservoir. In comparison, the populations of piscivorous lake trout may be increasing, which may be having adverse effects on species such as bull trout. Studies should therefore also build upon completed and ongoing work in the Peace Reach Lake Trout Movements multi-year study and efforts to understand potential competitive effects of lake trout on bull trout (Culling and Euchner 2019). Projects that involve citizen science are also encouraged.	Identification of actions to maintain or increase ecosystem health and the sustainable use of fish, based on an increased understanding of relationships between reservoir productivity, carrying capacity for fish, and interactions among species such as kokanee, lake trout, and bull trout.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
5	Research & information acquisition	**PEA.RLR.S02. RI.05 Conduct aerial surveys of kokanee-P2**	2	Kokanee and other fish	Continue assessments of the distribution and abundance of kokanee spawners in tributaries of the Williston Reservoir using aerial surveys. Spawner survey work should follow recommendations developed in the Williston Watershed Kokanee Spawner Distribution and Aerial Enumeration Surveys project (DWB 2019 or more recent report once available).	Increased knowledge on the status of Kokanee in the watershed to support identification of actions to help address concerns about introduced kokanee and impacts to other fish species or populations.	Directed
6	Research & information acquisition	**PEA.RLR.S02. RI.06 Conduct assessments of kokanee distribution, abundance, and habitat use-P2**	2	Kokanee and other fish	Conduct assessments of the distribution, abundance, and habitat preferences of kokanee spawners in tributaries of the Williston Reservoir not currently covered by aerial surveys (Action #5) to help address concerns about kokanee impacts to other species or populations. Work could include a) assessments of kokanee spawning abundance; b) identification of native versus introduced kokanee habitat use, abundance, and potential introgression; c) determination of predictors of habitat use by spawning kokanee; and/or d) environmental DNA (eDNA) assessments across a large number of sites that could be used to identify additional rivers and streams used by kokanee for spawning.	Increased knowledge on the status of Kokanee in the watershed to support identification of actions to help address concerns about introduced kokanee and impacts to other fish species or populations.	Open

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
7	Research & information acquisition	**PEA.RLR.S02. RI.07 Document effects of kokanee introductions-P2**	2	Kokanee	Assess effects of kokanee introductions to spawning tributaries including potential competitive effects of kokanee spawning to other fish and the nutrient dynamics of spawning tributaries. Studies of nutrient dynamics could include assessment of kokanee nutrient contributions to predators such as bears, wolves, and eagles that feed on kokanee carcasses. Work should build upon the Ecosystem Impact of Kokanee Study (Coxson et al. 2018) and the First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling (Pearce et al. 2019a,b,c,d,e), and address Indigenous Nation interests regarding kokanee.	Identification of the risks and benefits of kokanee reintroductions to fish and wildlife in spawning tributaries.	Open
8	Research & information acquisition	**PEA.RLR.S02. RI.08 Develop cost-effective lake trout monitoring-P2**	2	Lake trout	Develop a cost-effective method for monitoring lake trout populations in the Williston Reservoir. Basic index monitoring of lake trout is challenging and is key to understanding potential competitive effects on bull trout. Monitoring could potentially consider using gill netting at representative sites in the reservoir. Studies should involve local communities and Indigenous Guardians, including potential monitoring of lake trout fishing effort and catch in addition to population status. Monitoring work should address competitive interactions between lake trout and bull trout, potential long-term implications for bull trout productivity, and opportunities to increase sustainable use of lake trout in the Williston reservoir. Work must build on the previous FWCP lake trout study (Culling and Euchner 2019).	Identification of a cost-effective monitoring program to determine lake trout population status, potential competitive effects on bull trout and opportunities for increased sustenance use of lake trout.	Open

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Conservation sub-objective 3: maximize the population viability of Arctic grayling							
9	Research & information acquisition	**PEA.RLR.S03. RI.09 Conduct research and monitoring of Arctic grayling-P1**	1	Arctic grayling	Conduct research and monitoring of Arctic grayling to obtain population data (i.e., distribution, abundance, population trend) and identify critical habitats and key limiting factors at a level of geographic accuracy suitable for delineating conservation and enhancement actions. Monitoring should build on past work and follow priorities defined in the Arctic Grayling Information Synthesis (Stamford et al. 2017) and the Arctic Grayling Monitoring Framework (Hagen & Stamford 2017). See Table 1 in the monitoring framework for the highest priority actions. Note that this is Step 1 to 3 in the Monitoring Framework.	Identification of habitat- or species-based actions to increase population viability of Arctic grayling, informed by increased knowledge of critical habitats and key limiting factors.	Open
10	Habitat-based action	**PEA.RLR.S03. HB.10 Implement high priority habitat-and species-based actions for Arctic grayling-P1**	1	Arctic grayling	Implement high-priority habitat conservation, restoration, and enhancement options for Arctic grayling. Work should build off the monitoring conducted to date including data gaps in action #9 and work completed for the Arctic Grayling Information Synthesis (Stamford et al. 2017) and the Arctic Grayling Monitoring Framework (Hagen & Stamford 2017). See Table 1 in the monitoring framework for the highest priority actions. This is Step 4 in the Arctic Grayling Monitoring Framework.	Implementation of actions to increase Arctic grayling population viability.	Open
	Species-based action		1				

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
11	Monitoring and evaluation	**PEA.RLR.S03.ME.11 Assess success of actions for Arctic grayling-P2**	2	Arctic grayling	Assess success of actions for Arctic grayling funded by FWCP (e.g., research and information acquisition activities in action #9 or enhancement activities conducted in action #10) and use this information to update the Arctic Grayling Monitoring Framework (Hagen & Stamford 2017). An assessment of performance of the progress made on all activities under the monitoring framework is required after at least five years of implementing studies (no earlier than 2024). Success of habitat- or species-based actions should be assessed through monitoring of biological and/or physical habitat responses (after implementation) and include collection of quantitative population data (abundance, trend, distribution) necessary to assess the effectiveness of conservation and enhancement actions and refine knowledge of limiting factors. Implement updates to the monitoring framework based on progress and findings.	Identification of further monitoring, conservation and/or enhancement actions, to increase Arctic Grayling population viability, through updates to the Arctic Grayling Monitoring Framework.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Conservation sub-objective 4: maximize the population viability of bull trout							
12	Research & information acquisition	**PEA.RLR.S04. RI.12 Determine population genetic structure for bull trout-P1**	1	Bull trout	Conduct a population genetic structure study for bull trout in tributaries of the Williston and Dinosaur reservoirs to inform conservation unit designation (key data gap in Bull Trout Information Synthesis; Hagen and Weber 2019). For example, bull trout population status has been inventoried in the past in Gething Creek in the Dinosaur Reservoir, although it is unknown whether this is a genetically unique population or is simply enhanced periodically via entrainment of bull trout populations from the Williston Reservoir. This work should attempt to partner with other monitoring programs to obtain tissue samples from key index streams (such as actions #4, #8, and #13). Work should be used to prioritize bull trout populations for further monitoring or conservation and enhancement actions.	Prioritization of bull trout populations for conservation and enhancement actions.	Open
13	Research & information acquisition	**PEA.RLR.S04. RI.13 Conduct research and monitoring of bull trout-P1**	1	Bull trout	Conduct monitoring actions that build on the work conducted to date to address data gaps limiting understanding of conservation status, critical habitats, and limiting factors for bull trout. Specific studies are defined in the Bull Trout Information Synthesis Monitoring Framework (Hagen and Weber 2019). See Table 6.2a in Monitoring Framework for highest priority actions. Work should be used to develop specific conservation or enhancement actions for bull trout.	Identification of habitat- or species-based actions to increase bull trout population viability, informed by increased knowledge of critical habitat and limiting factors.	Open

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
14	Habitat-based action	**PEA.RLR.S04. HB.14 Implement high priority habitat- and species-based actions for bull trout-P1**	1	Bull trout	Implement habitat conservation, restoration, and enhancement activities targeting bull trout. Work should follow continued monitoring of data gaps in action #13 and work completed in the Bull Trout Information Synthesis Monitoring Framework (Hagen and Weber 2019). See Table 6.2a in the Monitoring Framework for highest priority actions. Potentially promising enhancement methods include: 1) stream fertilization, 2) fish access improvement, 3) side channel development, and 4) riparian restoration.	Implementation of habitat- or species-based actions to increase population viability of bull trout.	Open
	Species-based action		1				
15	Monitoring and evaluation	**PEA.RLR.S04. ME.15 Assess success of actions for bull trout-P2**	2	Bull trout	Assess success of habitat-based or species-based actions for bull trout funded by FWCP (e.g., enhancement activities conducted in action #14). Success could be assessed through monitoring of biological and/or physical habitat responses and include collection of quantitative population data (abundance, trend, distribution) necessary to assess the effectiveness of conservation and enhancement actions and refine knowledge of limiting factors.	Identification of proven conservation and enhancement actions for bull trout.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Conservation sub-objective 5: maximize the viability of priority aquatic species							
16	Research & information acquisition	**PEA.RLR.S05.RI.16 Research lesser-known priority species to inform conservation status-P2**	2	Fish	Conduct research on priority, but lesser-known, fish populations, including analysis of limiting factors to support prioritization of future projects in stream, lake, and reservoir habitats. This could include an assessment of existing data and monitoring of population status, key limiting factors and/or threats, and habitat status or habitat capacity. See Table 2 in the Rivers, Lakes, & Reservoirs Action Plan for priority aquatic species. Work related to pygmy whitefish, mountain whitefish, burbot, brassy minnow, and northern pikeminnow may be of particular interest. Projects that involve citizen science are encouraged.	Prioritization of conservation and enhancement actions for lesser-known fish species, informed by increased knowledge of population status, and limiting factors.	Open
17	Research & information acquisition	**PEA.RLR.S05.RI.17 Develop a habitat restoration and protection plan for priority aquatic species-P3**	3	Fish and aquatic invertebrates	Develop a comprehensive habitat restoration and protection plan for priority aquatic species in streams, lakes, and/or reservoirs assessed in action #16 or other actions in this action plan related to limiting factors analyses and assessment of conservation status and/or habitat capacity.	Prioritization of cost-effective, habitat- and/or species-based actions for fish that can be supported by the FWCP.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
18	Habitat-based action	**PEA.RLR.S05.HB.18 Implement high-priority habitat- and species-based actions for priority aquatic species-P3**	3	Fish and aquatic invertebrates	Implement habitat conservation, restoration, and enhancement activities in streams, lakes, and/or reservoirs for priority aquatic species. This action may be dependent on assessment of population status, assessment of limiting factors, and development of a restoration plan and options for enhancement in actions #16 and #17.	Implementation of habitat- and/or species-based actions to increase the population viability of priority aquatic species.	Open
	Species-based action		3				
Conservation sub-objective 6: address fish passage issues in streams to enhance the productivity of priority species							
19	Research & information acquisition	**PEA.RLR.S06.RI.19 Conduct research to prioritize fish passage actions-P1**	1	Fish	Conduct research to identify fish passage issues in streams, and locations for habitat-based actions to improve fish access. Perched culverts are one reason fish access can be limited. The FWCP is interested in supporting the improvement of fish access when there are significant habitat gains possible. Research in this action should build upon the Fish Passage Planning project (SERNbc 2015), the Orphaned Culvert project (Ecofor 2016), and the Fish Passage Assessments and Habitat Confirmations (SERNbc 2020) project where appropriate and should identify opportunities for fish passage actions.	Identification of fish passage issues and locations for habitat-based actions to improve fish access to stream habitats.	Open

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
20	Research & information acquisition	**PEA.RLR.S06. RI.20 Conduct engagement to prioritize options for fish passage improvement-P1**	1	Fish	Conduct engagement with FWCP partners and stakeholders to assess options and prioritize areas for fish passage improvements. Engagement should involve Indigenous Nations, landowners and resource use tenure holders, agencies, and other stakeholders. The engagement should build upon the Fish Passage Planning project (SERNbc 2015), the Orphaned Culvert project (Ecofor 2016), and the Fish Passage Assessments and Habitat Confirmations (SERNbc 2020) project and any other work conducted in action #19.	Prioritization of options to restore fish access to streams.	Open/ Directed
21	Habitat-based action	**PEA.RLR.S06. HB.21 Restore fish access to streams-P1**	1	Fish	Implement habitat improvements to restore fish access to streams. The FWCP is interested in supporting the improvement of fish access when there are significant habitat gains possible and opportunities for other funding partners to implement habitat-based actions to improve fish passage. This action could involve the removal, restoration, or replacement of existing culverts, and where appropriate, should build upon the Fish Passage Planning project (SERNbc 2015), the Orphaned Culvert project (Ecofor 2016), the Fish Passage Assessments and Habitat Confirmations (SERNbc 2020) project, and actions #19 and #20.	Restoration of fish access in streams.	Open/ Directed

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Sustainable use sub-objective 7: enhance sustenance and recreational resources based on input from Indigenous Nations and stakeholder communities							
22	Research & information acquisition	**PEA.RLR.S07. RI.22 Conduct research and monitoring of culturally important fish and aquatic invertebrate species-P1**	1	Culturally important species	Conduct research and monitoring of culturally important fish species or in priority freshwater habitat locations as defined by results of action #10 in the Cross-Ecosystem Action Plan, or by existing surveys of Indigenous knowledge (e.g., Pearce et al. 2019a,b,c,d,e). Monitoring could be conducted by local Indigenous Guardians or others to support local interests about potential stressors to freshwater habitats and sustenance resources. Work should support identification of next steps such as conservation or enhancement actions.	Identification of conservation and enhancement opportunities for culturally important fish species.	Open
23	Habitat-based action	**PEA.RLR.S07. HB.23 Enhance culturally important fish and aquatic invertebrate species-P2**	2	Culturally important species	Implement conservation, restoration, or enhancement actions for priority fish species or priority freshwater habitat locations as defined by action #10 in the Cross-Ecosystem Action Plan or by monitoring in action #22 of Rivers, Lakes, & Reservoirs Action Plan. Habitat-based or species-based actions that include Indigenous Guardians, community engagement, citizen science, and volunteer support are encouraged.	Implementation of habitat- and/or species-based actions to sustain and/or increase populations of culturally important fish species.	Open
	Species-based action		2				

Action #	Action Type	Priority Action Short Description	Priority	Priority Species or Species Group	Priority Action	Intended Outcome	Delivery Approach
Sustainable use sub-objective 8: enhance sustenance and recreational resources through the monitoring of fish stocking and fish catch							
24	Monitoring and evaluation	**PEA.RLR.S08.ME.24 Monitor fish populations or catch associated with stocking programs-P2**	2	Fish	Support monitoring of species-based enhancements in lakes (e.g., stocking) associated with the regional stocking program to understand sustenance and recreational use of fish. Monitoring work undertaken in this action needs to occur in partnership with the Freshwater Fisheries Society of BC and the Province of B.C. to support evaluation of stocking effectiveness and opportunities to maximize sustenance and recreational use of fish. Work could include monitoring of fish populations and fisheries catch (i.e., creel surveys). Projects that involve citizen science are also encouraged.	An assessment of sustenance and recreational use of fish in stocked lakes and recommendations for further action related to stocking.	Open

REFERENCES

Azimuth Consulting Group Partnership (Azimuth). 2019. Williston-Dinosaur Watershed Fish Mercury Investigation. 2016-2018 Final Summary Report. Prepared for the Fish & Wildlife Compensation Program, Peace Region. Project No. CO94394. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57731. Accessed on June 10, 2020.

Beauchamp, D.A., M.G. Lariviere, and G.L. Thomas. 1995. North American Journal of Fisheries Evaluation of Competition and Predation as Limits to Juvenile Kokanee and Sockeye Salmon Production in Lake Ozette, Washington. 37–41.

Blackman, B.G. 1992. Fisheries Resources of Williston Reservoir Twenty Years After Impoundment. PWFWCP Report No. 239. 35 pp. Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=20547. Accessed on June 10, 2020.

Blackman, B.G. 2001. A Strategic Plan for the Conservation and Restoration of Arctic Grayling in the Williston Reservoir Watershed. PWFWCP Report No. 241. 17 pp. Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35424. Accessed on June 10, 2020.

Blackman, B.G., D.A. Jesson, D. Ableson, and T. Down. 1990. Williston Lake Fisheries Compensation Program Management Plan, PWFWCP Report No. 58. 38 pp. Available online at: http://a100.gov.bc.ca/appsdata/acat/documents/r8090/HQ2368_1161300706883_81eea397bdfb42ff8fe6fee6d78d31d1.pdf. Accessed on June 10, 2020.

Blackman, B.G., E.B. Murphy, and D.M. Cowie. 2004. 2003 Dinosaur Reservoir Littoral Fish Population and Habitat Enhancement Assessments, PWFWCP Report No. 298. 13 pp. Available online at: http://a100.gov.bc.ca/appsdata/acat/documents/r39984/pwfwcp_report_no_298_1384888819770_9cbd061b67f4467c6a6965473332f0004306a5a025ec1f9a8717b394387086a6.pdf. Accessed on June 10, 2020.

Cannings, S.G., and J. Ptolemy. 1998. Rare freshwater fish of British Columbia. BC Ministry of Environment, Lands, and Parks. Conservation Data Centre, Victoria, BC.

Clarke, A.D., K.H. Telmer, and J.M. Shrimpton. 2007. Habitat use and movement patterns for a fluvial species, the Arctic grayling, in a watershed impacted by a large reservoir: evidence from otolith microchemistry. Journal of Applied Ecology 44: 1156-1165. Available online at: https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/j.1365-2664.2007.01350.x. Accessed on June 10, 2020.

COSEWIC. 2012. COSEWIC assessment and status report on the Bull Trout *Salvelinus confluentus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 103 pp. Available online at: https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_omble_tete_plat_bull_trout_1113_e.pdf. Accessed on June 10, 2020.

Coxson, D.S., D.P.W. Huber, J.M. Shrimpton, A.C. Thielman, and A. Wiensczyk. 2018. Ecosystem impact of nutrient enrichment by Kokanee in the Williston Reservoir Watershed. FWCP Project No. PEA-F18-F-2296. Prepared for the Fish & Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=55493. Accessed on June 10, 2020.

Culling, B., and T. Euchner. 2019. Williston Reservoir Peace Reach Lake Trout Movements – Year 3 (2018). Project PEA-F19-F2622. Prepared for the Fish & Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57066. Accessed on June 10, 2020.

Doyle, M.W., and D.G. Havlick. 2009. Infrastructure and the Environment. Annual Review of Environment and Resources 34:349–373.

DWB Consulting Services Ltd. (DWB). 2019. Williston Watershed Kokanee Spawner Distribution and Aerial Enumeration Surveys (2018). FWCP Project No. PEA-F19-F-2895-DC-103364. Prepared for the Fish & Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57120. Accessed on June 10, 2020.

Ecofor. 2016. Orphaned culvert assessment project: Ingenika River, Finlay River and Finlay Arm Watersheds. FWCP Peace Project PF16-W17. Prepared for the Fish & Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=52027. Accessed on June 10, 2020.

Fausch, K.D. 2007. Introduction, establishment and effects of non-native salmonids: considering the risk of rainbow trout invasion in the United Kingdom. Journal of Fish Biology 71:1–32.

Hagen, J., and M. Stanford. 2017. FWCP Arctic Grayling Monitoring Framework for the Williston Reservoir Watershed. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=54464. Accessed on June 10, 2020.

Hagen, J., and S. Weber. 2019. Limiting Factors, Enhancement Potential, Critical Habitats, and Conservation Status for Bull Trout of the Williston Reservoir Watershed: Information Synthesis and Recommended Monitoring Framework. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57250. Accessed on June 10, 2020.

Hammond, R. 1987. Evaluation of Dinosaur Lake stocking program (1986 - year 4). 48 pp.

Harris, S.L., A.R. Langston, J.G. Stockner, and L. Vidmanic. 2006. A limnological assessment of four Williston Reservoir embayments, 2004. Peace/Williston Fish & Wildlife Compensation Program. PWFWCP Report No. 305. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=40006. Accessed on June 10, 2020.

Hohndorf, H., G. Hopcraft, and T. Down. 1993. Stream Surveys of the West (Upper) Moberly River Watershed, PWFWCP Report No. 67. 17 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35348. Accessed on June 10, 2020.

Interim Assessment Protocol for Aquatic Ecosystems in British Columbia. Version 1.2. 2019. Prepared by the Provincial Aquatic Ecosystems Technical Working Group – Ministry of Environment and Climate Change Strategy and Ministry of Forests, Lands and Natural Resource Operations and Rural Development. 48 p. Available online at: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/interim_aquatic_ecosystems_protocol_dec2017_v11_final.pdf?bcgovtm=CSMLS. Accessed on June 10, 2020.

Langston, A.R. 1992. Stream Fertilization Feasibility Study 1991 Data Report. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35347. Accessed on June 10, 2020.

Langston, A.R., and B.G. Blackman. 1993. Fisheries Resources and Enhancement Potentials of Selected Tributaries of the Williston Reservoir Volume II, PWFWCP Report No. 70. 185 + appendices pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35366. Accessed on June 10, 2020.

Langston, A.R., and R.J. Zemlak. 1998. Williston Reservoir Stocked Kokanee Spawning Assessment, 1994, PWFWCP Report No. 176. 13 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35404. Accessed on June 10, 2020.

Langston, A.R., and E.B. Murphy. 2008. The History of Fish Introductions (to 2005) in the Peace /Williston Fish and Wildlife Compensation Program Area, PWFWCP Report No. 325. 59 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=40141. Accessed on June 10, 2020.

Lewis, D., B. Grainger, and M. Milne. 2016. A GIS Indicator-Based Watershed Assessment Procedure for Assessing Cumulative Watershed Effects. 31pp. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-

stewardship/cumulative-effects/watershed_assessment_procedure_final.pdf?bcgovtm=CSMLS. Accessed on June 10, 2020.

Luxon, P.L., P.V. Hodson, and U. Borgmann. 1987. Hepatic aryl hydrocarbon hydroxylase activity of lake trout (*Salvelinus namaycush*) as an indicator of organic pollution. Environmental Toxicology & Chemistry 6:649–657.

Morgan, M.R. 1995. Carbon Creek spawning/rearing channel preliminary design. Peace/Williston Fish and Wildlife Compensation Program Report No. 81. 24pp plus appendices. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=8088. Accessed on June 10, 2020.

Pearce, T., J. Morgan, and R. Sam. 2019a. First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling: Nak'azdli Whut'en. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Project Number: PEA-F19-F-2866. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57237. Accessed on June 10, 2020.

Pearce, T., J. Morgan, and S. Case. 2019b. First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling: Kwadacha Nation. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Project Number: PEA-F19-F-2866. Available online at: https://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57239 Accessed on May 19, 2020.

Pearce, T., J. Morgan, J. Foerderer, and L. McArthur. 2019c. First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling: Saulteau First Nations. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Project Number: PEA-F19-F-2866. Available online at: https://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57246 Accessed on May 19, 2020.

Pearce, T., and S. Abadzadesahraei. 2019d. First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling: Tsay Keh Dene Nation. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Project Number: PEA-F19-F-2866. Available online at: https://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57247 Accessed on May 19, 2020.

Pearce, T., S. Liske, J. Morgan, and A. Solonas. 2019e. First Nations Information Gathering on Kokanee, Bull Trout and Arctic Grayling: Tse'khene First Nations (McLeod Lake Indian Band). Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Project Number: PEA-F19-F-2866. Available online at: https://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=57248 Accessed on May 19, 2020.

Pickard, D., D. Tripp, M. Porter, L. Reese-Hansen, R. Thompson, B. Carson, and P. Tschaplinski. 2018. Memekay River Watershed Status Evaluation Report. Natural Resource Sector Monitoring, B.C. FREP WSEP Extension Note #1. Available online at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/integrated-monitoring/190430_wse__memekay_final_v164.pdf?bcgovtm=Cowichan%20Valley%20Newsletter. Accessed on June 10, 2020.

Plate, E.M., R.C. Bocking, and D.J. Degan. 2012. Williston Fish Index in the Vicinity of W.A.C. Bennett Dam. Peace Project Water Use Plan: Monitoring Programs for the Peace Spill Protocol (GMSMON-4 WAC Bennett Dam Entrainment Study). Prepared by LGL Limited for BC Hydro, July 2012. Available online at: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/environment-sustainability/water-use-planning/northern-interior/gmsmon-4-fish-index-final-2012-07-01.pdf. Accessed on June 10, 2020.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime – a paradigm for river conservation and restoration. BioScience 47:769–784.

Schiefer, E., and B. Klinkenberg. 2004. The distribution and morphometry of lakes and reservoirs in British Columbia: a provincial inventory. The Canadian Geographer/Le Geographe Canadien 48:345–355.

Slaney, T.L., and V.A. Lewynsky. 1991. Walleye Feasibility Study: Moberly and Gwillim Lakes, PWFWCP Report No. 60. 76 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=12186. Accessed on June 10, 2020.

SERNbc (Society for Ecosystem Restoration in North Central BC). 2015. Fish Passage Planning – Williston Final Report. FWCP Project # PF15-F07. FLNRO Project #10005-40 ER15DVA-005. March 31, 2015. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=49088. Accessed on June 10, 2020.

SERNbc (Society for Ecosystem Restoration in North Central BC). 2020. Fish Passage Assessments and Habitat Confirmations. PEA-F20-F-2967. See http://fwcp.ca/project/improving-fish-passage-peace-region/. Accessed on June 10, 2020.

Stamford, M., J. Hagen, and S. Williamson. 2017. Limiting Factors, Enhancement Potential, Conservation Status, and Critical Habitats for Arctic Grayling in the Williston Reservoir Watershed, and Information Gaps Limiting Potential Conservation and Enhancement Actions. Report prepared for the Fish and Wildlife Compensation Program – Peace Region, Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=52757. Accessed on June 10, 2020.

Stockner, J.G., A.R. Langston, and G.A. Wilson. 2001. The Limnology of Williston Reservoir, PWFWCP Report No. 242. 51 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35843. Accessed on June 10, 2020.

Stockner, J.G., E. Rydin, and P. Hyenstrand. 2000. Cultural oligotrophication: causes and consequences for fisheries resources. Fisheries Habitat - Perspective 25:7–14.

Triton Environmental Consultants Ltd. 2012. Carbon Creek Project Evaluation. Fish and Wildlife Compensation Program – Peace Region Report No. 359. 37 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=38267. Accessed on June 10, 2020.

Wesche, T.A., C.M. Goertler, and C.B. Frye. 1987. Contribution of Riparian Vegetation to Trout Cover in Small Streams. North American Journal of Fisheries Management 7:151–153.

West, D., M. Bayly, T. Sherstone, A. Tamminga, E. Clark, M. Hocking, and T. Hatfield. 2020. Site C Clean Energy Project Tributary Mitigation Opportunities Evaluation Program – Final Report. Draft V1. Consultant's report prepared for BC Hydro by Ecofish Research Ltd. and Mainstream Aquatics Ltd., *In Final Preparation*.

Wilson, G.A., and A.R. Langston. 2000. Williston Reservoir Zooplankton Analysis Program, 1999. Peace/Williston Fish & Wildlife Compensation Program. PWFWCP Report No. 215. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=35419. Accessed on June 10, 2020.

Wilson, G.A., K. I. Ashley, P.A. Slaney, and R.W. Land. 2008. Williston Reservoir River Fisheries Restoration: The Mesilinka River Fertilization Experiment, 1992-99. Peace/Williston Fish and Wildlife Compensation Program Report NO. 319. 95 pp + appendices. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=38247. Accessed on June 10, 2020.

Zemlak, R.J., and A.R. Langston. 1998. Fish Species Presence and Abundance of the Table River, 1995, PWFWCP Report No. 173. 28 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=39339. Accessed on June 10, 2020.

Zemlak, R.J., and D.M. Cowie. 2003. Fish Stocking Assessment of Lost Lake, 2002, PWFWCP Report No. 269. 12 pp. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=39501. Accessed on June 10, 2020.

Zemlak, R.J., and J.D. McPhail. 2004. Pygmy Whitefish Studies on Dina Lake # 1, 2001. PWFWCP Report No. 279. 35 + appendices pp. Prince George, BC. Available online at: http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=39503. Accessed on June 10, 2020.

GLOSSARY

Action plan: The Fish & Wildlife Compensation Program has identified conservation priorities for fish and wildlife in each of its three regions and these are reflected in a series of Action Plans. The priorities and plans vary by region.

Blue-listed species: Includes any native species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): An independent advisory panel to the Minister of Environment and Climate Change Canada that meets twice a year to identify and assess the status of wildlife species at risk of extinction. Members are wildlife biology experts from academia, government, non-governmental organizations, and the private sector responsible for designating wildlife species in danger of disappearing from Canada.

Community engagement: Community engagement refers to range of actions intended to inform and/or involve communities of interest, including but not limited to geographic communities, in a priority action and/or proposed project. The appropriate level of engagement and the engagement actions selected will vary depending on the desired outcomes (i.e., informing vs involving).

Cross-ecosystem action: An action that is relevant to two or more ecosystem-based action plans and may require the consideration of multiple ecosystems.

Delivery approach: Priority actions identified as “open” are eligible for a grant. Actions identified as “directed” are not eligible for a grant. These are projects that our Regional Boards will direct through the appropriate procurement process (e.g., a request for proposal).

Endangered species: A fish or wildlife species that is facing imminent extirpation or extinction, as listed under the federal *Species at Risk Act*.

Entrainment: Fish entrainment can be defined as fish being transported along with the flow of water and out of their normal river, lake, or reservoir habitat into unnatural or potentially harmful environments.

Fish & Wildlife Compensation Program (FWCP): The FWCP is a partnership between BC Hydro, Fisheries and Oceans Canada, the Province of B.C., Indigenous Nations, and public stakeholders to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams.

Floodplain: An area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.

Focal species: Defined by the FWCP’s Peace Region as having a strong linkage to dam footprint impacts and are of high priority. At least some information related to population status, critical habitats and key limiting factors have been defined for focal species based on previous FWCP projects (e.g., through development of a monitoring framework), and therefore specific follow-up actions have already been developed. Actions for focal species should build upon previous FWCP projects with an aim to restore and/or enhance suitable habitats in the relevant ecosystems.

Footprint impacts: The permanent loss of habitat associated with a dam and related infrastructure, including the permanently flooded habitat (below the drawdown zone) resulting from reservoir creation.

Habitat protection: Land securement or land conservation through legal mechanisms (e.g., wildlife habitat area designation) that conserve important habits by preventing further degradation.

Habitat restoration: Manipulation of abiotic or biotic site factors through habitat or species-based actions that drive the return of natural ecological functions to an area where these functions have been lost or degraded.

Indigenous Guardians: Indigenous Guardians are involved in community-based Indigenous Guardian programs that "manage protected areas, restore animals and plants, test water quality, and monitor development projects." Land Guardians also "welcome visitors to traditional territories and maintain cultural sites."[1]

Indigenous knowledge: The United Nations Educational, Scientific and Cultural Organization (UNESCO) refers to Indigenous knowledge as the "understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings."

Invasive species: An organism (plant, animal, fungus, or bacterium) that is not native and has negative effects on our economy, our environment, or our health. Invasive species can spread rapidly to new areas and will often out-compete native species as there are no predators or diseases to keep them under control.

Inventory species: Defined by the FWCP's Peace Region as species that have been affected by dams, but detailed inventory and/or trend monitoring is required to better understand population status, critical habitats, and key limiting factors. Actions for inventory species should aim to provide the basis for future compensation actions, if required.

Lacustrine: Relating to or associated with lakes.

Lake: A naturally occurring body of water deeper than 2 m, classified by FWCP Columbia as small (less than 1,000 hectares) or large (greater than 1,000 hectares).

Littoral: Part of a lake or river that is close to the shore. The littoral zone typically extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged.

Oligotrophic: Having a deficiency of plant nutrients that is usually accompanied by an abundance of dissolved oxygen.

Pelagic: The open water area of lakes, neither close to the bottom nor the shore.

Sustenance resources: Natural resources harvested directly by Indigenous Peoples or licensed hunters and anglers for personal food or medicinal use.

Upper Peace River Basin: The geographic area (i.e., watersheds) that drains into the Peace River, upstream of the Peace Canyon Dam. The geographic boundary of this area is the same as the administrative boundary for the FWCP's Peace Region.

[1] https://landneedsguardians.ca/what-guardians-do