Brilliant Headpond Reservoir Ecological Studies Review

Submitted to:

Living Lakes Canada's Brilliant Headpond Stewardship Initiative
Nelson, British Columbia

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
Nelson, British Columbia

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IMPORTANT NOTICE

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

The Brilliant Headpond Reservoir (herein referred to as “the headpond”) encompasses a section of the lower Kootenay River adjacent to the communities of Shoreacres, South Slocan, Tarrys, Glade and Thrums in southeast British Columbia (Figure 1). Water levels and flow in the headpond are controlled by hydroelectric dams at the upstream and downstream boundaries while natural inflows enter from unregulated tributaries, the largest being from the Slocan River. The headpond and adjacent lands provide habitat for species of conservation concern including fish, turtles, reptiles and birds. A need to compile background scientific reports and studies related to the ecology of the headpond was identified by the Brilliant Headpond Stewardship Initiative (BHPSI), a group initiated by the Regional District of Central Kootenay (RDCK) Area I Advisory Planning Commission and Director consisting of headpond and community stakeholder representatives. The BHPSI contracted Living Lakes Canada in 2015 to assist them develop a comprehensive stewardship strategy for the headpond that ensures riparian management practices, recreational access and watershed management are undertaken in ways that protect the natural resource and community values of the area (RDCK 2016). This report summarizes existing scientific literature, reports and research related to the ecology of the Brilliant Headpond Reservoir and identifies potential areas for community involvement in future ecological stewardship activities.

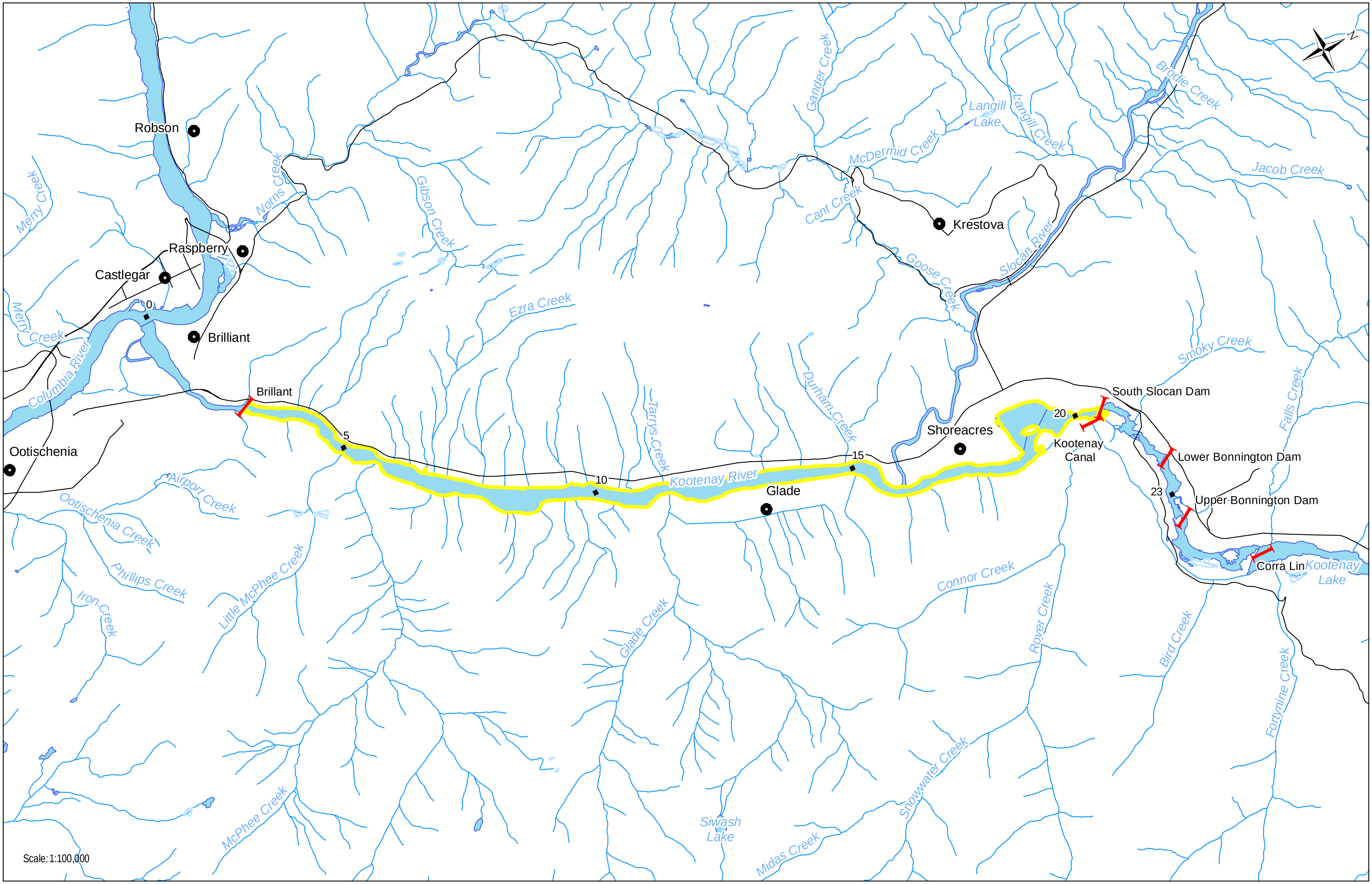
1.1 The Brilliant Headpond Reservoir

The Brilliant Headpond Reservoir is located on the lower Kootenay River and is bounded by South Slocan and Kootenay Canal dams upstream and Brilliant and Brilliant Expansion dams downstream (Figure 1). This section of the lower Kootenay River is in the Regional District of Central Kootenay Area I. Access is available at various points along the west bank but is limited along the east bank, restricted to areas around Glade including Glade Regional Park (Figure 1). The headpond is approximately 18 km in length with a mean annual inflow of 883 m^3/s (R.L. & L. 1999). The headpond is operated as a run-of-the-river reservoir resulting in a water retention time of approximately 0.7 days (R.L. & L. 1999). Significant tributaries and watersheds that feed the headpond include the Slocan River, Glade Creek and McPhee Creek (Selkirk College 2015). Other tributaries to the headpond include Durham, Ezra, Hood, Little McPhee and Tarry creeks; other unnamed ephemeral creeks also exist (Selkirk College 2015).

1.2 Objectives

The following are the objectives of this information review:

1. Summarize the existing scientific literature and studies that have been published with respect to the ecology of the Brilliant Headpond Reservoir area;
2. Present a brief overview of the key findings of these studies; and,
3. Highlight potential focus areas for further research and community engagement.



Legend

- City / Town
- Km Mark
- Dam
- Brilliant Headpond Reservoir
- Road
- Stream
- Lake
- Wetland

0 0.5 1 2
Kilometers

Reference:
DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)

Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)

CLIENT: Wildsight	PROJECT: Brilliant Headpond Reservoir Ecological Studies Review
TITLE: Brilliant Headpond Reservoir	DATE: March, 2017 · ANALYST: MY · QA/QC: CL · Figure 1
	GIS FILE: 02-01-001_Overview
	JOB No: VE52625
	COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

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2 METHODS

The focus of the review was primarily on aquatic habitat and species within the headpond itself. Terrestrial and avian species information was included only if a significant portion of the species life history was reliant on the headpond or riparian areas and/or the species was of conservation concern. Information for tributaries was included but restricted to those headpond species that may utilized these habitats for a portion of their life history (i.e. fish migration into tributaries for spawning and/or rearing). The Slocan River was not included in this review because it is outside the scope of this project.

The following resources were consulted to collect scientific reports relevant to the ecology of the Brilliant Headpond Reservoir:

- EcoCat: The Ecological Reports Catalogue;
- BC Environmental Assessment Office (EAO) – Brilliant Powerplant Expansion;
- BC Conservation Data Center (CDC) – CDC iMap and BC Species & Ecosystem; Explorer
- Selkirk College Geospatial Research Center – Columbia Basin Watershed Management; and,
- Google and Google Scholar.

Data sources consisted mostly of consultant reports as peer-reviewed information specific to the headpond was not located. Local consultants and researchers with current projects in the area were also contacted and in-progress studies and information was included as personal communications. All reports reviewed are summarized in table format and provided in Appendix A which includes a quick look-up key for each topic covered. Resources that were cited and suspected to contain information pertinent to this review but were not publically available or located are also listed in Appendix A. For example, the application made to the BC EAO for the upgrade of Brilliant Dam (Brilliant Expansion) included a summary table of available resources related to aquatic habitats impacted by the project, some of which were not located or available.

3 BRILLIANT HEADPOND RESERVOIR ECOLOGICAL INFORMATION REVIEW

The following sections summarize studies, research projects and scientific reports that have been published with respect to the ecology of the Brilliant Headpond Reservoir. Appendix A provides a summary of each report reviewed and identifies key topic areas covered.

3.1 Aquatic Habitat Connectivity

Brilliant Headpond Reservoir is an 18 km section of the lower Kootenay River that was formed by the construction of South Slocan (1928) and Kootenay Canal (1976) dams at the upstream extent and Brilliant Dam (1944) and Brilliant Expansion (2007) at the downstream extent. Prior to construction of the dams, a natural barrier to fish migration existed at Bonnington Falls, located approximately 3 km upstream of South Slocan Dam, isolating fish populations in Kootenay Lake from those in the Columbia River (Westslope 2001). The construction of Brilliant Dam in 1944 and creation of Brilliant Headpond Reservoir further isolated fish populations in the lower Kootenay River from populations downstream in the Columbia River system. The Slocan River is the largest tributary within the headpond and is unregulated; fish populations can move freely between the two systems today as they could prior to dam construction. Water level at the Slocan River confluence upstream to the Highway 3A bridge can be impacted by the water level of the headpond.

3.2 Water Regulation and Flow

Water levels in Kootenay Lake are dictated by the International Joint Commission (IJC) Order of 1938. The order specifies a maximum elevation Kootenay Lake must be drawn down to by April 1 in preparation for spring runoff. Between April 1 and August 31, the maximum water level in Kootenay Lake is calculated using a lowering formula based on what the natural lake elevation would have been if it were not regulated. The 1972 Canal Plant Agreement (CPA) outlines the coordinated operation of the BC Hydro owned Kootenay Canal and the lower Kootenay River and Pend d'Oreille River plants owned by FortisBC (Corra Linn, Upper Bonnington, Lower Bonnington, South Slocan, Waneta Expansion), Columbia Power Corporation/Columbia Basin Trust (Brilliant, Brilliant Expansion, Waneta Expansion) and Teck Metals Ltd. (Waneta).

BC Hydro directs the CPA and is responsible for planning the overall operation of these dams while the individual plant owners are responsible for ensuring that the operation of their plants are consistent with their Water License as well as other regulatory obligations. There is a minimum flow requirement of 5,000 cfs which is to be maintained through the less efficient Kootenay River plants (owned by FortisBC) at all times while water is preferentially diverted to the Kootenay Canal plant (owned by BC Hydro). Kootenay Canal is often operated as a peaking plant to meet higher energy demands during the morning and evening. The headpond is operated for daily shaping of flows and has limited storage capacity (Province of BC 2013). There is no Water Survey of Canada (WSC) gauging station in the headpond; WSC stations record parameters such as discharge, water elevation and temperature. Discharge and elevation data is recorded by local power providers but it is not publically available.

3.3 Water Quality and Chemistry

Brilliant Headpond Reservoir is an oligotrophic system meaning it naturally unproductive and low in nutrients (R.L. & L. 1999). R.L. & L. (1999) obtained water samples from upper and lower sections of the headpond as well as from the Slocan River in 1997 during each season.

The sections below include a summary of water quality information specific to the headpond. Information pertaining to tributaries has only been included for water temperature as it is an important variable for fish migration. However, note that additional water quality data is available for Glade Creek which is the drinking water source for the community of Glade. The Glade Creek Irrigation district measures water quality variables including E. coli and total coliform every two weeks while free and total chlorine as well as turbidity are measured daily. The results are available via their website (Glade Creek Irrigation District 2017) and were not included herein. Several terrain and stability assessment reports were completed for the Glade Creek watershed and these findings may have water quality implications for the headpond (e.g., Carver et al. 2001, Halleran 2007, Green 2016). A summary of these reports are provided in Appendix A and not discussed further.

3.3.1 *Water Quality*

Targeted water quality sampling was conducted in the headpond in 1997 and 2000 (R. L. & L. 1999, EVS and NHC 2000). In 1997, water quality parameters analyzed included pH, alkalinity, nutrients (nitrate/nitrite), metals and other routine variables (R. L. & L. 1999). Results indicated that water chemistry at all locations sampled within the headpond were similar and fell within the Approved and Working Criteria for Water Quality in B.C. at the time (Pommen et al. 1995) and did not suggest any major limiting factors to aquatic life. Aluminum levels in the Slocan River were higher in all seasonal samples than at the headpond sampling sites; the headpond spring sample was above the suggested maximum concentration as outlined in the Approved and Working Criteria for Water Quality in BC (Pommen et al 1995). It is unknown why aluminum levels were higher in the Slocan River but elevated levels were not observed in the headpond downstream of the confluence.

In May 2000, water samples were taken along a 700 m long section of the west bank of the headpond immediately upstream of the Brilliant Dam (EVS and NHC 2000). Sampling was conducted to evaluate acute and long-term impacts of using this location as a waste rock disposal site during construction of Brilliant Expansion. Total cadmium concentration in most water samples exceeded guidelines while the chromium, copper, iron and zinc exceeded guidelines at one sampling location. EVS and NHC (2000) concluded that metals are present under ambient conditions in the headpond in particulate-bound state (i.e. as total rather than dissolved). Dissolved concentrations of the metals are low and this is the state typically responsible for toxicity. Studies conducted in May 2000 (EVS and NHC 2000) indicated that dissolved metal concentrations were generally similar to those measured in 1997 (R.L.&L. 1999) and that no significant changes in water quality had occurred between the two sample sessions.

3.3.2 *Water Temperature*

Continuous water temperature monitoring was conducted in the Brilliant Dam forebay (i.e. area immediately upstream of the dam intake and spillway gates) in 1997 by R.L. & L. (1999). The forebay reached seasonal minimum temperatures between late December and mid-May (~3°C) and maximum temperatures between August and mid-September (~18°C). It was found that water temperature within the Brillant Dam forebay was almost identical to water temperature downstream of the dam year round regardless of whether discharge was through unit (turbine) or spill gates because the river is isothermal, meaning it is the same or similar temperature from top to bottom and does not become stratified with warm water on the surface and cooler water at depth as a lake does in the summer (Section 3.3.4, R.L. & L. 1999). Water temperature monitoring below Brilliant Dam has been more extensive (R.L. & L. 1999) compared to that conducted in the headpond.

More recently, a water temperature logger was installed in Glade Creek in February 2016 and remains in place recording hourly water temperature (Baxter and Irvine 2017). Water temperature in Glade Creek was just above freezing when installed in February and reached a maximum of approximately 17°C in August 2016 (Baxter and Irvine 2017).

3.3.3 *Total Gas Pressure*

TGP is a measure of dissolved gas in water which when elevated can lead to Gas Bubble Disease in fish. R.L. & L. (1999) measured Total Gas Pressure (TGP) in the Brilliant Dam forebay in 1999. TGP recorded in the Brilliant Dam forebay in the winter, summer and fall were within the B.C. Water Quality Guidelines (i.e. <110% saturation) while TGP in the spring was elevated above this guideline. R.L. & L. (1999) suggested a spill occurring at the lower Kootenay River generating plants was the source of elevated TGP in the spring (BC Ministry of Environment 2017). Aspen Applied Sciences (2000) modelled the results of monitoring completed by R.L. & L. (1999) to describe the level of TGP upstream and downstream of Brilliant Dam annually between 1991 and 1999. They found that TGP levels exceeded the recommended B.C. Water Quality Guideline in the Brilliant Headpond Reservoir between 30 and 121 days per year during that period.

3.3.4 *Stratification and Mixing*

Water temperature and dissolved oxygen profiles measured at 1 m intervals in the lower section of the headpond indicated it was well mixed and isothermal in all seasons (R.L. & L. 1999); this was confirmed by additional studies conducted by BC Hydro (1984), R.L. & L. (1998) and EVS and NHC (2000). Thermal stratification likely doesn't occur in the headpond due to the relatively low storage volume and short water retention time.

3.3.5 *Sediments*

Sediment samples were taken along a 700 m long section of the west bank of the headpond immediately upstream of the Brilliant Dam in May 2000 (EVS and NHC 2000). As mentioned, this sampling was conducted to evaluate acute and long-term impacts of using this location as a waste rock disposal site during construction of Brilliant Expansion. Benthic (bottom) substrates in this area were bedrock with a thin veneer of sediment typically in pockets behind large outcrops (EVS and NHC 2000). Sediment total organic carbon was generally low, ranging from 0.06% to 0.71%. Sediment grain size was primarily sands and gravels with trace amounts of fines. Metal concentrations were within the Canadian Interim Sediment Quality Guidelines (ISQG) with the exception of chromium which exceeded the ISQG at all sample stations (EVS and NHC 2000). Sediment toxicity sampling was done by exposing aquatic invertebrates (*Ceriodaphnia dubia* and *Daphnia magna*) and Rainbow Trout (*Onchorynchus mykiss*) to various sediment concentrations; no significant effects on mortality were observed in the sediment/water mixtures.

3.4 <u>Brilliant Headpond Instream and Foreshore Habitat</u>

R.L. & L. (1999) documented a variety of habitats in the Brilliant Headpond Reservoir with some general differences between the uppermost and lowermost sections. The upper section of the headpond immediately downstream of South Slocan Dam and Kootenay Canal consisted of a high velocity, deep channel confined within a steep bedrock-walled canyon. Immediately downstream is a deep scour hole with depths >20 m referred to locally as Slocan Pool. The downstream end of Slocan Pool is known as Wards Bay where the channel was shallow (10-12 m) with moderate velocity, and braided with treed islands, shallow shoals and had extensive macrophyte growth in the summer months. Downstream from Wards Bay to the confluence with the Slocan River, the headpond was narrower and deeper. From the Slocan River to the Brilliant Dam the headpond was generally 10-20 m deep with steeply sloped banks, low to moderate velocity and had extensive aquatic vegetation growth in the summer that formed dense weed beds in narrow or wide bands that were dependent on the shoreline slope (R.L. & L. 1999).

Important habitat areas for fish species included areas in the South Slocan Dam tailrace, channel margins, shallow shoal areas, the Slocan River confluence and its lower reaches, and the alluvial outwash fans of McPhee and Little McPhee creeks (R.L. & L. 1999).

R.L. & L. (1999) also completed assessments of the physical habitat conditions in the lowermost reaches of McPhee and Little McPhee Creeks in 1997. A series of cascades approximately 300 m upstream of the McPhee Creek mouth were identified as barriers to fish passage. The 300 m downstream of the cascades was likely accessible to headpond-based fish populations year-round (R.L. & L. 1999). Low flow conditions observed in Little McPhee Creek during most of the year likely limit access to the creek by larger fish species and a cascade located 62 m upstream of the mouth was identified as a fish passage barrier.

The Thrums Shoreline Restoration Project was conducted in the spring of 2005. The objective of the program was to establish wetland vegetation along with other soil bioengineering techniques to mitigate the impacts of shoreline erosion resulting from wave action within the section of the headpond adjacent to Thrums (Terra Erosion 2010). Vegetation including sedges (*Carex spp.*), bulrushes (*Schoenoplectus spp.*) and cattails (*Typha latifolia*) were selectively harvested from local wetlands and planted along the foreshore at depths where the species naturally occur.

3.5 Fish Species in the Brilliant Headpond Reservoir

The most comprehensive assessment for fish species presence/absence, abundance and aquatic habitat in the Brilliant Headpond Reservoir was conducted in 1990-1993 and 1997 by R.L. & L. (1999) which included an assessment of seasonal and temporal population trends for the prevalent fish species in the headpond. As discussed above, important fish habitat included areas within the South Slocan Dam tailrace, along channel margins and shallow shoal areas, and at confluence areas of the Slocan River, McPhee Creek, and Little McPhee Creek. In general, native fish species were distributed throughout the headpond, but tended to be in areas of low velocity with some form of submerged cover (e.g., aquatic vegetation, stumps, boulders). Rainbow Trout and Mountain Whitefish (*Prosopium williamsoni*) were the only species more commonly observed in higher velocity areas of the upper section of the headpond between South Slocan Dam and Glade. Further information on native fish species in the headpond is provided below.

As outlined in Section 3.1, there are no physical barriers to fish migration between the Slocan River and the headpond. Migration between the two waterbodies likely occurs, however, little to no research has been done to confirm this.

3.5.1 *Bull Trout*

Interior populations of Bull Trout (*Salvelinus confluentus*) are blue-listed (of special concern) in BC. Bull Trout have been observed in Glade Creek, the Slocan River but there are few published reports of Bull Trout being observed in the headpond (R.L.& L. 1999, Baxter and Irvine 2017). Bull Trout that live in lake/large river habitats such as the headpond would likely be the adfluvial form, meaning they migrate into smaller tributaries to spawn in the fall then return back to the larger water body (i.e., they do not die after spawning). Spawning occurs in gravel substrate where a female has dug a redd (spawning nest) and deposits her eggs while a male fertilizes them with milt; the female buries the eggs with the excavated gravels. Eggs incubate in the gravels over the winter and after hatching juvenile Bull Trout will spend 2-3 years in the spawning stream before returning to the larger water body. Bull Trout reach spawning age after 5-6 years and can live up to 24 years (McPhail 2007).

Low numbers of Bull Trout were captured in the lower section of the headpond during sampling conducted in 1992 but this species was not observed again during subsequent sampling in 1993 and 1997 (R.L. & L. 1999). Bull Trout were captured in Glade Creek during sampling conducted by Selkirk College in 2013 (Vandenbos 2013) and based on the size and lack of signs of maturity/fertility, these fish were likely juveniles that had been spawned by adfluvial adults entering the creek from the headpond. Baxter and Irvine (2017) conducted two Bull Trout spawning surveys in Glade Creek in late September and mid October 2016. No Bull Trout or spawning redds were observed during these surveys though suitable substrate was located. Water temperature monitoring has been ongoing in Glade Creek since February 2016 and review of water temperature data suggested daily average temperature exceeded optimal conditions for Bull Trout migration (12°C) and spawning (9°C) during the appropriate timing windows. Baxter and Irvine (2017) suggest Bull Trout spawning in Glade Creek may be infrequent and limited to years when environmental conditions (i.e. water temperature) are suitable.

3.5.2 *Rainbow Trout*

Rainbow Trout have been found throughout the headpond as well as in its tributaries. Prior to dam construction on the lower Kootenay River, Slocan Pool below Bonnington Falls was a natural gathering spot for fish, and thus for anglers, where salmon were captured seasonally and game fish including Rainbow Trout were captured year round (Westslope 2001). Following construction of Brilliant Dam, Rainbow Trout were stocked in the lower Kootenay River in locations including Slocan Pool to increase angler opportunities (Province of B.C. 1950). Rainbow Trout spawn in the spring in areas of flowing water and are triggered to move to spawning streams or spawning areas by rising water temperature (above 5°C) and rising water levels (McPhail 2007). Rainbow Trout pairs spawn in gravel substrate, similarly to Bull Trout (Section 3.5.1). Egg incubation is dependent on water temperature, typically emerging from the gravels by early summer. Rainbow Trout spawned in streams can rear for up to a year before migrating downstream as smolts; they reach sexual maturity after 1 to 4 years depending on the life history and body size of the population (McPhail 2007).

Golder (2002) conducted the most extensive Rainbow Trout sampling program in the headpond. They found catch-rates were highest in the upstream section but decreased with increasing distance downstream of South Slocan Dam. Population estimates (with 95% confidence intervals) were: 2040 (1940-2151) juveniles, 1154 (958-1451) adults, and 3194 (2899-3602) for all Rainbow Trout. Previous population estimates has been generated by BC Hydro (1984) and R.L. & L. (1998), however, data analysis and low recapture rate issues limited the validity of the estimates of these other studies (Golder 2002).

Rainbow Trout have consistently been captured in Glade Creek during surveys conducted by Selkirk College (Vandenbos 2007, 2008, 2009, 2013 and 2014) and others (Hildebrand 2000). Rainbow Trout spawning has also been observed in Glade Creek, the mouth of the Slocan River and near the island at the downstream end of Slocan Pool (Jeremy Baxter, Mountain Water Research, pers. comm. 2017). R.L. & L. (1999) did not observed Rainbow Trout spawning but suggested they likely spawn in the Slocan River and possibly in the lower reaches of the headpond and alluvial fans of McPhee and Little McPhee creeks.

Entrainment of Rainbow Trout from the West Arm of Kootenay Lake into the headpond likely occurs and some entrainment out of the headpond occurs via Brilliant Dam (Ardnt 2009). Ardnt (2009) suggested the overall abundance of fluvial Rainbow Trout has declined due to habitat alterations and loss of connection with the Columbia River and that genetic diversity may also have been reduced due to population fragmentation.

The lower section of Glade Creek has been identified as an excellent candidate for habitat enhancement and restoration to increase spawning habitat at existing gravel beds near the creek's mouth (Jeremy Baxter, Mountain Water Research, pers. comm. 2017).

3.5.3 *Kokanee*

Kokanee (*Oncorhynchus nerka*) are a salmonid that has been documented rarely in the heapond. Kokanee migrate into spawning tributaries or nearshore areas from lakes and large rivers in the early fall to spawn. Spawning is completed similarly to Bull Trout, however, Kokanee die after they spawn. Eggs incubate in the gravels until the late winter/spring at which point they emerge. Recently emerged Kokanee are immediately taken downstream with the current to the lake/large river if they had been spawned in a tributary and remain in the lake if spawned nearshore. Kokanee typically reach sexual maturity after their third or fourth summer (McPhail 2007).

Kokanee were captured in the lowest abundance of all fish species by R.L. & L. (1999) during river indexing surveys conducted in 1992 and 1997. Kokanee may spawn in the headpond at the mouth of Glade Creek based on an observation of disturbed gravels which were potentially Kokanee spawning redds in September 2016 (Jeremy Baxter, Mountain Water Research, pers. comm. 2017). Glade Creek provides suitable gravel size and spawning habitat for Kokanee and they may also spawn within the creek. Glade Creek was also identified as a potential location for habitat enhancement to improve the access to the existing substrate to make the area more suitable for Kokanee spawning.

3.5.4 *Mountain Whitefish*

Mountain Whitefish typically spawn in flowing water during the late fall and early winter. River dwelling populations may migrate into smaller tributaries to spawn but mainstem spawning occurs in both the Columbia River and lower Kootenay River downstream of Brilliant Dam (McPhail 2007). Spawning occurs at the head end of pools or in the lower end of riffles. Mountain Whitefish are broadcast spawners, meaning females will release eggs over the substrate (i.e., no spawning redd is dug) with males synchronizing their release of milt to fertilize the eggs which then settle into interstitial spaces between the substrate to incubate over the winter. Fry emerging in streams immediately drift downstream before moving into shallow, low-velocity areas such as sidechannels, backwatered areas and river margins. Mountain Whitefish reach sexual maturing after 3 to 6 years and few individuals live longer than 12 years (McPhail 2007).

Mountain Whitefish abundance was highest in the upper section of the headpond in 1990 and decreased with increasing distance downstream of South Slocan Dam (R.L.&L. 1999). Only the lower section of the headpond was sampled during 1992, 1993 and 1997 and catch-rates varied between survey years and seasons with overall higher abundance observed during all seasons except fall 1997 compared with earlier years (R.L.&L. 1999). Mountain Whitefish were observed in similar abundance to Rainbow Trout in 1997 (R.L. & L. 1999). A concentration of Mountain Whitefish juveniles was observed at the McPhee Creek mouth during 1997 summer sampling, however because catch-rates were low there is limited information on spatial distribution of the species within this lower section of the headpond.

3.5.5 *Redside Shiner*

Redside Shiners (*Richardsonius balteatus*) were the most abundant fish species captured in the headpond during 1997 sampling (R.L. & L. 1999). Redside Shiners are a minnow that spawn in the spring with increasing daylight and water temperature triggers spawning migrations. Spawning typically occurs in flowing water over clean substrates with lacustrine populations moving into the lowest reaches of tributary streams. They are broadcast spawners and eggs are demersal and adhesive when fertilized, sticking to interstitial spaces within the substrate. After a short incubation and hatch period, fry emerge from the substrate and migrate the short distance downstream to a lake or larger river. Redside shiners forage throughout the littoral zone in small groups during the day, moving to deeper offshore areas at night. Sexual maturity is reached after 3-4 years and the maximum age recorded in B.C. is 7 years (McPhail 2000).

Abundance of Redside Shiners varied significantly both annually and seasonally during surveys conducted in 1990, 1992 and 1997 (R.L. & L. 1999). Redside Shiners were most abundant in areas with large angular substrates and used deep shoreline areas which is a habitat type more abundant in the lower portion of the headpond along the west bank (R.L. & L. 1999). They were also recorded in shallow areas over sand and silt substrates.

3.5.6 *Peamouth Chub*

Peamouth Chub (*Mylocheilus caurinus*) was the second most abundant fish species captured in the headpond in 1997 (R. L. & L. 1999). The reproductive strategy of Peamouth is the same as Redside Shiners (Section 3.5.5). Adult Peamouth are found in deeper habitat during the late fall through winter, moving closer to shore and into streams to spawn in the spring. In the spring and summer, Peamouth are diel migrators, moving toward the surface and inshore in the evening and back to deeper water in the morning. Peamouth reach sexual maturity after 3-4 years; males rarely live longer than 8 years while females can live up to 19 years (McPhail 2000).

R.L. and L. (1999) found Peamouth distributed throughout the headpond with generally higher abundances along the east bank compared to the west. Concentrations of Peamouth were observed at the mouths of McPhee and Little McPhee creeks as well as along an old slide area on the east bank of the headpond (R. L. & L. 1999).

3.5.7 *Sucker Species*

R.L. & L. (1999) identified three sucker species in the headpond: Largescale Sucker (*Catostomus macrocheilus*), Longnose Sucker (*Catostomus catostomus*) and Bridgelip Sucker (*Catostomus columbianus*). The species has been grouped as sucker species in all abundance and distribution studies in the headpond. Suckers spawn in the spring with the Longnose Sucker spawning period preceding that of other sucker species. Spawning occurs over gravel substrates in both flowing water (rivers, streams and lake outlet/inlets) as well as in shallow water in lakes. Suckers are broadcast spawners and eggs settle into the substrate to incubate for periods of a week to a month, depending on water temperature and this varies slightly by species. Fry are common in shallow, low or no velocity nearshore areas including seasonally flooded vegetation. Adult suckers will typically be found in deeper water during the day and move closer to shore to forage at night. Male suckers mature after 5 or 6 years and females after 6 or 7 years; all three species can live up to 30 years (McPhail 2007).

R.L. & L. (1999) found suckers were distributed throughout the headpond in a variety of habitats with broad ranges of depth and velocity. Suckers were more abundant along the west bank of the headpond compared to the east with adults using both deep and shallow habitats while juveniles occupied nearshore, shallow channel margins with low velocities (R.L. & L. 1999). The abundance of sucker species in the headpond generally increased over the winter, spring and summer sessions then decreased slightly in the fall during 1997 sampling; a similar trend has been recorded for sucker species in the lower Kootenay River below Brilliant Dam (R.L. & L. 1999).

3.5.8 *Northern Pikeminnow*

The headpond contains habitats suitable for all life stages of Northern Pikeminnow (*Ptychocheilus oregonensis*) in many areas and the species is distributed throughout all areas (R.L.&L. 1999). Northern Pikeminnow are spring spawners and typically spawn in the lower reach of inlet streams though spawning can occur in flowing rivers and lakes (McPhail 2007). Aggregations of males move into shallow spawning areas at dusk while females cruise by offshore until ready spawn at which time a single female moves into the aggregation, eggs and milt are released in the shallows and settle into gravel and cobble substrates (McPhail 2007). Egg incubation is relatively short (6 days to hatch at 18°C) and fry grow rapidly over their first summer, rearing in nearshore habitats. Northern Pikeminnow reach sexual maturity after 3-6 years and can live up to 15-20 years (McPhail 2007).

R.L. & L. (1999) found Northern Pikeminnow tended to be more abundant along the west bank compared to the east bank of the headpond and juveniles utilized shallow channel margin areas for rearing. Catch-rates were highest during fall surveys in 1990, 1992 and 1997 compared with other seasons (R. L. & L. 1999).

3.5.9 *Sculpins*

Sculpin species documented in the headpond include Torrent Sculpin (*Cottus rhotheus*), Prickly Sculpin (*Cottus asper*), Slimy Sculpin (*Cottus cognatus*), Columbia Sculpin (*Cottus hubbsi*), and Shorthead Sculpin (*Cottus confuses*) (R.L. & L. 1999, AMEC 2011 and AMEC 2012). Shorthead Sculpins and Columbia Sculpins are listed as a *Species Of Special Concern* under the Canadian Species at Risk Act (SARA) and are blue-listed in BC. Sculpins are benthic, spending their lives in and on riverbed substrates usually in areas of moderate to swift current. Sculpins spawn in the spring in flowing water or the nearshore area of lakes. A male sculpin will select and defend a nest rock where one or many females will deposit her eggs, typically on the underside where they are protected from river flow and predation. Males will stay with the nest until the eggs hatch approximately 3-4 weeks later. Sculpins reach sexual maturity at around age 3 and can live up to 7-8 years (McPhail 2000).

Sculpins and their nests were found to be vulnerable to stranding during flow reductions that occur during the spawning period (AMEC 2014). Male sculpins have been observed to stay with their nests when water levels drop and eggs become desiccated and unviable (AMEC 2014). Sculpin have been captured in low abundance during studies conducted in the 1990's but this is due, at least in part, to the capture methodology used (boat electrofishing) because sculpins tend to use interstitial spaces and do not rise to the surface as other fish species do when using this method (R.L. & L. 1999). Shorthead Sculpin were only observed near the Slocan River mouth by AMEC (2011 and 2012) though sampling was completed throughout the headpond. Columbia Sculpin were identified by Peden et al. (1989) immediately downstream of the confluence with the Slocan River in habitat dominated by large boulders.

3.5.10 *Dace*

Dace species recorded in the headpond include Longnose Dace (*Rhinichthys cataractae*), Leopard Dace (*Rhinichthys falcatus*) and Umatilla Dace (*Rhinichthys umatilla*) (R.L. & L. 1999). Umatilla Dace are listed as a *Species Of Special Concern* under SARA and are red-listed (endangered or threatened) in BC.

Longnose Dace spawn in the spring in riffles over coarse gravel substrates. Spawning occurs in pairs over a cleaned depression in the substrate created and defended by the male. Eggs start to hatch in about a week. Two spawning pulses have been recorded in the Columbia system in the spring. Longnose Dace reach sexual maturity after three years and live up to six years (McPhail 2007). Longnose Dace and Leopard Dace were captured occasionally by R.L. & L. (1999) during surveys conducted from 1990 to 1993 and in 1997. Longnose Dace were also captured by AMEC (2011 and 2012).

Little is known about Leopard Dace spawning and it has never been observed in the wild. It is assumed Leopard Dace spawning timing, habitat and behaviour is similar to Longnose Dace (McPhail 2007). Leopard Dace were observed by R.L. & L. (1999) during 1997 surveys.

Umatilla Dace spawning has also not been observed in the wild and until recently was assumed to be similar to that of Longnose Dace. Porto and Lawrence (2016) reported that Umatilla Dace spawn during the summer in slow velocity areas associated with aquatic macrophytes. Umatilla Dace eggs incubate for about one week and fry are found in slack, nearshore habitats. Umatilla Dace were initially recorded in the headpond by Hughes and Peden (1989) who captured the fish at various sites below South Slocan Dam in the vicinity of Slocan Pool and Ward’s Bay (CDC 2017). Umatilla Dace have been identified during surveys conducted by R.L. & L. (1999) and more recently by AMEC (2011, 2012). Umatilla Dace are also abundant in the Slocan River where fish in spawning condition as well as young-of-the-year have been recorded (Porto and Lawrence 2016). Umatilla Dace were captured throughout the headpond by AMEC (2011, 2012).

3.5.11 *White Sturgeon*

White Sturgeon are listed as an *Endangered* species under SARA and are red-listed in BC. Two White Sturgeon populations potentially existed on the lower Kootenay River (Kootenay and Columbia) which were historically separated by the natural barrier at Bonnington Falls. Prior to construction of the Brilliant Dam, Columbia White Sturgeon were able to move between the Columbia, lower Kootenay and Slocan rivers. The Kootenay White Sturgeon population historically could access the area between upper Bonnington Falls and Kootenay Lake, prior to the construction of Corra Linn Dam (1932), but likely did not migrate downstream of the falls unless entrained accidently.

The historical presence of White Sturgeon in the lower Kootenay River was confirmed during construction of the dams in the early 1900s (Westslope 2001). Several White Sturgeon were killed during blasting associated with dam construction and others were trapped between the dams as they were constructed; residents recall stories of sturgeon jumping downstream of the Lower Bonnington Dam in the 1930s and 1940s (Westslope 2001). R.L. & L. (1999) suggested White Sturgeon may still be present in the headpond in low numbers based on reported observations by South Slocan Dam operators. However, White Sturgeon have not been captured during fish inventory surveys in the headpond (e. g., R.L. & L. 1999) nor during a targeted White Sturgeon sampling program conducted by R.L. & L. in the headpond in June and August 1995 (R. L. & L. 1996). It is unlikely a self-sustaining population of White Sturgeon is present in the headpond (or Slocan Lake upstream) and if individuals are observed they may have been trapped following the construction of Brilliant Dam in 1944 or, more likely, they may have been entrained from the upstream Kootenay Lake population through the Kootenay River facilities (R.L. & L. 1996).

3.5.12 *Salmon*

Prior to impoundment of the Kootenay and Columbia rivers, Chinook Salmon (*Oncorhynchus tshawytscha*) and Sockeye Salmon (*Oncorhynchus nerka*) migrated upstream from the Pacific Ocean through the Columbia River and entered into the lower Kootenay River as well as the Slocan River to spawn and die (Westslope 2001; Duke Engineering 2000). Salmon and other migratory fish like Bull Trout and Steelhead (Rainbow Trout that migrate to the ocean) were plentiful in Slocan Pool and the area was a gathering spot for fishing and hunting. First Nations would gather on Gold Island in the Slocan Pool in the fall to fish for these species (Westslope 2001). The completion of South Slocan Dam in 1929 blocked salmon from reaching traditional spawning beds further upstream near the mouth of Grohman Creek. However, Slocan Pool and the Slocan River were still accessible until Grand Coulee Dam (1941) was constructed on the Columbia River through the 1930's. The final year that salmon were able to reach the headpond was 1935 (Westslope 2001). Brilliant Dam (1944) does not have fish passage capabilities and blocked fish migration between the Columbia and lower Kootenay River.

In recent years, the feasibility of salmon reintroduction to the Columbia and Kootenay watersheds upstream of Chief Joseph and Grand Coulee dams has been evaluated by reviewing facility-specific fish passage requirements, upstream habitat suitability, hatchery rearing program requirements, climate change impacts, funding opportunities and regulatory/treaty considerations (Columbia Basin Tribes 2015). Partners involved suggest reintroduction is likely to occur within the next three years (Kenton Andreashuk, Canadian Columbia River Intertribal Fisheries Commission (CCRIFC), pers. comm., 2017). If salmon were to be successfully reintroduced to the Canadian portion of the Columbia River, there is a legally binding commitment for the Brilliant Expansion project to install fish passage facilities if fisheries agencies permit the installation (BEPC 2001). Duke Engineering (2001) found construction of passage facilities for adult upstream and juvenile downstream migration is technically possible though the expense would be considerable.

3.6 Other Wildlife in the Brilliant Headpond Reservoir Watershed

For the purposes of this study, only information pertaining to wildlife species with a direct reliance on the Brilliant Headpond Reservoir and its riparian areas for the majority of their life history and/or are species of conservation concern were reviewed. Significant wildlife species in the area other than fish include Painted Turtle, Banded Tigersnail, Coeur D'Alene Oregonian (snail), Western Skink, Great Blue Hernon, Lewis's Woodpecker, Bobolink and Western Screech Owl (CDC 2017, Ryan Durand, Durand Ecological, pers. comm. 2017).

3.6.1 *Painted Turtle*

Painted Turtles of the Intermountain Rocky Mountain Population (*Chrysemys picta* pop.2) are listed as a *Species of Special Concern* under SARA and provincial status listing (blue-listed). A small population (<20 turtles) was documented sometime prior to 2005 in the headpond in an area referred to as the Brilliant Slough on the east side of the headpond upstream of Brilliant Dam. The turtles were identified in a backwater slough/seasonal wetland area (CDC 2017).

3.6.2 *Mussels*

The Syilx, Ktunaxa and Secwepemc nations are currently completing an inventory of native freshwater mussels in the Columbia River basin. Surveys are completed visually by walking the shoreline and/or by snorkelling to identify native mussels at predetermined site locations (Zimmer 2016). One mussel of unknown species was detected along the shoreline of the Slocan Pool area below South Slocan dam in September 2016 (Amy Duncan, Okanagan Nation Alliance, unpublished data). The Canadian Columbia River Intertribal Fisheries Commission (CCRIFC) observed mussels immediately upstream of the Slocan River confluence and surrounding Gold Island in 2016 (Kenton Andreashuk, CCRIFC, pers. comm. 2017).

3.6.3 *Crayfish*

There are anecdotal reports of Signal Crayfish (*Pacifastacus leniusculus*) in the Kootenay River watershed. Signal Crayfish are found in southern BC, the Kootenays is the eastern limit of their range (Bondar et al. 2005). Direct observations of Signal Crayfish have not been recorded in the headpond, however, they have been observed upstream in Kootenay Lake and the Kootenay Canal as well as downstream below Brilliant Dam making it possible they are present in the headpond as well (Kenton Andreashuk, CCRIFC, pers. comm. 2017).

3.6.4 *Snails*

Recently, two species of provincially Blue-listed snails, Banded Tigersnail (*Anguispira kochi*) and Coeur D'Alene Oregonian (*Cryptomastix mullani*), have been identified in multiple research plots around the headpond (Ryan Durand, Durand Ecological, pers. comm. 2017). Banded Tigersnail occurs in forested areas generally dominated by trembling aspen or paper birch with deep, continuous leaf litter and are more abundant in lower elevations, often near watercourses. Coeur D'Alene Oregonian occurs in a wide variety of forested habitat and most individuals were observed in moist deciduous forests and moist coniferous forest in areas of the Slocan River watershed. Most of the occurrences in the headpond watershed have been in the Glade and Kootenay Canal areas. This data has not been published at this time, however, observation records will be available through the Conservation Data Center in the near future (Ryan Durand, pers. comm. 2017).

3.6.5 *Birds*

Bird species of conservation concern identified in proximity to the headpond watershed include: Great Blue Heron (*Ardea herodias*), Lewis's Woodpecker (*Melanerpes lewis*), Bobolink (*Dolichonyx oryzivorus*) and Western Screech Owl (*Megascops kennicottii*) (CDC 2017).

3.6.6 *Large Mammals*

Large mammals occurring in the vicinity of the headpond include Cougar (*Felis concolor*), Wolves (*Canis lupus*), Black Bear (*Ursus americanus*), Grizzly Bear (*Ursus arctos horribilis*), Rocky Mountain Elk (*Cervus elaphus nelsoni*), White-tailed Deer (*Odocoileus virginianus*) and Mule Deer (*Odocoileus hemionus*). Published reports outlining population dynamics and movements in the vicinity of the Brilliant Headpond watershed were only available for Elk.

Rocky Mountain Elk are an indigenous ungulate species found throughout the Kootenays. DeGroot and Woods (2006) studied the behaviour and population dynamics of Elk ranging in the headpond watershed and Slocan Valley between 2002 and 2005. Their results indicated elk winter at low elevations at or near the main valley bottoms and in proximity to human settlement. While a small proportion stay at low elevations throughout the summer as well, an equal proportion move away from human settlement completely during the summer and the majority move back and forth but primarily away from human settlement between August and October. Mortality due to predation during the study was not observed but likely; highway mortalities are known to occur in the area. The elk population was estimated between 600 and 700 elk. Changes to the Limited Entry Hunt proposed included changing allocations, limiting the hunt to elevations below 1200 meters, amalgamating hunting zones, and a higher harvest rate prior to October 10 (DeGroot and Woods 2006). No recommendations for future studies were proposed.

3.7 <u>Invasive Species</u>

Invasive species are any plant or animal species found in the Brilliant Headpond Reservoir whose natural distribution does not include this area. Aquatic invasive species identified in the headpond at this time include two aquatic plants: Curly-leaf Pondweed (*Potamogeton crispus*) and Eurasian Milfoil (*Myriophyllum spicatum*). Aquatic invasive species found in the Kootenay River upstream (specific locations not identified) with a potential for natural introduction to the headpond by downstream migration include American Bullfrog (*Lithobates catesbeianus*), Brook Trout (*Salvelinus fontinalis*), Brown Bullhead (*Ameiurus nebulosus*), Mosquitofish (*Gambusia affinis*), Pumpkinseed (*Lepomis gibbosus*), Largemouth Bass (*Micropterus salmonides*) and Yellow Perch (*Perca flavescens*) (Silverwing 2015). Human pathways for introduction of these and other invasive species to the headpond identified by Silverwing (2015) include:

- Recreation (boating, fishing, diving);
- Horticulture and water garden trade;
- Aquarium, school and pet trade;
- Intentional unauthorized introductions;
- Agency and restoration activities; and,
- Industrial marine works.

Terrestrial invasive species identified along the shoreline or near the headpond include Yellow Flag Iris (*Iris pseudacorus*), Bohemian knotweed (*Fallopia x bohemica*), Giant knotweed (*Fallopia sachalenensis*), Japanese knotweed (*Fallopia japonica*), Himalayan balsam (*Impatiens gladulifera*) and Purple loosestrife (*Lythrum salicaria*) (Silverwing 2015).

4 POTENTIAL FOCUS AREAS FOR COMMUNITY ENGAGEMENT AND RESEARCH

The following sections identify potential focus areas for further research and community engagement based in this information review.

4.1 Water Temperature Monitoring in Brilliant Headpond and Tributaries

Long-term water temperature data has been used to model the impacts of ecological, land-use and hydraulic changes in a watershed. Water temperature data has also been used to model climate change related shifts in a system. Publically available long-term water temperature data was not located for the headpond and tributaries. It may be useful to gather long-term water temperature data in the headpond and in major tributaries such as Glade, McPhee and/or Little McPhee creeks.

Water temperature monitoring is being conducted by other stewardship groups in the region. For example, the Slocan River Streamkeepers have maintained water temperature monitoring stations in the Slocan River and tributaries since the early 2000's. Thermologgers are downloaded annually and data is maintained by a designated member of the group.

4.2 Water Quality Monitoring for Pharmaceuticals and Personal Care Products

There are several municipal effluent discharges entering the Kootenay River and tributaries upstream of the headpond. Effluent includes septic discharge which may contain pharmaceuticals and personal care products (PPCP's). Long-term exposure to low levels of PPCPs could have adverse effects of aquatic ecosystems and organisms (ECCC 2017). PPCPs have been shown to accumulate in the tissues of aquatic plants and mussels; initial studies have found juvenile Rainbow Trout exposed to environmentally relevant concentrations of PPCPs showed significant changes in immune-related and metabolism-based genes (ECCC 2017). Monitoring for PPCPs has not been conducted in the headpond and should be included in future water quality monitoring programs if they occur (Kenton Andreashuk, CCRIFC, pers. comm. 2017).

4.3 Sensitive Habitat Inventory and Mapping of the Foreshore

Sensitive Habitat Inventory and Mapping (SHIM) surveys (also referred to as Foreshore Inventory and Mapping when completed on a lake) have been used regionally as a method to inventory and map sensitive lake foreshore and river/stream habitats. Surveys are conducted from a boat while GPS tracking and marking information such as habitat type segments, land uses, level of disturbance, aquatic habitat values, and habitat modifications such as docks and retaining walls. The inventory provides a snapshot of the shoreline habitat that can be used to compare changes over time. The survey also provides a baseline inventory of sensitive aquatic habitat areas and an Aquatic Habitat Index (AHI) can be used with the results of the SHIM to identify the most sensitive and potentially at-risk headpond habitats thus providing a focus for future conservation and/or restoration efforts.

4.4 Habitat Enhancement and Restoration in Brilliant Headpond and Tributaries

During this review one location was identified as an excellent candidate for habitat restoration and/or enhancement to improve fish access and habitat. Glade Creek provides habitat for Rainbow Trout and it is likely used as an intermittent spawning and juvenile rearing location for Bull Trout and possibly Kokanee. Issues for fish passage including sedimentation and infilling of the lower reaches were identified during a Bull Trout survey conducted in fall 2016

(Baxter and Irvine 2017). Enhancements could be made in Glade Creek to improve fish passage by removing potential migration barriers and, to increase spawning and rearing habitat, by improving spawning substrates and instream cover within the creek (Jeremy Baxter, Mountain Water Research, pers. comm., 2017). Next steps for potential enhancement of Glade Creek include conducting an inventory of habitat values and an evaluation of potential habitat restoration options. Other tributaries, such as McPhee and Little McPhee creeks, may provide additional opportunities for enhancement though current aquatic habitat values are unknown at this time.

Areas of erosion created by wave action due to boat traffic and headpond water level fluctuations may be another potential area for habitat improvements. A wetland habitat restoration project was conducted along the foreshore near Thrums in 2005. Monitoring reports were not located for this work and the success of the project is unknown at this time. However, the project provides a good example of a potential restoration project that could be considered if erosion issues are identified elsewhere in the headpond. Erosion is one habitat variable inventoried during a SHIM survey (Section 4.3).

Potential exists for riparian and terrestrial restoration projects along the headpond shoreline. Selkirk College students have been involved in habitat restoration and enhancement projects in terrestrial areas adjacent to the headpond and may be a potential partner for future restoration projects. Students enhanced 6 hectares of late winter and spring range habitat adjacent to the headpond in the Skattebo Educational Forest using thinning and slash piling prescribed treatment. The students completed wildlife tree assessment, inventory, mapping and field marking of wildlife trees in the Forest (285 ha). They found animal sign increased post-treatment due to improved trafficability for larger mammals and habitat cover for small mammals (Greame 2001).

4.5 <u>Bull Trout Spawning Monitoring in Tributaries</u>

Bull Trout spawning monitoring is required for some of the main tributaries of the headpond. Bull Trout adults have been captured in the headpond and juveniles have sporadically been observed in Glade Creek but spawning locations have yet to be documented. It is likely that Bull Trout spawning in tributaries to the headpond is limited and may only occur in years when water temperatures reach critical thresholds for Bull Trout migration and spawning (Baxter and Irvine 2017). Jeremy Baxter (Mountain Water Research, pers. comm. 2017) recommends additional Bull Trout spawning surveys occur in Glade Creek. McPhee Creek may also provide spawning habitat for Bull Trout as R.L. & L. (1999) noted the creek was wetted year-round and 300 m of habitat was accessible before the fish migration barrier. Little McPhee Creek is unlikely to provide Bull Trout spawning habitat as low flow during most of the year may impede fish passage. However, Little McPhee Creek would be worth investigating if a survey of McPhee Creek is conducted.

Bull Trout spawning surveys are conducted between migration barriers that would restrict Bull Trout passage upstream (i.e. waterfalls, culverts, log jams, etc.) and the outlet of the creek. Surveys are conducted by experienced observers who can identify both Bull Trout and Bull Trout spawning redds. Surveys are conducted in late September/early October in this region.

4.6 Invasive Species Awareness and Training

Invasive species education, control and monitoring is a potential area for community involvement. At present invasive aquatic plants have been identified in the headpond but not aquatic animals (Section 3.7). Engagement with the Central Kootenay Invasive Species Society (CKISS) would be an initial step to identify local awareness, training and monitoring needs. The Canadian Columbia River Aquatic Invasive Species 2015-2020 Program Framework (Silverwing 2015) identified the following relevant areas for community engagement and monitoring:

- ***Goal 2.2 Reduce the potential for aquatic invasive species-fouled boats and equipment to enter local water bodies through education***
  - *Target marinas, boat ramps, boat shops, marine mechanics, divers, anglers, etc. for face to face outreach*
  - *Conduct outreach and coordinate to have watercraft inspection and decontamination stations at high priority events*
- ***Goal 2.3 Engage stewardship groups, community organizations, educational institutions and industry for aquatic invasive species outreach.***
  - *Coordinate with and provide training (when required) to stewardship groups and others who do aquatic outreach to facilitate incorporating aquatic invasive species messaging into programs*
- ***Goal 4.3 Increase opportunities to participate in aquatic invasive species monitoring***
  - *Promote a citizen science aquatic invasive species reporting program and link high priority sites with nearby stewardship groups*
  - *Provide training workshops to relevant regional groups on aquatic invasive species identification, monitoring standards and disinfection protocols*

The CCRIFC Fishery Guardian Program may be able to assist with aquatic invasive species education and watercraft inspection at the Glade public boat launch (Kenton Andreashuk, CCRIFC, pers. comm., 2017). Other education partners could include CKISS and the BC Inter-Ministry Invasive Species Working Group's Watercraft Inspection Program.

4.7 CABIN Monitoring in Brilliant Headpond and Tributaries

The Canadian Aquatic Biomonitoring Network (CABIN) is a program run by Environment Canada to monitor the aquatic biological community and provide an indication of overall watershed health. CABIN monitoring uses a standard methodology to collect benthic macroinvertebrates from the stream bed and uses the composition of the species in the macroinvertebrate community as a biological indicator. Certain macroinvertebrates are very sensitive to a variety of disturbances and their presence or absence can be used to evaluate the overall health of a system over time. Participants are trained in CABIN's standardized sampling methods, samples are assessed in the field or submitted to a lab for processing and data is entered into a national database that allows the public to access to all data collected from a site.

Currently, there are no CABIN monitoring locations in the headpond or its tributaries (ECCC 2017a). In the Canadian portion of the Columbia River basin there are 9 stewardship groups participating in CABIN. Locally, the Slocan River Streamkeepers have various CABIN monitoring sites on the Slocan River and its tributaries and the data they collected has been included in effectiveness monitoring related to the jet fuel spill in Lemon Creek (SNC Lavalin 2014). CABIN training is provided by the Canadian Rivers Institute and involves both online and field components with nearby field training available in Cranbrook and Nelson annually.

5 SUMMARY & CONCLUSIONS

This information review used publically available information to summarize the ecology of the Brilliant Headpond Reservoir with a focus on the aquatic environment. Potential areas for further research and community engagement include: conducting water quality monitoring (water temperature, PPCPs, CABIN); completing a SHIM survey to inventory and map sensitive lake foreshore habitats; investigating enhancement opportunities (Glade Creek, erosion); conducting Bull Trout spawning surveys; and, invasive species awareness, training and monitoring, where applicable.

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Appendix A
Brilliant Headpond Reference Summary Table