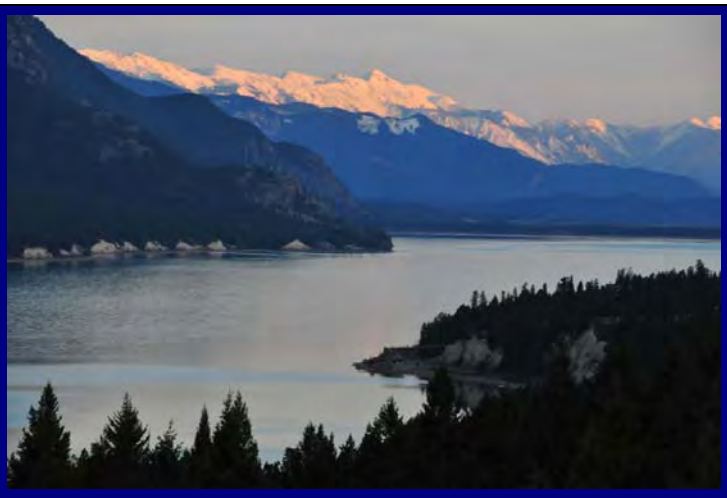

Columbia Lake
Sensitive Habitat Inventory and Mapping

Prepared for the East Kootenay Integrated Lake Management Partnership

Sherri McPherson, Darcy Hlushak, Ian Adams and Mary-Louise Polzin

INTERIOR REFORESTATION CO. LTD.

Final Report
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Cover Photos: Top: Columbia Lake looking south east (L. Halverson); Bottom Left: western shore (L. Porto); Bottom Right: eastern shore (S. McPherson).

Disclaimer

The results contained in this report are primarily based upon data collected during three, one-day field surveys completed by parties other than Interior Reforestation Co. Ltd. This data was augmented using previously documented material and a site inspection during low water level period. Interior and the authors assume that data collected are accurate and reliable. Data in this assessment was not analysed statistically. Use or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Interior, nor the authors of this report are liable for accidental mistakes, omissions or errors made in its preparation because best attempts were made to verify the accuracy and completeness of data collected and presented.

Executive Summary

Columbia Lake is located in the southern interior of British Columbia (BC), near Canal Flats and Fairmont Hot Springs, BC. The East Kootenay Integrated Lake Management Partnership (EKILMP) commissioned Interior Reforestation Co. Ltd. to complete this project which includes: 1) a Foreshore Inventory and Mapping study (FIM), 2) a Fish and Wildlife (F&W) Assessment, and 3) Columbia Lake Shoreline Management Guidelines for Fish and Wildlife Habitats.

The purpose of the FIM project was to provide baseline information on foreshore condition and environmental values to aid in future decision-making. This was achieved by following FIM standards which included the collection of field data and a literature review of known environmental values. Field reviews were initially completed in September 2007 by EKILMP partners, who collected data on foreshore morphology, land use, riparian condition and anthropogenic alterations for the lake. This information was supplemented by additional field reviews in March 2009, by Interior professionals. The 43.3 km foreshore of Columbia Lake was delineated into eight segments based on contiguous characteristics. The physical analysis revealed the most prevalent shore type to be gravel beach (43%). Wetland and bluff shore types also extended along substantial lengths (29% and 22%, respectively); while stream mouth and cliff shore types were minimal (4% and 2%, respectively). Emergent aquatic vegetation was common and extended along 75% of the shoreline, covering an overall area of approximately 300 ha. The emergent aquatic vegetation was composed of mainly bulrush species. The study area falls in the Interior Douglas-Fir very dry cool, biogeoclimatic zone (IDFxk) and riparian vegetation along the natural shoreline areas were mainly composed of mature species providing abundant coverage. Over half (63%) of the foreshore was found to be in a natural condition. A great of extent of this (55%), is protected through a wildlife management area (WMA) and provincial park covering extensive areas of the eastern shore and the southern and northern wetlands. The disturbed foreshore sections (37%) were mainly impacted by transportation infrastructure (33% CPR) and there was also some private residential and urban parkland influence. Riparian disturbance and upland disconnect was apparent along the segments with CPR influence. The residential and urban areas exhibited loss of riparian and emergent aquatic vegetation as well as some foreshore structures (i.e., retaining walls, boat launches, groynes, docks and a marina). Approximately 3 km of private land areas had not been developed as of 2007.

EKILMP conducted F&W field assessments during the summer (July 15 – 16, 2009) and fall periods (September 15, 16 and 24, 2009). Thirteen sites were selected to conduct fish sampling and document wildlife observations. Aquatic invertebrate sampling was conducted at five sites. This data as well as literature review information on species and habitats was used to document the ecological status of the shoreline. Overall, the foreshore (and adjacent upland areas) of Columbia Lake was found to be biologically diverse and important to numerous plant, fish and wildlife species. Several sensitive species inhabit or potentially inhabit the area, including: four invertebrate species, two fish species, one amphibian species, two reptile species, nine bird species, three mammal species and three sensitive plant species. An Aquatic Habitat Index (AHI) analysis was used to score and rank each shoreline segment in terms of its biological value. The AHI used numerical data from four categories of parameters: 1) biophysical, 2) zones of sensitivity, 3) riparian and 4) modifications. Parameters values were based on their positive or negative contributions to environmental health. Zones of Sensitivity for Columbia Lake were determined to be burbot spawning and rearing areas, kokanee staging/rearing, areas of biological significance for wildlife (i.e., Armstrong Bay, painted turtle habitat, mussel beds and a significant heron rookery). The following Existing Ecological Shore Rankings were determined from the AHI: Very High - 27% of shoreline, High – 35%, Moderate – 4%, Low – 32%, Very Low - 2%. With restoration (modifications were removed), the AHI also determined that the Low and Very Low areas would improve by a ranking.

The Shoreline Management Guidelines were prepared by using templates from Windermere and Moyie/Munroe Lakes. Segments were colour coded and mapped using the AHI rankings and

appropriate activities for each colour zone were identified. Segments ranked as Very High are coloured Red. These areas are designated for conservation use, with the guideline that no development occurs within them other than very low impact activities. Segments ranked as High are coloured Orange, indicating that they are sensitive to development and that an environmental assessment would be required for most activities. Moderately ranked segments are yellow, and Low and Very Low segments are coded as grey shoreline. Although a greater number of activities are permissible in areas with lower ecological value, proper planning is still required to protect environmental values.

The information collected will aid government and organizations overseeing foreshore and upland developments. This report serves as a benchmark by documenting land use and riparian habitat changes necessary for the development of regulations, standards, policies and education materials. Several recommended actions are proposed, including: conducting species and habitats inventories, addressing modifications, developing a foreshore protection plan, conducting monitoring and further educating the community.

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1 Introduction

Columbia Lake is situated along Highway 93-95, just north of Canal Flats, in the East Kootenay. Columbia Lake is a large lake that is relatively warm (averaging 18^{o}C in July) and is an important recreation area (BC Parks 2004a; 2007). The lake drains into the Columbia River which enters Windermere Lake approximately 15 km to the north. The Columbia River and tributaries are one of the most significant aquatic ecosystems in the East and West Kootenays and encompass most of the Ktunaxa traditional territory (Bisset pers comm.). The Columbia Lake area has been an area of great importance to First Nations for many centuries and it contains important parts of the Ktunaxa creation story such as the Hoodoo formation, the spirit trail along Columbia Lake and the headwaters of the Columbia River (RDEK 2004). Columbia Lake has very important habitat values, for a host of fish, wildlife and plant species. Thus, much of the Crown land portions of the lake are managed for environmental protection through BC Provincial Parks or Wildlife Management Area (WMA). The lake is also very important to local residents. During the Columbia Lake Management Strategy process the public sent a strong message that 'Columbia Lake must be conserved and not become another Windermere Lake', referring to the perceived overuse of that lake (RDEK 1997).

As with many lakes across the province, Columbia Lake's growing recreational popularity has resulted in an increase in foreshore disturbance. With escalating property values many private properties have experienced development pressure, including: Canal Flats, Lot 48 (an allotment of agricultural land surrounded by protected area) and the existing developments of Columere Park, Bella Vista, Painted Ridge and Spirits Reach (Leschied pers comm.). Columbia Lake also faces recreation pressures due to its proximity to the resort community of Fairmont Hot Springs, which has a high level of residential and resort development (e.g., golf courses and hotels [BC Parks 2004a]). Additional activities such as cattle ranching and the Canadian Pacific Railway (CPR) on the western shore have the potential to impact foreshore environmental conditions and/or water quality. During development, the shoreline is often modified in order to improve recreational access (e.g., docks, vegetation removal, boat launches), and to protect land from erosion forces (e.g., groynes and retaining walls). These alterations and their potential negative impacts on the foreshore environment have become a concern with local citizens and regulatory agencies.

The East Kootenay Integrated Lake Management Partnership (EKILMP) formed in 2006 in response to concerns over the very fast pace of foreshore development in the East Kootenay (EKILMP 2006). The partnership includes:

- BC Integrated Land Management Bureau;
- BC Ministry of Environment (BC MoE);
- Canadian Columbia River Inter-Tribal Fisheries Commission (CCRIFIC);
- District of Invermere
- Fisheries and Oceans Canada (DFO);
- Interior Health Authority;
- Regional District of East Kootenay;
- Transport Canada;
- Village of Canal Flats
- Wasa Lake Land Improvement District
- Wildsight

The EKILMP's aim is to protect lakes in the East Kootenay by encouraging integrated and coordinated approaches and providing guidance on best practices and restrictions of use where necessary (EKILMP 2006). Foreshore Inventory and Mapping (FIM) and Fish and Wildlife (F&W) assessments completed in this report will be used to develop science-based coordinated shoreline management guidelines for land and water uses. The guidelines will be used in decision-making by all levels of government, developers, planners and other interests (EKILMP 2006). Further, this information together with the water quality and quantity objectives are the key environmental value components used in developing Comprehensive Lake Management Plans (Figure 1).

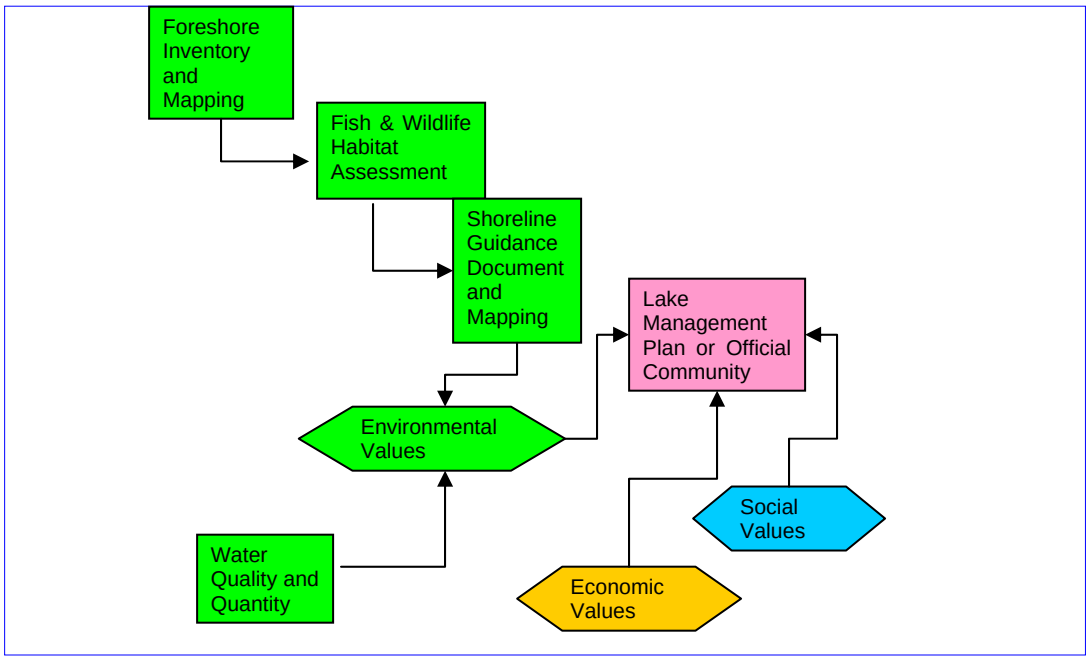


Figure 1. Lakeshore Inventory and Management Planning Process (Source: Holmes, pers. comm.).

1.1 Foreshore Significance and Sensitivity

In BC, the lake foreshore is defined as the land between the high and low water mark. This area, including the permanently wetted lake area is considered "Aquatic Crown land" and falls under the limits of provincial jurisdiction. Land adjacent to foreshore may be privately owned, but in common law the public retains the privilege or "bare licence" to access the foreshore. Individuals cannot build on or develop Aquatic Crown land, including Crown foreshore, without the province's authorization, even if they own adjacent property or "upland" (BC Ministry of Agriculture and Lands 2009).

The foreshore is an important link between the aquatic and terrestrial environments, and has important biological, ecological and social significance and is extremely sensitive to disturbance (RDCO 2005). The foreshore has four components: the littoral zone, the shoreline, the riparian area and the upland zone (Figure 2).

Littoral Zone

From the water's edge to where sunlight no longer penetrates the lake bottom.

Up to 90% of the species in the lake either pass through or live in this zone. This area is important for primary production (production of plants). Stones, twigs and plants are important components, serving as substrates for food production and providing a variety of habitats for animals. This is a typical area for ducks to forage on plants and invertebrates; as well as for fish to spawn, and then to forage and seek cover as juveniles. Plants in this area are important in converting sunlight into food and releasing oxygen.

Shoreline

Where the land and the water meet.

This is an important barricade against erosion. Naturally, it is a profusion of stones, plants, shrubs, fallen limbs and tree trunks. It is also a busy intersection for animals, insects and birds travelling back and forth between the lake and the upland areas. Overhanging vegetation here shades and cools the water and provides important food sources for fish.

Riparian and Upland Zones

The riparian area is the land closest to the foreshore and the upland is the higher, drier ground.

Vegetation in the riparian and upland zones provides a barrier for contaminants entering the lake as runoff (including septic seepage, fertilizers and pesticides). Deep roots of trees stabilize the slopes and the forest canopy cools the area. This is an important refuge for wildlife, for example, tall grasses are used by water birds for nesting, and in the winter it provides shelter to many animal species.

Figure 2. Definition of the foreshore components – littoral zone, shoreline, riparian and upland zones (Fisheries and Oceans Canada 2008)

Foreshore vegetation, habitat structure and species use is commonly altered by anthropogenic disturbances. Holmes (pers. comm.) provided the following description of common foreshore disturbances:

> *Types of disturbance include direct habitat loss, loss of native plant communities, avoidance, alteration of predator prey relationships and direct mortality. For instance, road and house construction result in direct habitat loss and alterations of natural drainage patterns. Conversion of natural vegetation to ornamentals results in removal of native nesting and foraging habitats. Human presence reduces species use of desired attributes through avoidance and through alteration of structure such as kids playing in a sand or clay bank and destroying nesting sites of bank swallows. Most predator species tend to avoid areas with high human densities resulting in prey species congregating in other areas and abnormal population levels. Furthermore, many species considered a nuisance, such as bats, are killed by property owners, and domestic animals prey on birds and other small vertebrates.*
>
> *Few studies have been undertaken to assess the impacts on wildlife resulting from increased development around lakes. One study, however, showed increased foreshore development does have a significant influence on the presence of some breeding bird species (Lindsay et al. 2002). The study found that the most dramatic effects from development on lakeshores were changes in nesting guilds. Developed lakes had more seed-eaters and fewer species dependent on insects and shrub nesting birds. The reduction in shrub nesters was explained by the removal of shrubs in yards and by increased success of predators.*

Woodford and Meyer (2003) found that human caused riparian and littoral zone alterations also impacted amphibians. Their study revealed that green frog densities were reduced where coarse woody debris and wetland plants were removed.

Habitat complexity in the littoral zone is also important to fish productivity. Coarse woody debris, aquatic macrophytes and substrate compositions are habitats important to fish that often become compromised as a result of foreshore development. Developments can impact these habitats through direct removal of vegetation, construction of structures (such as piers, docks and marinas), and alteration of the shoreline with riprap or concrete (e.g., retaining walls and groynes). Radomski and Goeman (2001) found that developed shorelines had substantially less emergent and floating leaf vegetation than undeveloped shorelines; and that the abundance of three fish species in Minnesota Lakes was positively correlated with emergent and floating plants. At lakes with greater development density, Jennings *et al.* (2003) also found that the quantity of woody debris, emergent vegetation and floating vegetation decreased and that littoral sediment contained more fine particles increasing substrate embededdness. Embeddeddness occurs when finer materials (silts/sands) fill in the interstitial spaces between courser substrates, and can be a concern because it reduces flow/permeability, surface area for phytoplankton and invertebrates and can smother eggs (Bisset pers. comm.).

1.2 Current Foreshore Management

Currently, land use activities at Columbia Lake are governed by several bylaws and policies, including the Fairmont Hot Springs Area Official Community Plan (OCP - Bylaw 1734; RDEK 2004), the Village of Canal Flats OCP (Bylaw 50; Village of Canal Flats 2005), the Upper Columbia Valley Zoning (Bylaw 900-Consolidated; RDEK 2009) and the Columbia Lake Management Strategy (RDEK 1997). Details relating to protection of foreshore or other associated environmental features in these documents are as follows:

Fairmont Hot Springs Area OCP (RDEK 2004)

The Fairmont OCP includes the northern portions of the lake, incorporating much of the west and the east side south to and including District Lot 48 (Figure 3). During the public consultation for the OCP, natural and environmental attributes were among the most highly valued characteristics of the area. Broad environmental goals identified in the OCP are to: a) to minimize the impact of human developments on the natural environment by protecting ecologically sensitive natural areas, including floodplains, riparian zones and wildlife corridors; and b) to enhance the wildlife and habitat values by preserving important natural areas and wildlife corridors.

Further, the OCP (Section 9.6) recognizes Columbia Lake as a special landscape feature, with its own specific environmental objectives. Objectives include preserving the character of the lake with careful management of future developments, ensuring water and sewer systems do not compromise the water quality, providing public access which does not compromise the environment, and adhering to the Columbia Lake Management Plan. The related policies are as follows (RDEK 2004):

(a) There are few areas of Crown land on the west shore of the lake. Remaining Crown lands on the west shore should be preserved for environmental and natural resource management functions as well as for public use and enjoyment.

(b) This plan supports the policies and recommendations included in the RDEK's 1997 Columbia Lake Management Plan, specifically:

- To support the activities and responsibilities of the Columbia Lake Management Steering Committee or similar body.
- To support the continuation of natural processes in determining the water level of the lake and the configuration of the Dutch Creek alluvial fan.
- To not support the development of new private marinas or the expansion of on-water overnight storage of boats.
- To support the provision of a publicly accessible day use area and boat launch on the north end of the lake, subject to the mitigation of any negative environmental impacts.
- Foreshore leases are not supported in areas of important riparian habitat or other environmentally sensitive areas.

- The plan supports the recommendations of the Columbia Lake Management Plan with respect to motorized use of the lake.

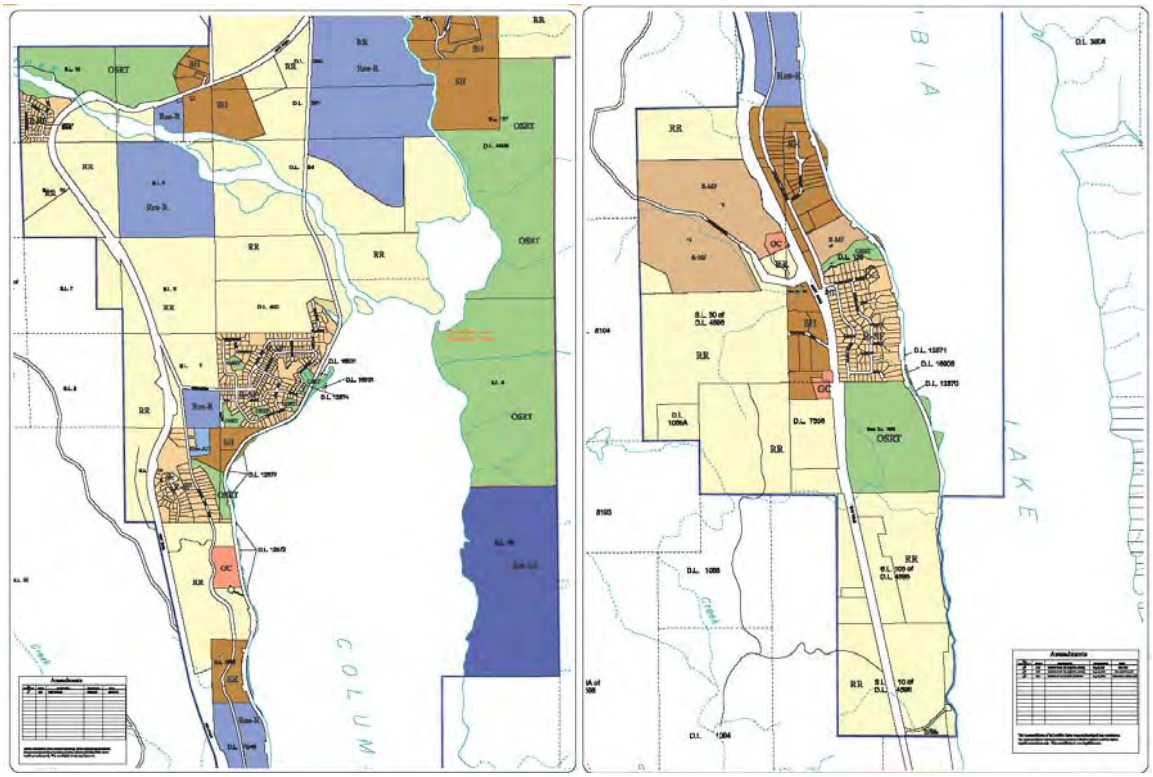


Figure 3. Extent of Columbia Lake within the Fairmont OCP (Source: RDEK 2004).

Village of Canal Flats OCP (2005)

The Canal Flats OCP includes the south end of the lake. The south end wetlands and bighorn sheep (*Ovis canadensis*) habitat which comes down to the lake on the east shore are designated as environmentally sensitive areas in the Canal Flats OCP (Figure 4). Development in these areas is to be limited and the retention of a natural greenbelt along watercourses is encouraged. There are 16 policies related to meeting these objectives with key foreshore related policies including, for example:

- Set back development from bodies of water (30 m from high water mark);
- Limit use of sensitive shorelines to education, park or conservation areas and restrict recreational boat use; and
- Limit impacts of storm water and pollution on shoreline.

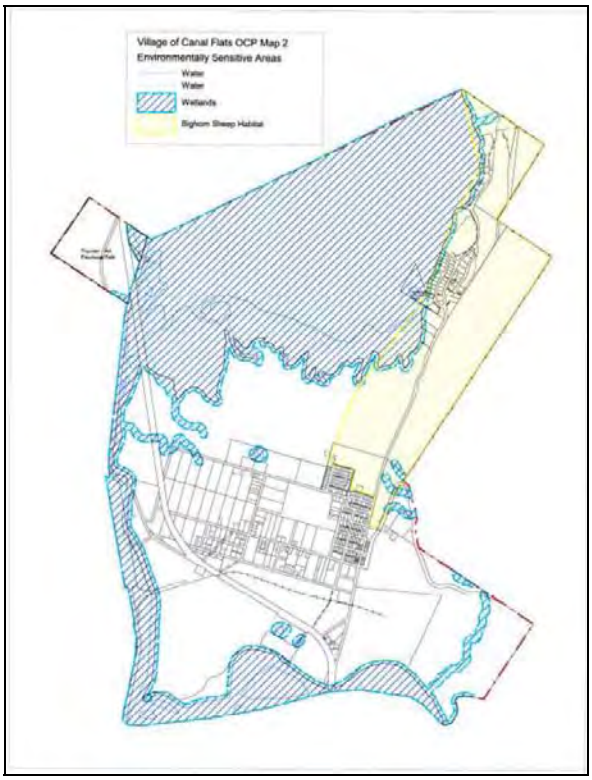


Figure 4. Village of Canal Flats Environmentally Sensitive Areas (wetlands shown as blue hashed area and bighorn sheep habitat shown as yellow area). Source: Village of Canal Flats 2005.

Upper Columbia Valley Zoning (Bylaw 900 Consolidation; RDEK 2009).

The main body of Columbia Lake south of Columere Park, has been designated as a Water Resource Zone (WR-1) by the RDEK and the Village of Canal Flats in 2007 and 2008 respectively (RDEK 2009; Village of Canal Flats 2008). The shoreline adjacent to Columbia Ridge developments (on the west side of the lake), the Columere Park marina area (not shown on map), Thunder Hill Provincial Park and Canal Flats Provincial Park have been designated as Water Resource Community Zones (WR-2) (Figure 5 and Figure 6).

The WR-1 zoning permits only public access, recreational water activities and day use moorage along the shoreline. The WR-2 zoning is similar, but also permits docks (recreational), launching ramps, and swimming rafts. Specifications are provided for docks, launching ramps and swimming rafts to limit impacts on the shoreline. Examples of specification details are: maximum number of each structure per tenure is one; maximum dock dimensions are 80 m^2 and 3 m wide by 20 m long; and materials are to be untreated and non toxic. With both WR-1 and WR-2 zoning, no overnight moorage is permitted.

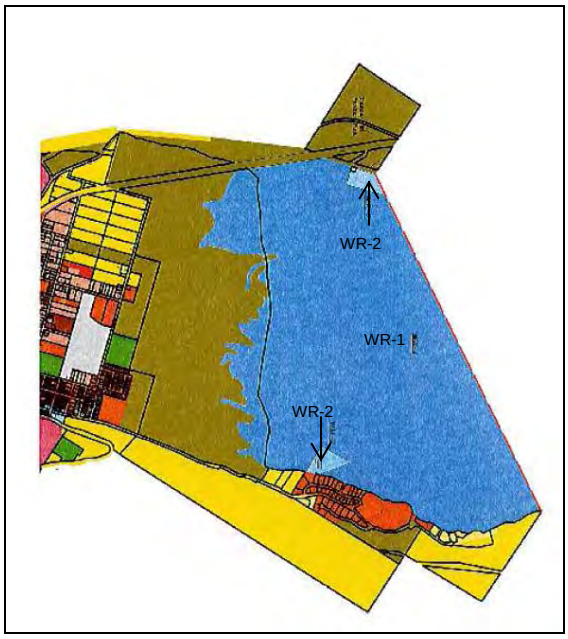


Figure 5. Water Resource Zones (WR-1 and WR-2) at south end of Columbia Lake (Source: Village of Canal Flats 2008).

Figure 6. Water Resource Zones in Central Columbia Lake (Source: RDEK 2009).

Columbia Lake Management Strategy (RDEK 1997).

The Columbia Lake Management Strategy encompasses all of the lake. The strategy provides the results of a study reviewing a number of issues as expressed by the public, including: water quality, lake levels, Dutch Creek channel movements and alluvial fan, weed growth, boating activities, conservation of fish and waterfowl habitats, protection of aesthetic values, regulation of private marina development, public access points and CPR's activities and side casting practice.

Protected Areas

In addition to these policies, substantial stretches along the lake fall into the WMA and the Columbia Lake Provincial Parks; these areas are managed for conservation of fish and wildlife values and are discussed in greater detail in the Results Section (3.1.4 Protected Areas).

Boating Restrictions

To protect environmental values, Transport Canada (2001) regulations identify that no person shall operate a power-driven vessel or a vessel driven by electrical propulsion in excess of the 10 km/h maximum speed in the part of the channel connecting Columbia Lake to Mud Lake and within 100 m from the shore on the east side of Columbia Lake.

1.3 Objectives

Although these land use bylaws provide some environmental direction, shoreline management guidelines, based on site specific ranking of biophysical values (physical condition, and fish and wildlife values) of shoreline segments are required. These shoreline guidelines will help agencies provide consistent policy information and direct future development in a timely manner. This study will complete the FIM and F&W assessments and use the findings to prepare shoreline management guidelines. The assessments will be completed using standards established on other lakes in the province (e.g. Okanagan Lake (Regional District of Central Okanagan – RDCO, 2005, Windermere Lake (McPherson and Hlushak 2008 and McPherson *et al*. 2009), and Moyie and Munroe Lake (Schleppe 2009).

The objectives of this study are to provide an overview of foreshore habitat condition, rank contiguous shoreline segments based on their fish and wildlife habitat values and prepare management guidelines for the ranked segments, specifying development risks of various activities. These objectives will be achieved through completion of the following activities:

1. Foreshore Inventory and Mapping

- Delineate the shoreline into segments, based on contiguous physical features using field findings and geographic data; and
- Inventory foreshore morphology, land use, riparian condition and anthropogenic alterations within each of the segments.

2. Fish and Wildlife Assessment

- Report on fish habitat values using field and literature findings;
- Report on wildlife habitat values using field and literature findings;
- Prepare an index that ranks habitats along the foreshore based on biophysical attributes; and,
- Develop a GIS database on the ecological integrity of the lake's foreshore.

3. Guidance Document

- Colour code segments, based on their habitat index values; and
- Identify risk for development activities in each colour zone.

2 Methods

Standard Methods for Completion of Foreshore Inventory and Mapping Projects (Schleppe and Mason 2009; herein FIM Standards) were used in preparation of the FIM component of this report. Additions or omissions to the FIM standards have been outlined below. The F&W Assessment and Shoreline Management Guidelines generally adhered to methods used at Moyie Lake (Schleppe 2009), which are the result of refinements from other earlier studies, namely shoreline F&W assessments at Okanagan Lake (Schleppe and Arsenault 2006) and Windermere Lake (McPherson and Hlushak 2008).

2.1 Field Review

The initial FIM field assessment was conducted on September 27, 2007 from a boat, by EKILMP partners and/or consultants Brad Mason (DFO), Heather Leschied (Wildsight) and Louise Porto (DFO). With funding from DFO and BC MoE, Terrasaurus Ltd. flew Columbia Lake in July 2008 and created orthophotos. Interior Reforestation staff (Darcy Hlushak and Sherri McPherson) revisited the shoreline by way of ATV over the frozen lake, on March 4 2009. Using the field data, available literature and orthophotos Interior Reforestation prepared the FIM report and map products in September 2009.

EKILMP members conducted the field-sampling component for the F&W study in the summer and fall of 2009 (July 15-16 and September 15, 16 and 24 2009), which included sampling fish and aquatic invertebrates and documenting wildlife observations. Individuals involved in data collection included Peter Holmes (BC MoE), Bruce MacDonald (DFO) and Heather Leschied and Kalista Pruden (Wildsight). Findings and subsequent analysis were used by Interior Reforestation to prepare this report which includes updates to the FIM, F&W assessment and Shoreline Management Guidelines. The Columbia basin Trust funded the preparation of this report.

2.2 Foreshore Inventory and Mapping

FIM report development involved: 1) summarizing available information on environmental values; and, 2) preparing detailed descriptions for each segment, 3) analyzing and summarizing biological and physical data for the lake using the FIM database, and 4) using GIS to map segment locations, emergent vegetation polygons, and other pertinent segment data.

During the field assessment, the shoreline was delineated in contiguous segments based on biophysical features. Standard FIM data for each segment was collected to provide an understanding of features and condition. This data was summarized in the FIM database and includes parameters such as: segment length, land use, shore type, substrates, riparian cover, aquatic vegetation, shoreline modifications and flora and fauna details. Interior Reforestation updated the 2007 field database provided by EKILMP using the March 4, 2009 field review and conducted orthophoto analysis to complete the database. Description of the alterations made to the original field data provided by EKILMP and lake specific parameter definitions not provided in the FIM standards are provide below.

2.2.1 Wetland Shore Types and Emergent Vegetation

The FIM Standards (Schleppe and Mason 2009), identify that the wetland shore type is based on extent of 'shore marsh wetland' as defined in the Wetlands of British Columbia (MacKenzie and Moran 2004). The FIM Standards describe the shore marsh as having seasonally or permanently flooded, non tidal, mineral wetland that is dominated by emergent grass like vegetation. From a review of the Wetlands of BC Guide (MacKenzie and Moran 2004), this definition appears to include both Marsh Wetlands Class and Shallow-Water Wetlands. For this study, it was necessary to distinguish between the Marsh Wetland Class and Shallow-Water Wetlands. Soils and hydrology were the key differences between these two wetland types. The seasonally flooded wetlands which had soil development (Marsh Wetland Class) were classified as the Wetland Shore Type, while the

permanently flooded wetlands with little in the way of soil development (Shallow-Water Wetlands) were typed as Emergent Vegetation.

If the Marsh Wetlands Class and Shallow-Water Wetlands were included together to classify the Shore Type, most of the Columbia Lake would be described as a Wetland Shore Type; precluding the opportunity to describe the other physical features (cliffs, bluffs, gravel beaches etc.) and their influences/habitat benefits.

Wetland Shore Type (Marsh Wetland Class)
In this study, Wetland Shore Types included wetlands categorized under the Marsh Wetland Class, which contain the following characteristics according to the Wetlands of British Columbia Guide (MacKenzie and Moran 2004):

- permanently to seasonally flooded mineral wetland dominated by emergent grass-like vegetation;
- a fluctuating water table is typical, and subsequently exposure of the substrate in late season or during dry years is common;
- the substrate is usually mineral, but may have a well-decomposed organic veneer derived primarily from marsh emergents;
- aquatic plants are common, especially in marshes that retain standing water for most or all of the year;
- simple plant communities with low species diversity and strong dominance by one or two species;
- >10% cover of emergent grasses, rushes, sedges, or (occasionally) forbs or horsetails; and
- trees, shrubs, and bryophytes are usually absent or very sparse (< 10%).'

The areas delineated as marsh wetlands at Columbia Lake had a variety of plants but most were dominated by bulrush and also had sedges. These plants were not identified to species and thus all marshes were categorized together whether they were sedge or bulrush dominated. Many also had common pondweed, cattails, reedgrass, pond lily, horsetail, etc in varying percentages (RDEK 1997). According to the Wetlands of BC Guide (MacKenzie and Moran 2004), the marsh wetlands would be classified as Wm06 in complex with Wm05 while others would be a complex of Wm06, Wm05, and Wm-sedges in general. These marsh wetlands were differentiated from the shallow-water wetlands (emergent vegetation) (Figure 7).

Figure 7. Wetland shore type or marsh wetland class (left) versus emergent vegetation area or shallow-water wetlands (right).

Emergent Vegetation (Shallow-Water Wetlands)
Emergent Vegetation fell under the definition of 'Shallow-Water Wetlands'. The Wetlands of BC Guide, describes Shallow-Water Wetlands as being (MacKenzie and Moran 2004):

> 'Permanently flooded by still or slow-moving water and dominated by rooted submerged and floating leaved aquatic plants. Like marshes, the shallow water wetlands are often

> simple communities dominated by one to several species and they have less than 10% emergent cover. The most common shallow-water habitats occur in littoral zones of lakes, particularly in protected waters where fine sediments collect and in potholes.'

The Canadian Wetland Classification System (Wetlands Research Centre 1997) further provided that 'Shallow Water Class Wetlands have free surface water up to 2 m deep, present for all or most of the year, with less than 25% of the surface water area occluded by standing emergent or woody plants. Submerged or floating aquatic plants usually dominate the vegetation.' The Canadian Wetland Classification System further classifies these areas as 'Lacustrine Water – Lacustrine Shore Water wetlands, which occur in the zone of wave action in beach areas (including the high shore, and low shore and littoral zones)'.

Another important differentiation between the shallow water wetlands and the marsh wetland class is that the soil profile is not as diverse in shallow water wetlands. As stated in the Wetlands of BC Guidebook, 'aquatic substrates are generally classified as non-soil because they are permanently flooded at depths greater than 60 cm and do not undergo profile development' (MacKenzie and Moran 2004). Substrates can be sands, silts, clays, muck (a mix of silt, clay, and organic matter), degraded peat sediments, marl, or limnic sediments'. Columbia Lake generally has a narrow gravel seam along the shoreline, which transitions to silt and organic substrates or the 'non-soil' category.

The areas defined as emergent vegetation areas at Columbia Lake had standing emergent vegetation (bulrush), and submerged or floating aquatic plants, including charaphytes and floating pondweed. GPS was used to map the presence of emergent vegetation along the foreshore of Columbia Lake during the March 2008 field review. Remnant emergent vegetation from the 2008 growing season, which was dominated by bulrush, extended above the ice and was clearly visible. The orthophotos were also used as a tool for mapping extent of emergent vegetation. The extent (metres along shoreline and total area) of emergent vegetation was determined from the GIS application for each segment.

2.2.2 Removing the Vegetation Shore Type

Differentiating between Gravel Beach and Vegetated Shore Type is difficult, since in many areas visited in March 2009, under low water levels, vegetated areas were closely associated with a narrow gravel beach. Because of situations like this, the FIM Standards (Schleppe and Mason 2009), updated shore type categorization options by removing the Vegetated Shore Type. At Columbia Lake, typically the Vegetated Shore Type was replaced with the Gravel Beach Shore Type, while in some areas Wetland or Stream Mouth Shore Types were appropriately assigned.

2.2.3 Demarcating Cliff from Bluff Shore Type

The FIM standards (Schleppe and Mason 2009) and the studies completed on Windermere Lake (McPherson and Hlushak 2008) have cliff and bluff shores identified as one combined shore type (Cliff/Bluff). However, in this study Cliff and Bluff Shore Types have been identified separately because the influences and values of these features are recognized as being quite different. Cliffs are typically very steep, comprised of hard bedrock material, which tend to have deep drop-offs into the lake. These deep water areas often provide valuable cool water refuge for fish. Bluffs, although also steep, consist of mostly erodible silts and clays, often lending to a beach area along the shore that may be vegetated. Bluffs provide unique wildlife habitat (e.g., support grasses for foraging and provide homes for nesting birds) and would be expected to provide different fisheries values than cliffs (e.g., more likely to have a beach supporting spawning or rearing).

2.2.4 Demarcating Stream Mouth Shore Type

The database was also updated to include the Stream Mouth Shore Type. The Stream Mouth Shore Type was recognized as an important fisheries and biodiversity feature in similar studies completed on Windermere Lake (McPherson and Hlushak 2008) and Wasa Lake (McPherson *et al.* 2009) and has now been included in the FIM standards (Schleppe and Mason 2009). The stream

mouth was measured using the orthophotos and by measuring the distance of the stream's zone of influence on the lake (as evident from sediment deposition).

2.2.5 Data Base Updates

The boundary of the shoreline was digitized using the orthophotos to achieve the 5 m accuracy recommended in the FIM standards. The segment lengths reflect this accurate delineation.

Where information was absent, the database was updated using available office tools including orthophotos and GIS applications. Adhering to the FIM Standards, the following parameters were determined for each segment:

- land use;
- riparian: stage, bandwidth, band 1 score, vegetation quality band 1 score, band 2 score, vegetation quality band 2 score, and bankslope;
- overhanging vegetation;
- shore cover; and
- emergent vegetation.

Substrates were determined by averaging segment data (from FIM, where available) with detailed site data obtained during the fish and wildlife assessment.

Submergent vegetation extent (percentage of segment) was removed since it was not collected for all segments during the FIM or F&W sampling. The submergent vegetation data was substantially less than the measured extent of emergent aquatic vegetation and would be expected to be fairly close in value. Also, RL&L (1993) found submergent macrophytes in approximately 80% of the main body of the lake, unlike this study.

Numbers of riparian veterans and snags should likely be more intensively reviewed. This is suggested for Segments 1 and 2 in particular, which are reported to have mixed mature forest, yet zero veterans or snags were documented during the FIM. However, during the F&W assessment, 'wildlife trees' were documented at the sample sites.

2.2.6 GIS Products

The shoreline of Columbia Lake was defined by digitizing the boundary using the July 2008 orthophotos. Delineation using orthophotos provides a higher level of accuracy (+/- 5 m) than delineation using TRIM base (+/- 20m). Segment breaks were interpolated by overlying GPS locations and field markers onto the base map. Necessary updates to the 2009 FIM results (e.g., segment lengths, extent disturbed) were included.

The legal boundaries of properties (parcel fabric) around the lake were provided by the RDEK. The RDEK parcel fabric metadata states horizontal accuracy of approximately +/- 10 m. The RDEK makes no warranties or representations concerning the validity or accuracy of the data.

The Sensitive Habitat Inventory and Mapping Methods (Mason and Knight 2001) and the Foreshore Inventory and Mapping Standards (Schleppe and Mason 2009) provide additional technical procedures including GPS, data management, database development and quality control.

2.2.7 Integration of the FIM into the Community Mapping Network's Digital Atlas

The Community Mapping Network (CMN) provides online natural resource information and maps and makes it accessible to the public through a user friendly mapping system. The database and mapped results from this study will be provided to the CMN database manager so that it may be incorporated into the digital atlas, located at www.cmnbc.ca.

2.3 Fish and Wildlife Assessment

2.3.1 Fish Sampling and Analysis

Fish assessments were completed at 13 sites (representing 6 out of 8 segments) around the lake during sampling events on July 15-16 and September 15, 16 and 24, 2009. A variety of sampling techniques were utilized to obtain information on species presence and relative abundance, including snorkel, seine, Gee trap, trap net and observations from the boat. The most appropriate technique considering the site conditions was used. For instance, Gee traps were used under silty conditions when visibility was low and seines were conducted on shallow gravel/sandy beaches. The following details were recorded for each site sampled: a description of substrate type, general aquatic vegetation details, air temperatures, water temperatures, numbers of each fish species, life stage for fish, as well as site observations. Any fish captured were released in the area where they were found once sampling data was recorded.

Fish data was generally not analyzed using statistical methods since the sampling program was designed only to determine presence/absence and relative abundance. To provide a general understanding of fish use at each sample site, relative abundance was calculated for each species. Data from all sampling techniques was pooled in the relative abundance calculations. Summer and fall data were analysed separately in order to identify any seasonal distinctions in habitat use. Where raw data provided numbers that were not absolute (e.g., >200 or 100+), only the whole number (e.g., 200 or 100) was considered for mathematical and graphical purposes.

Using the 2009 field data and historical accounts, a fish summary was prepared that discussed Columbia Lake specific data and identified important habitats and interactions, particularly for sensitive or regionally significant species. Any confirmed habitat for sensitive species along the shoreline was included in the aquatic Habitat Index as an area of biological significance or Zone of Sensitivity (ZOS).

2.3.2 Aquatic Invertebrate Sampling and Analysis

Aquatic invertebrates were sampled at five sites around the lake, representing three shore types on July 15 and 16, 2009. A standard sized D-net was placed into the water and the substrate was disturbed by kicking and vigorous hand rubbing of larger substrates (i.e., large cobble and small boulders) to dislodge invertebrates. For each site, the total area disturbed was approximately 2 m x 2 m, and the duration of the disturbance was 1.5 to 2 minutes. The contents were transferred from the D-net to a white tray and invertebrates were identified by order. Following identification, all of the invertebrates were returned back to the water.

In the office, Interior Reforestation transcribed data to a spreadsheet, and data was updated as necessary to identify all samples to Species Grouping by Order. Simpson's Index of Diversity was utilized to account for the richness and evenness of the samples collected at each site. This biodiversity index measures the probability that two individuals randomly selected from a sample will belong to different species. The value of this index ranges between 0 and 1, 0 represents no diversity and 1 represents infinite diversity.

Equation 1: Simpson's Index of Diversity $\mathbf{1 - [\sum n(n-1) \div N(N-1)]}$

Where:

n = the total number of organisms of a particular taxon
N = the total number of organisms of all taxa

2.3.3 Wildlife / Sensitive Species Observations and Analysis

The wildlife assessment was completed during the July and September field program. The assessment involved walking along the upland side of the foreshore area (approximately 200 m length and 50 m or more in width) at each site where a fisheries assessment was completed.

Species presence (particularly bird) and other wildlife attributes were recorded. Bird presence was reported using both visual and audio accounts.

A review of the BC Conservation Data Centre (BC CDC 2009) records was conducted to identify sensitive vegetation and wildlife species potentially in the area. Where background information was available, a short summary on each sensitive species was provided. Additional accounts for wildlife species closely associated with foreshore ecosystems are also provided. Any confirmed habitat for sensitive species along the shoreline was included in the Aquatic Habitat Index (AHI) as an area of biological significance or ZOS.

2.3.4 Aquatic Habitat Index (AHI)

The AHI estimates the environmental sensitivity or biological value of the shoreline. The index incorporates physical and biological data into a model which analyses and ranks each segment. For consistency and comparison between lake systems, the AHI methods closely followed those used in the recently completed Moyie F&W study (Schleppe 2009) and those used at Windermere Lake (McPherson *et al.* 2007). Lake specific modifications to the analysis were incorporated to account for attributes of local significance. Schleppe and Arsenault (2006) deserve special recognition for initially developing this complex matrix for Okanagan Lake.

The AHI uses physical (FIM data) and biological (F&W data) variables to mathematically score each segment. The scores allow segments to be compared to one another, to determine their importance to fish or wildlife habitat. The index incorporates both positive habitat features such as natural areas that add to the habitat value of a segment, and negative habitat features such as marinas which decrease the habitat value. Parameter values were based upon their positive or negative contribution to aquatic habitat.

The index includes four categories of parameters: 1) Biophysical, 2) Zones of Sensitivity, 3) Riparian and 4) Modifications. Table 1 summarizes the categories and parameters that were incorporated into the index and provides a summary of calculations and associated parameter values. The following section briefly describes the parameters in terms of how they contribute or detract from the habitat value of a shore segment.

Table 1. Aquatic Habitat Index Parameters, Calculation Method and Values for Columbia Lake

Category	Parameter	Maximum Point	*Percent of the Category*	*Percent of the Total*	Calculation	Value Categories
Biophysical	Shore Type	20	*33.9*	*20.4*	(% of Segment) x (Shore Type Value)	Stream Mouth = Wetland (20) > Gravel Beach = Rocky Shore (15) > Sand Beach = Cliff /Bluff (10), Other (5)
	Substrate	10	*16.9*	*10.2*	(% Substrate) x (Substrate Value)	Cobble (10) > Gravel (8) > Boulder = Organic = Mud = Marl (6), Fines = Sands (4) > Bedrock (2)
	Percentage Natural	15	*25.4*	*15.3*	(% Natural) x (Natural Score)	Natural Score (15)
	Aquatic Vegetation	8	*13.6*	*8.2*	(% Aquatic Vegetation) x (Aquatic Vegetation Score)	Aquatic Vegetation Score (8)
	Overhanging Vegetation	6	*10.2*	*6.14*	(% Overhanging Vegetation) x (Overhanging Vegetation Score)	Overhanging Vegetation Score (6)
Zones of Sensitivity	Burbot Spawning	5	*21.7*	*5.1*	Present (5), Absent (0)	Present (5), Absent (0)
	Kokanee Staging/Rearing	5	*21.7*	*5.1*	Present (5), Absent (0)	Present (5), Absent (0)
	Burbot Rearing	5	*21.7*	*5.1*	Present (5), Absent (0)	Present (5), Absent (0)
	Wildlife	5	*21.7*	*5.1*	Present (5), Absent (0)	Present (5), Absent (0)
	Mussel bed	3	*13.0*	*3.1*	Present (3), Absent (0)	Present (3), Absent (0)
Riparian	Band 1 (Riparian)	10	*62.5*	*10.2*	(Vegetation Bandwidth Category) x (Vegetation Quality x Vegetation Score)	**Vegetation Bandwidth Category** 0 to 5 m (0.2) < 5 to 10 m (0.4) < 10 to 15 m (0.6) < 15 to 20 m (0.8) < 20 m (1)
	Band 2 (Upland)	6	*37.5*	*6.1*	(Vegetation Bandwidth Category) x (Vegetation Quality) x (Vegetation Score)	**Vegetation Quality Category** Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)
Modifications	Retaining Wall	-3.5	*18.9*	*-3.1*	(% Retaining Wall) x (-5)	(% Retaining Wall) x (-5)
	Docks	-3	*16.2*	*-2.7*	(# Docks) x (-0.1)	(# Docks) x (-0.1)
	Groynes	-3	*16.2*	*-2.7*	(# Groynes) x (-0.5 per groyne)	(# Groynes) x (-0.5 per groyne)
	Boat Launch	-3	*16.2*	*-2.7*	(# Launches) x (-3 per launch)	(# Launches) x (-3 per launch)
	Marina	-6	*32.4*	*-5.4*	Small Marina (< 20 slips), Medium Marina (20-50 slips), Large Marina (>50 slips)	Small Marina (-2), Medium Marina (-4), Large Marina (-6)

2.3.4.1 Biophysical Parameters

The determination of extent of each of the biophysical parameters is described in full in the FIM.

Shore Type

Shore Type breaks the shore zone into distinct segments that correspond to the physical features of the land/water juncture. This parameter assumes that all shore types have similar physical features in their natural state and that habitat utilization by the different species is similar in identical shore types (e.g., the use of one sand beach by fish is similar to the use of a different sand beach in another area) (Schleppe and Arsenault 2006).

The Shore Type values were established in the earlier lake studies through detailed habitat specificity analyses using local data and literature reviews. The Okanagan Lake Shore Type scored each Shore Type according to fish usage. In the Windermere Lake analysis, although Shore Type scores were still based on fish values, the value of wetland habitat for values other than direct fish usage (e.g., primary productivity, wildlife and aquatic health) was identified as a unique parameter. The Moyie Lake study refined this step by incorporating the full spectrum of wetland values into the Shore Type score. Although the Shore Type Scoring has gone through an iterative development process from lake to lake, the importance of each Shore Type has remained relatively constant.

For this study, the Shore Type Scores from the most recently completed assessment, Moyie Lake, were used as a standard. This standard is applicable to Columbia Lake, since there are similar species inhabiting both shorelines. Stream mouths and wetlands were rated as having the highest values for fish and wildlife, followed by gravel beach and rocky shore. Sand beach and cliff/bluff habitats were valued the lowest.

Substrate Type

Lakebed substrates relate directly to lake productivity (Schleppe 2009). Many fish species depend on coarse substrate compositions for egg deposition (spawning) and for seeking cover from predators (rearing). Substrates also provide rooting areas for aquatic vegetation, foraging opportunities for benthic macro-invertebrate, and three-dimensional structure (Randall *et al.* 1996). Schleppe and Arsenault (2006) ranked substrate types based on life history requirements for different fish species. Their attributed substrate values have subsequently been accepted as standards for this and other lake assessments (Windermere and Moyie Lakes).

Percentage Natural

Natural shorelines have a high fisheries, wildlife and ecological value because they have few anthropogenic disturbances that can degrade habitat integrity (e.g., docks, transport infrastructure). This parameter recognizes that natural areas typically function better and are more similar to historical ecosystems than highly disturbed shorelines. This parameter's value follows the standard established at Moyie Lake, which was based on the Windermere and Okanagan Lake studies.

Aquatic Vegetation

All vegetation below the high water level is considered productive (Schleppe 2009). Aquatic plants provide fish and wildlife with food, spawning or nesting habitat, foraging substrates, and cover from sun and predators (Engel 1990). During the FIM emergent aquatic vegetation was mapped and was determined to be shallow-water wetlands or lacustrine shore water wetlands according to BC and Canadian Wetland Guides (MacKenzie and Moran 2004, Wetlands Research Centre 1997- *see* Section 2.2.1). The extent of emergent aquatic vegetation mapped for each segment in Columbia Lake was used for the AHI.

Overhanging Vegetation

Overhanging vegetation is a valuable component of the shoreline. Leaf litter, fallen branches/trees and associated insect drop provide food and habitat for aquatic organisms (Holmes pers comm.). Overhanging vegetation extent calculated during the FIM using the orthophotos and GIS applications, was used in the AHI.

2.3.4.2 Zones of Sensitivity

Zones of sensitivity (ZOS) are areas of biological importance specific to Columbia Lake. ZOS were defined as being confirmed habitats for sensitive species or regionally significant species (as identified by BC MoE or DFO). ZOS were confirmed through this study's F&W field investigations, literature review, or by other reputable sources. Supporting information for each of the ZOS is provided in the Results Section of this document (Section 3.3 Fish Results and Section 3.5 Wildlife Results) and information has also been summarized in the Appendix C. Segment Database for each segment.

Burbot Spawning

Shoreline spawning habitat was given a high weighting in the index since it relates directly to the productive capacity of a given area of the lake and is often a habitat limiting factor that fish have a high specificity for (Schleppe 2009). Burbot has experienced significant declines in the Columbia System, including Columbia Lake (Paragamian *et al.* 2000). As a result of these declines, burbot are considered a species of regional concern in the Columbia River System (McPhail 2007). Segment 4 was identified as a ZOS for burbot spawning, since Arndt (2001) identified that burbot spawned under the ice here. Burbot are also known to spawn in an unnamed tributary in Segment 8 (Arndt and Hutchinson 2000, Arndt 2002), located in the proximity of the shoreline and this segment has also thus been identified as a ZOS.

Burbot Rearing Area

Shoreline habitat with coarse substrate has been identified as important for burbot juvenile rearing in the AHI. Taylor (2001) found that juvenile burbot were strongly associated with interstitial spaces in the substrate along the shoreline. Sites with intermediate sized substrate (gravel and cobble) had mostly age 0 burbot. Shelter size increased with increasing body size, with older juveniles associated with cobbles and boulders (substrate sizes are defined in Table 6).

As this assessment and Taylor (2002) found, other than in the northern and southern wetlands, Columbia Lake tends to have a seam of coarse substrates (gravels, cobbles, boulders) along the foreshore. Substrate size generally decreases with increasing depth. Under high water conditions, coarse substrates are prevalent. Under low lake levels (fall to early spring), there is an increase in the percent composition of fines, and much of the complex shoreline habitat is above water. This elevates the potential for a bottleneck for particularly larger juvenile burbot (Taylor 2002).

Kokanee Migration Corridor

Dutch Creek is an important tributary for kokanee spawning in the Upper Columbia Basin (Manson 2006 and Oliver 1995). The wetlands at the north end of the lake (Segment 4) are important for fish migrating upstream to Dutch Creek to spawn and for the fry as they move downstream to their rearing grounds in the Kinbasket reservoir.

Biologically Productive Areas

Biologically productive areas for plant or animal species other than fish were also identified. These included:

- Segments 1, 6 and 7: mussel beds (Moore and Machial 2007; and F&W field assessments),

- Segment 3: Armstrong Bay
- Segment 4: An active Great Blue Heron nesting colony in the Dutch Creek fan at the north end of Columbia Lake. This is one of the most productive and successful colonies in the East Kootenay (Machmer 2008).
- Segment 8: painted turtle habitat known in the small section of the lake in the south west corner isolated by a CPR railway berm (I. Adams pers. obs.).

2.3.4.3 Riparian Parameters

Band 1 (riparian) and Band 2 (upland)

Vegetation adjacent to lakes is important for fish and wildlife habitat as described above for the Overhanging Vegetation parameter. It is also important for terrestrial wildlife species since it can incorporate important habitats such as grasslands and migration corridors. Vegetated shorelines help to reduce erosion through both soil stabilization and reducing the erosional energy of rainfall and wave action (Holmes pers. comm.). The vegetation is distinct from upland habitats due to the presence of water and is thus considered more productive than drier or wetter habitats (Holmes pers. comm.).

As described in the FIM methods (Section 2.2.5) lengths, scores and vegetation quality of the Riparian Band 1 and Riparian Band 2 were determined for each segment using GIS. The index considered the extent, score and quality of Riparian Band 1 and the Riparian Band 2 individually for each segment. Following the Moyie Lake index, Band 1 vegetation, situated directly adjacent to the lake (and theoretically contributing more to the lake productivity) was weighted higher than Band 2 vegetation.

2.3.4.4 Habitat Modification Parameters

Schleppe and Arsenault (2006) provided detailed descriptions of the influences of habitat modification parameters on the shoreline habitats and have been directly quoted here (as shown in italics). Additional background in plain text was obtained through personal communications during the Windermere Lake study.

Retaining Walls

Retaining walls are considered to be negative habitat features for a variety of reasons. These structures are generally constructed to armour or protect shorelines from erosion. Kahler et al. (2000) summarized the effects of piers, docks, and bulkheads (retaining walls) and suggested that these structures may reduce the diversity and abundance of nearshore fish assemblages because they eliminate complex habitat features that function as critical prey refuge areas. Carrasquero (2001) indicated in his review of overwater structures that retaining walls might also reduce the diversity of benthic macroinvertebrate communities more than other structures such as riprap shoreline armouring because they reduce the habitat complexity.

Natural erosion along a shoreline can be the result of removal of riparian or lakeside vegetation, which may have been the cause of the erosion in the first place. In other cases, retaining walls have been constructed to hold up soil material, possibly reclaiming land, so that lawns can be planted or for other landscaping purposes. The construction of structures by residents, may lead to neighbours imitating their neighbours. Also, construction of one retaining wall may lead to energy transfer via waves resulting in erosion somewhere else. The above arguments highlight the consequences of retaining wall construction and the potential negative habitat effects that they have.

Docks

The negative effects of docks on fish habitat are controversial. On one hand docks may provide areas of hiding for ambush predators, reductions in large woody debris inputs, and these structures are often associated with other anthropogenic disturbances such as retaining walls (Kahler et al. 2000; Carrasquero 2001). On the other hand, docks also provide shaded areas that can attract fish and provide prey refuge, and pilings can provide good structure for periphyton growth (Carrasquero 2001). Numerous factors, such as the scale of study and the cumulative effects of these structures, are also important and should be considered when discussing over-water structures (Carrasquero 2001).

Docks have also been documented to increase fish density due to fish's general congregation around structure, but decrease fish diversity in these same areas (Lange 1999). Coupled with this result, Lange also found that fish diversity and density were negatively correlated with increased density and diversity of shoreline development, meaning that increases in dock density may reduce fish abundance and diversity. Chinook salmon have been documented to avoid areas with increased overwater structures (e.g., docks) and riprap shorelines, and therefore, construction of these structures may affect juvenile migrating salmonids (Piaskowski and Tabor, 2001). Further, docks are known to create islands or bottlenecks in lake habitats, since they can modify predator/prey interactions which can cause fundamental shifts in the trophic structure of an ecosystem (J. Bisset pers. comm.).

It is apparent that docks do affect fish communities and the degree of effects are most likely related to the intensity of the development, the scale of the assessment and fish assemblage life history requirements. Different fish assemblages may respond differently to increased development intensity, and fish assemblages containing salmonids may be more sensitive than southern or eastern fish assemblages (e.g., bass, perch, and sunfish, etc.). It is for these reasons that dock density was included in the index, and that docks were treated as a negative parameter, with increasing dock density considered as having more negative effects than lower dock densities.

Groynes

*Groynes are structures that are constructed to reduce or confine sediment drift along a shoreline. These structures are typically constructed using large boulders, concrete, or some other hard, long lasting material. G*roynes are known to have significant impacts as docks on shoreline processes and fish. They concentrate fish, disrupt shoreline migration, and force juveniles into deeper waters away from refuge where they are easily predated upon (MacDonald pers. comm.). *Groynes also reduce the natural movement of substrates along the shoreline, which can increase the embeddedness of gravels. These structures are often considered a Harmful Alteration and Disruption of Fish Habitat (HADD) as defined under the federal Fisheries Act.*

Boat Launches

Boat launches were considered to be a negative parameter within the index. Boat launches are typically constructed of concrete that extends below the high water level. The imperviousness of this material results in a permanent loss of habitat, which ultimately reduces habitat quality and quantity for fish. Concrete does not allow growth of aquatic macrophytes, and reduces foraging and/or refuge areas for small fish and macroinvertebrates. The extent of the potential effects of boat launches relates to their size. Thus, multiple lane boat launches tend to have a large effect on fish habitat than smaller launches with fewer lanes.

The Okanagan and Moyie Lake studies treated each boat launch lane as one unit, and one launch could have multiple boat ramps. The intent of this was to incorporate the size of the structure (i.e., more ramps, decrease in available habitat). Since Columbia Lake only had three boat launches and the number of boat ramps/launch was not identified, the Windermere Lake calculation was used where each boat launch was given the same value of -3 in the Habitat Index.

Marinas

Marinas are a concentration of boat slips, offering a place of safety to vessels. In general, when marinas are constructed in the littoral zone there tends to be a large increase in shading, which reduces the potential for aquatic macrophyte growth and therefore reduces the productivity of a particular shoreline area. Also, marinas tend to have other associated activities, including extensive boat movements, which can reduce the use of an area by more timid species (e.g., rainbow trout). Other activities in marinas include fuelling stations, boat cleaning, bilge water, and sanitary waste disposal stations. Large marinas tend to have breakwaters, which affect lake processes and fish in a similar manner to groynes (B. MacDonald pers. comm.). Breakwaters impede shoreline migration and force juvenile fish to venture into deeper water making them subject to predation (B. MacDonald pers. comm.). The breakwaters further affect wave action, sediment scour, deposition and circulation. Dredging to maintain depth and access for boats is an additional significant impact on the foreshore (B. MacDonald pers. comm.). Other effects of marinas on the natural environment are that they tend to: have homogeneous substrates; concentrated hydrocarbon levels, alter water quality; provide a continuous disturbance to aquatic vegetation; and re-suspend sediments (J. Bisset pers. comm.). *Each of these activities has the potential to alter benthic communities, possibly altering the fish assemblage (i.e., congregations of more tolerant species and displacement of less tolerant species) and potential resulting in a loss in biodiversity, which can ultimately affect fish and/or fish habitat. Marinas also tend to be associated with other high intensity land developments, which may have a variety of effects including reducing water quality through inputs of chemicals, etc., increasing water turbidity, and reducing oxygen concentration, etc.*

Following the methods used for Windermere Lake, marinas at Columbia Lake were identified as being small, medium or large based on an orthophoto review. Large marinas had 50+ berths, medium marinas had 20+ berths, and small marinas had <20 berths.

2.3.4.5 Index Ranking

Once the biophysical, ZOS, riparian and modification scores were assigned for all parameters, the values were summated for each segment. The index results were run through several iterations comparing the outcomes to perceived habitat value. Minor adjustments were made to the parameter scores to ensure that items were not overly weighted. In this study, negative habitat parameters were constrained to have a negative effect of 18.5 % out of the total of a shore segment. This is lower than Windermere Lake and Okanagan Lake which had negative values accounting for 45 % and 43 % of the index respectively. The differences are mainly the result of the ZOS being built into the index with this study, while they were calculated as a separate step for Windermere Lake.

Once the segments were scored, the range in lake values were divided into five equal AHI Ranks - Very Low, Low, Moderate, High, and Very High. These categories are considered the **Current Ecological Value** of a shore Segment.

To investigate the potential for restoration, negative instream parameters were removed from the index and the index was re-run to determine the **Ecological Potential** of each segment. Segments that increased in value were considered to be areas where shoreline improvements would result in increased habitat value.

2.4 Shoreline Management Guidelines

Shoreline Management Guidelines (henceforth 'the Guidelines') are intended to conserve fish and wildlife habitat and are a tool to assist landowners and developers who want to propose shoreline development. Guidelines were prepared for Windermere Lake in 2009 (EKILMP and Interior Reforestation 2009). During the preparation of the Moyie Lake Guidelines (Schleppe 2009), the Windermere Lake template was modified slightly to account for the fact that ZOS had been built into the AHI. The methods employed here at Columbia Lake, followed these accepted templates in whole.

Guideline development involved attributing a colour scheme to the Current Ecological Rankings determined through the AHI. The colours represent a segment's level of vulnerability to development and are as follows:

1. Red Shoreline was designated for segments with a Very High Ecological Value;
2. Orange Shoreline was designated for segments with a High Ecological Value;
3. Yellow Shoreline was designated for segments with a Moderate Ecological Value; and
4. Grey Shoreline was designated for segments with Low and Very Low Ecological Value.

The risks for specific activities in each color zone and the associated review process were outlined in a brief and user-friendly document which both forms a component of this report and is also provided as a separate stand alone document.

3 Results

3.1 Biophysical Background

The Columbia Lake Management Strategy (RDEK 1997) provides a detailed description of the physical setting of Columbia Lake. This study highlights the general physical nature of the lake, summarizing information provided in the Lake Management Strategy. For more detail, please refer to the original document.

> *Columbia Lake is located in the southern interior of British Columbia in the Rocky Mountain Trench Ecosection. The lake is bound by the Kootenay Ranges of the Rocky Mountains to the east, the Purcell Range of the Columbia-Omineca Mountains to the west, the glacial terrace of the Kootenay River at Canal Flats to the south, and Dutch Creek's alluvial fan to the north. Columbia Lake it is situated in the headwaters of the Columbia River. The lake's location, configuration and morphometry, combined with the frequent wind action in the Rocky Mountain Trench, produces well-mixed water throughout the lake during the ice free period. Historic data indicates that Kootenay River flowed north during the last glacial period not south, as it presently does, and that Columbia Lake currently occupies a glacial channel of the Kootenay River.*

The foreshore perimeter of Columbia Lake was calculated to be 43.3 km and is depicted on the Foreshore Summary Maps (Appendix A). Table 2 summarizes Columbia Lake's physical parameters. A bathymetric map showing the depth profile for the lake is provided in Appendix B.

Table 2. Columbia Lake Physical Characteristics

Parameter[1]	Amount
Elevation[1]	809 m
Surface Area[1]	25.74 km^2
Length[1]	13.6 km
Maximum Depth[1]	5.2 m
Mean Depth[1]	2.9 m
Watershed Area[1,2]	881 and 185 km^2
Foreshore Perimeter	43.3 km

[1] Columbia Lake Management Strategy (RDEK 1997)

[2] Area including and excluding the Dutch Creek basin (RDEK 1997)

Columbia Lake has several small creeks draining into it along its periphery and it feeds into the Columbia River at its north end. It has extensive wetlands situated at the south and north (outlet) ends which were mapped based on the provincial wetlands maps (GeoBC 2009a).

3.1.1 Water Quality

The large surface area of Columbia Lake relative to shallow depth suggests that it warms quickly during the summer and does not stratify (Bisset *et al.* 2002). Groundwater contributions, however, may add some diversity to temperature conditions (Bisset *et al.* 2002).

The trophic stage reflects the productivity or nutrient levels of a lake (Figure 8). Based on total phosphorus and chlorophyll a data from 1973 to 1983, Columbia Lake was reported to be oligotrophic or nutrient poor (RDEK 1997, BC MoE 1985a, BC MoE 1985b). However, total phosphorus data from September 1992 indicated that it was mesotrophic to eutrophic (RL&L 1993). This increase in phosphorus, although from a limited dataset, may be an indication of increasing nutrient content with time. Columbia Lake does have characteristics of a mesotrophic lake, since it is shallow and has a productive littoral zone (Bisset pers. comm.). To confirm the current water quality conditions, trophic status, and identify any changes that have occurred with time, water quality monitoring should be conducted. Nutrient cycling also plays a role in the water quality of the lake and could be better understood. For example, the high volume of cool/dense groundwater may significantly affect nutrient cycling, particularly given the low volume of surface water (limited tributary inflow) and steep slopes (Bisset pers. comm.).

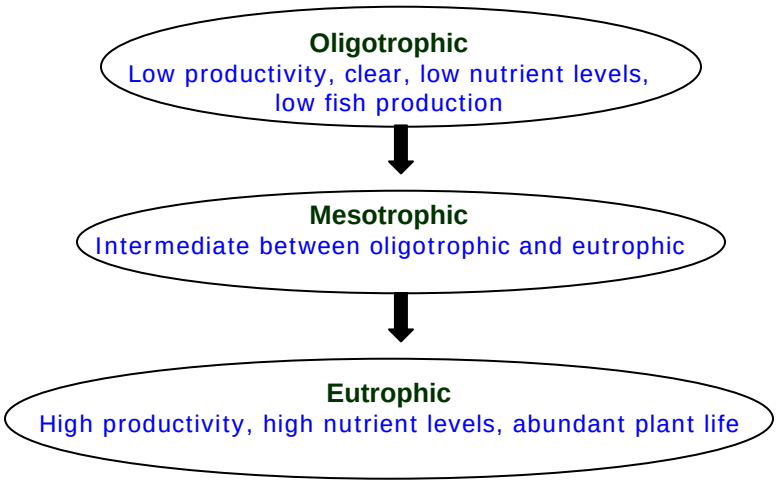


Figure 8. Lake Productivity Chart

Columbia Lake was identified as having a moderate water quality sensitivity, which relates to its ability to assimilate phosphorus without a detrimental affect on water quality and its sensitivity to additional sources of phosphorus (RDEK 1997). This sensitivity is due to several characteristics including that the lake is very shallow, it has a littoral zone where aquatic plants are capable of growing over the entire bottom of the lake, and it has embayments along its margins (RDEK 1997). This moderate rating means that the control of additional nutrient loads is important, such as that from domestic effluent and agricultural runoff (cattle), which are proximal to the lake (RDEK 1997). The water of Columbia Lake is replaced by inflow once a year (BC MoE 1985a, RDEK 1997). This 'flushing rate' is considered to be quite fast and helps keeps nutrients from building up in the lake (RDEK 1997).

Limiting nutrient loading in Columbia Lake is not only important to the health of Columbia Lake. Since Columbia Lake is situated at the headwaters of the Columbia Basin its water quality is also important to the continuum of downstream systems (e.g., Columbia River, Mud Lake and

Windermere Lake) (Bisset, pers. comm..). For example, elevated fecal coliform levels from domestic or agricultural effluents would not only result in concerns with recreational use of Columbia Lake, but also with downstream users (Bisset pers. comm.). Maintaining vegetated buffers and using other mechanisms for preventing re-inoculation of the lake should be identified (Bisset, pers. comm.).

3.1.2 Water Availability and Uses

As a result of the lake's drainage basin being fairly steep, small and restricted, only small creeks flow into the basin (RDEK 1997). During a September survey, RL&L (1993) found 14 out of 15 streams entering the lake to be dry. These creeks thus only contribute to the lake's water quantity in minor way. Principal east side tributaries are Warspite and Landsdown Creeks. West side tributaries are Dutch, Hardie, Marion and Sun Creeks. The contribution of Dutch Creek entering the lake at the northern end is unknown, since it has been reported that some of its flow is lost through the alluvial fan and channeled as groundwater into the Columbia River (RDEK 1997). At the south end, a considerable amount of water from the Kootenay River enters the lake as ground water (estimate is 100 million m^3/yr) (RDEK 1997). This groundwater inflow prevents the lake from freezing. The south and north ends were clear of ice during our early March 2009 inspection, while most of the lake had ice at a depth of greater than 1.5 feet.

The Lake Management Strategy considered if the water level of Columbia Lake was changing with time (RDEK 1997). Using data dating back to 1967, the Strategy found that that the lake levels were mainly influenced by precipitation, the levels had not fluctuated extremely from the average, and that from 1990-1995 lake levels closely approximated long term averages. Dutch Creek's channel movement at its alluvial fan toward the Columbia River was not considered to be a significant concern for lake water levels (Figure 9; RDEK 1997).

Figure 9. Dutch Creek alluvial fan at the north end of Columbia Lake. Orthophoto – July 2008.

The water in Columbia Lake is licensed for several uses including: domestic use (2 licenses, totaling 1000 gallons/day), irrigation (2 licensees, totaling 25 acre feet/annum) and waterworks (6 licenses, totaling 71 million gallons/year) (GeoBC 2009b). Together this totals 300,983 m^3/year. The Lake Management Strategy identified that the lake and tributaries were licensed to their maximum and withdrawals had insignificant effects on lake levels (RDEK 1997).

3.1.3 Biogeoclimatic Zone

Columbia Lake is situated in the Interior Douglas-Fir, very dry cool, biogeoclimatic zone variant (IDFxk; BC Ministry of Forests and Range 2008). The BC Ministry of Forests and Range (2006) description of this zone has been the basis for information provided here. This zone has been recently defined (most of this area was previously IDFun and IDFdm2) and occupies the valley

bottom of the Rocky Mountain trench from Canal Flats north to Edgewater. It follows the Columbia River and is approximately 6 - 8 km wide and 100 km long. It is characterised by warm, dry climatic regime and soil moisture deficits, particularly on the south aspects. Winters are generally mild, with snowfalls being intermittent and rarely exceeding 25 cm. As a consequence, the IDFxk provides important winter habitat for ungulates including elk (*Cervus elaphus*), bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*).

Most of the landscape is dominated by multi-story, uneven-aged Douglas-fir stands. Douglas-fir (*Pseudotsuga menzesii* var. *glauca*) is the dominant seral tree species and the dominant climax tree species. Ponderosa pine (*Pinus ponderosa*) occurs on dry south aspects; while, hybrid spruce (*Picea engelmannii* x *glauca*), trembling aspen (*Populus tremuloides*) and black cottonwood (*Populus balsamifera trichocarpa*) commonly occur on wet seepage sites, riparian areas and floodplains. Because of disturbance (fire, grazing, etc), climax plant communities are rare. The shrub layer tends to be poorly developed and dominated by Rocky Mountain Juniper (*Juniperus scopulorum*) and a low cover of Saskatoon (*Amelanchier alnifolia*), snowberry (*Symhoricarpos albus*) and rose species. The herb layer contains a diverse mixture of species and is dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*), rough fescue (*Festuca altaica*), northern goldenrod (*Solidago spathulata*), kinnikinnick (*Arctostaphylos uva-ursi*) and cut-leaved fleabane (*Erigeron compositus* var. *glabratus*). The bluebunch wheatgrass and rough fescue have been significantly reduced by domestic and wild ungulate grazing.

3.1.4 Protected Areas

Columbia Lake Provincial Park

Columbia Lake Provincial Park is located at the northeast corner of Columbia Lake (Figure 10). It is an undeveloped park that provides front country, non-consumptive recreational opportunities (such as wildlife viewing, paddling, nature appreciation, hiking and mountain biking; BC Parks 2004a). The park encompasses 257 hectares of land, which includes 3 km of undeveloped beach area (BC Parks 2004a). The park was designated primarily to protect a grassland ecosystem and essential wetland habitat (BC Parks 2004a). A secondary purpose is to provide recreational opportunities on Columbia Lake without development or services. The park is largely nested within the adjacent East Side Columbia Lake WMA, further protecting essential habitat for ungulates and waterfowl (BC Parks 2004a). Known species at risk in the park are Rocky Mountain bighorn sheep (park provides overwintering habitat), badger (*Taxidea taxus*), the great blue heron (*Ardea herodias*), and the two plant species Gastony's cliff-brake (*Pellaea gastonyi*) and Hooker's townsendia (*Townsendia hookeri)*. The Park also hosts an "abundance of known [Ktunaxa] archaeological and traditional use sites" (BC Parks 2004a).

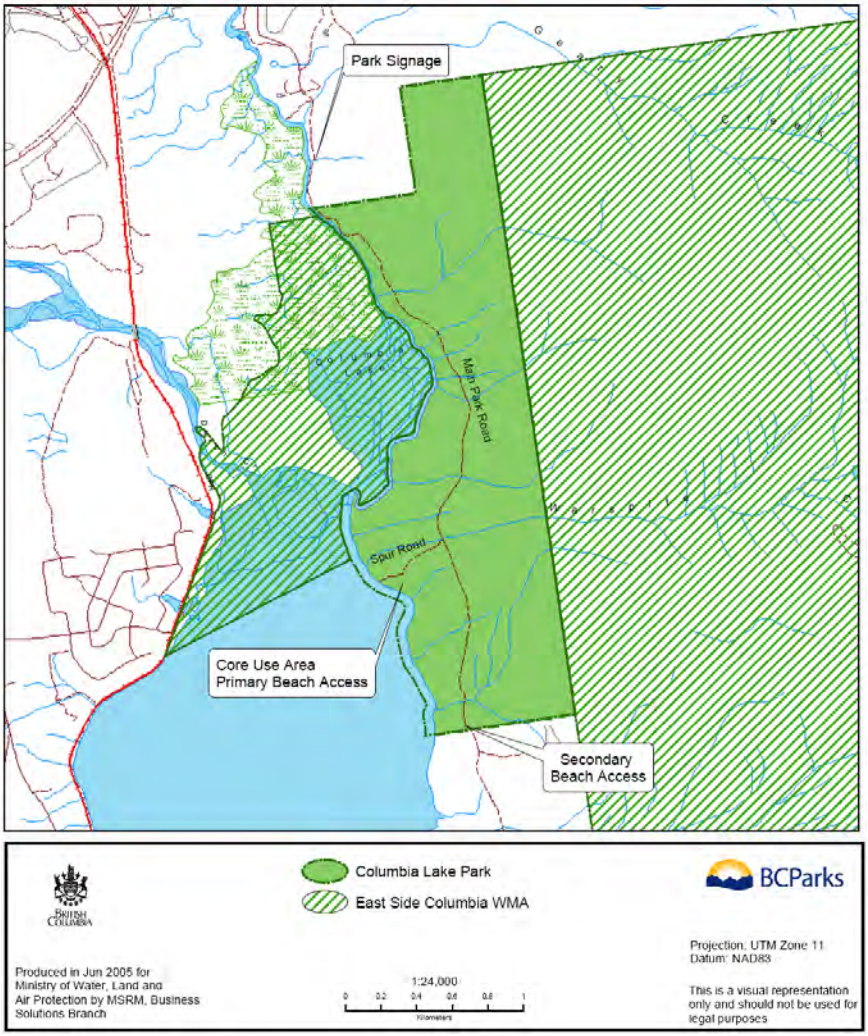


Figure 10: Columbia Lake Provincial Park in relation to Columbia Lake. Source: BC Parks 2004a.

Thunder Hill Provincial Park

Thunder Hill Provincial Park is located at the southwest corner of Columbia Lake. It is approximately 44 ha and primarily protects "remnant open forest and grassland ecosystems" (BC Parks 2003a). The park is mostly upland forest at elevations well above the lake and west of Highway 93/95. However, it does reach to Columbia Lake and borders a short length of shoreline in the small pond cut-off from the main lake by the CPR railway berm (Figure 11). This pond supports a variety of breeding and staging waterfowl as well as painted turtles (*Chrysemys picta*) and beavers (*Castor canadensis*) (I. Adams pers. obs.). Thunder Hill Park had all recreational developments removed in the early 1990s and there are no signs on the highway indicating its presence. Virtually the entire park (43 ha, 98%) is zoned "Natural Environment". The remaining hectare is a "Special Feature" protecting significant archaeological values (BC Parks 2003a).

Figure 11: Location of Thunder Hill Provincial Park in relation to Columbia Lake.

Canal Flats Provincial Park

Canal Flats Provincial Park occupies 125 m of foreshore (much of which is heavily altered) at the southwest corner of Columbia Lake, closely situated to the Village of Canal Flats. The primary purpose of the park is to provide recreational opportunities. The entire 6 ha of the park is zoned for "intensive recreation" (BC Parks 2003b). The park is expected to be withdrawn entirely from the provincial park system in the near future and turned over to the Village of Canal Flats and managed by the Village (Volp pers. comm.).

Figure 12: Location of Canal Flats Provincial Park in relation to Columbia Lake.

East Side Columbia Lake Wildlife Management Area

Wildlife Management Areas (WMA) are established under the BC *Wildlife Act* and are not considered legal "protected areas". Within their boundaries, wildlife habitat is the primary management concern, however other activities are permitted. The East Side Columbia Lake WMA was first designated as a game reserve in 1957, and was formally adopted as a WMA in the late 1997. The WMA is 6,886 hectares in size (BC Parks 2007).

The Canada Land Inventory depicts the entire east side of Columbia lake as representing the largest contiguous Class 1[1] ungulate winter range in the upper Columbia sub-region, and one of the least impacted of the low elevation Class 1 Rocky Mountain bighorn sheep winter ranges in BC (BC Parks 2004a).

The WMA provides extremely important winter range for ungulates such as bighorn sheep, elk, mule and white-tailed deer, and creates a connectivity and migratory corridor between important habitat south and north of the lake (Columbia Wetlands WMA) (BC Parks 2007). The area is also important for Grizzly Bear (*Ursus arctos horribilis*), Black Bear (*Ursus americanus*), Cougar (*Felis concolor*), Coyote (*Canis latrans*), American Badger (*Taxidea taxus jeffersonii*), rare Flammulated Owls (Otus flammeolus**)**, Bald Eagle (*Haliaeetus leucocephalus***)**, Golden Eagle *(Aquila chrysaetos)*, Osprey (*Pandion haliaetus***)** and Red-tailed Hawk (*Buteo jamaicensis)* (BC Parks 2007). Species dependent upon grassland or open forest habitat types at low elevations also frequent the WMA, such as Prairie Falcon (*Falco mexicanus***)**, Townsend's Big-eared Bat (*Plecotus townsendii*), and Rubber Boa (*Charina bottae*) (BC Parks 2007). The WMA includes lake and lakeshore areas, wetlands, dry open grasslands and open Douglas fir stands at low elevations, while Lodgepole Pine (*Pinus contorta***)**, Englemann Spruce and subalpine fir forests rise sequentially from low elevations to the highest ridges (BC Parks 2007).

In addition to the known values of the south and north end wetland areas and the east side upland area, Armstrong Bay is also known to be a special place in this WMA. It offers shelter from lake winds to many wildlife species and may have riparian and littoral plant associations which are unique on the lake.

[1] Class 1 defined as winter range in which animals from surrounding areas depend on for survival.

This area is internationally significant in its biological diversity as it is home to many rare and endangered species (CORE 1994 *In* RDEK 1997). The management activities in the WMA will be designed, where possible, according to the 'leave alone' approach where natural processes will continue without interruption (Phelps 1996 *In* RDEK 1997). Habitat enhancement was also envisioned where feasible and desirable to maintain and increase the carrying capacity of the forage base (Phelps 1996 *In* RDEK 1997). The entire WMA has an approved restoration plan, and to date 310 ha of habitat restoration has been completed (Holmes, pers comm.).

Columbia Lake Ecological Reserve

The Columbia lake Ecological Reserve Management Direction Statement (BC Parks 2004b) was the source for information on this protected area. The Ecological Reserve was established in 1971. It is 29 ha and is located on the south east side of Columbia Lake, in the upland area (Figure 13). The reserve protects regionally significant hydrological and terrestrial features associated with limestone stratification within the East Kootenay Trench and Southern Park Ranges ecosections. The plant communities associated with the mineral springs and calc-tufa/limestone deposits are unusual and provincially significant. The ecological reserve is also the only reserve in the Kootenay Region that protects Interior Douglas-fir grasslands, which are a remnant ecosystem containing essential habitat for numerous species at risk. At risk species include vascular plants (Gastony's cliff-brake, Hooker's townsendia, annual paintbrush, giant helleborine and marsh muhly) and vertebrates (Rocky Mountain bighorn sheep, and the Flammulated Owl).

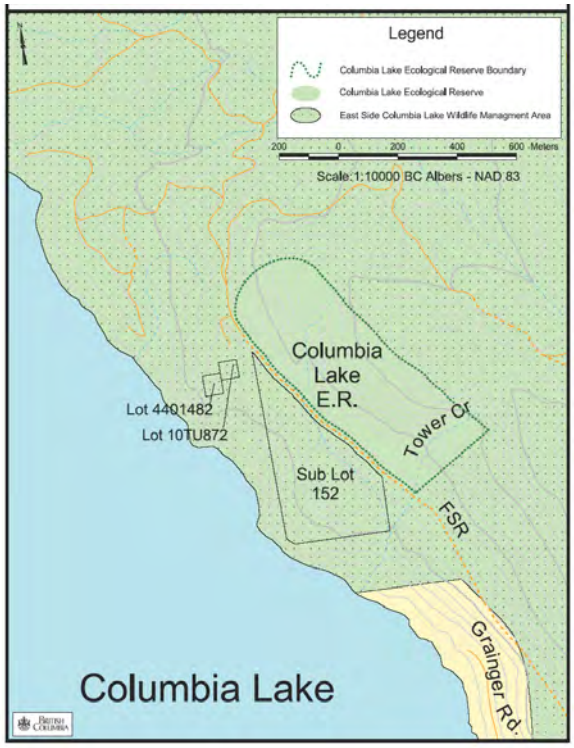


Figure 13. Location of Columbia Lake Ecological Reserve in relation to Columbia Lake.

3.2 Biophysical FIM Summary

In total, 43,292 m of foreshore were surveyed and divided into eight contiguous segments. The segments ranged in length from 755 m to 12881 m. GIS maps showing segment locations and key segment information are provided in Appendix A. The database of all physical findings is provided in Appendix C and detailed descriptions of segments are located in Appendix D. Natural vs. disturbed areas, land use, foreshore type, modifications along the foreshore and level of impact have been reviewed in detail in order to provide an inventory of the foreshore condition.

3.2.1 Land Use

Overall, results indicate that more than half (63% or 27,120 m) of the foreshore is in a natural condition and that 37% (16,172 m) has been disturbed (Table 3). The natural areas include lands located within the following areas:

- Columbia Lake Provincial Park (3,495 m in Segments 3,4);
- Wildlife Management Area (WMA = 20,122 m; Segments 2, 3, 4 and 8);
- Small Crown land areas between the lake and the railway on the west side of the lake (358 m, Segment 6); and,
- Substantial portions of the private/residential land located along the east side of the lake (approx. 3,198 m, Segments 1, 2 and 3).

The disturbed areas along the foreshore include those areas with the following land uses:

- Urban Parkland areas (890 m), including Canal Flats Provincial Park (Segment 1) and Columere Park (Segment 5);
- Some of the private residential areas including areas in the Canal Flats municipality (east side of lake) (656 m, Segment 1) and small pockets along the west side of the lake between the lake and the railway (358 m, Segment 6);
- Small portion of WMA (in Columere Park area – 53 m, Segment 5); and
- The railway (transportation) running the length of the west side of the lake (14,214 m, Segments 6, 7 and 8).

The land use types and extent for each segment are depicted in Figure 14 and the extent of disturbed and natural foreshore areas for each segment are provided in Figure 15.

Table 3. Columbia Lake shoreline condition (natural vs. disturbed) and land use summary.

Foreshore		Length (m)	% of total
Total Shoreline	Natural	27,120	63%
	Disturbed	16,172	37%
Land Use Summary	Private/Residential	4,212	10%
	Park (provincial)	3,495	8%
	Crown (non WMA)	358	1%
	Conservation (WMA)	20,122	46%
	Urban Parkland	890	2%
	Transportation	14,214	33%
Total Foreshore		43,292	100%

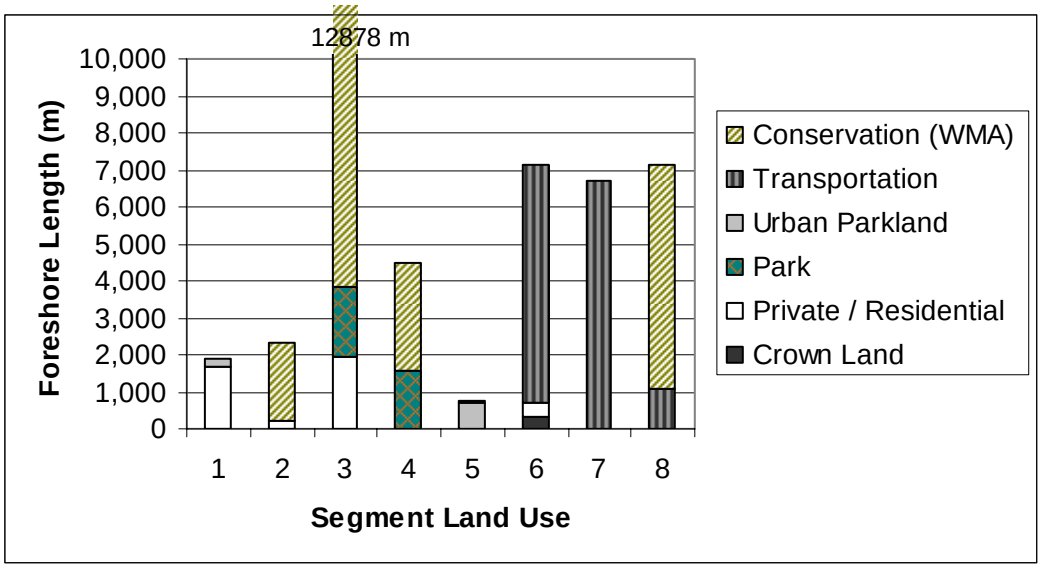


Figure 14. Land use type and extent for each segment

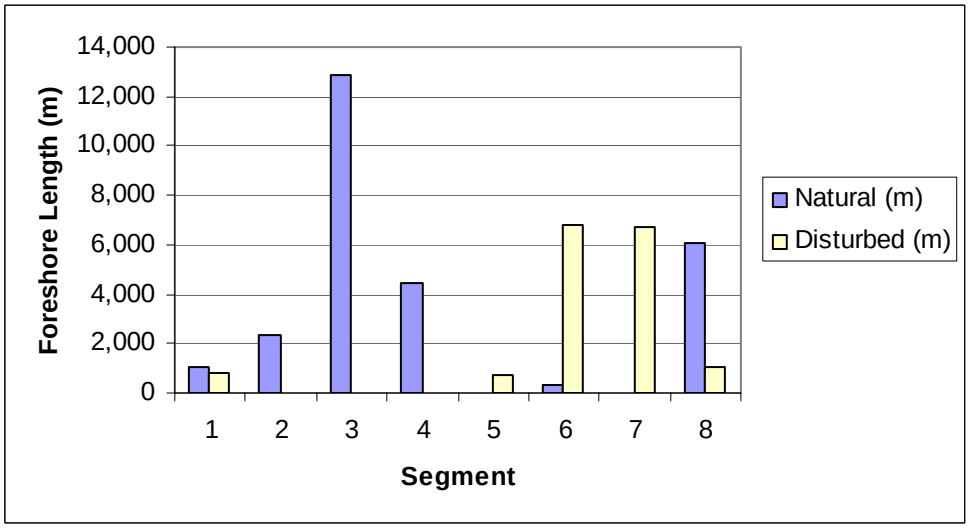


Figure 15. Extent (m) of natural and disturbed shoreline for each segment.

3.2.2 Shore Type

The foreshore of Columbia Lake is diverse consisting of gravel beach, wetland, cliff, bluff and stream mouth shore types. A breakdown of the length and overall percentage of each of these foreshore types along the perimeter of the lake is provided in Figure 16. The foreshore is mainly Gravel Beach Shore Type (19013 m or 43% of shoreline), which on the east side of the lake is typically backed by a well vegetated area, and on the west side of the lake is situated next to a railway with a bluff upland (Figure 17). Wetland and Bluff Shore Types also make up substantial lengths of the shore (12,273 and 9,457 m respectively), while Stream Mouth and Cliff Shore Types make up the smallest lengths of foreshore (1,733 m and 815 m respectively).

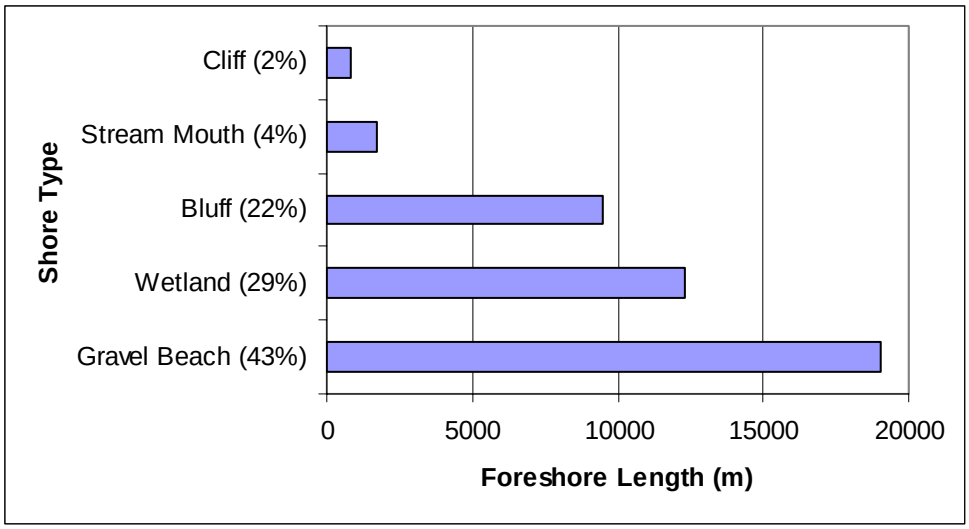


Figure 16. Total length (m) and percentage (%) of each Shore Type.

Figure 17. Gravel beach shore types - left photo shows beach backed by vegetated area along the eastern shore (Leschied Sept 2007) and the right shows railway and bluff features beyond (McPherson Mar 2009).

Figure 18 shows the extent of shore types within each segment. This figure indicates that there are some streams along the foreshore. Other than the Columbia River outlet in Segment 4, the Stream Mouth Shore Types are small creeks. Based on their outlet fan width, these creeks have been calculated to have an influence of approximately 75 m each respectively. The streams along the west side of the lake all flow under the railway through culverts (Segments 6 and 7, Figure 19). There are likely additional ephemeral streams not considered in this analysis. The streams considered here include (*See* Appendix A -GIS maps for locations):

- Segment 3 – Landsdown and Warspite Creeks;
- Segment 4 – Columbia River (lake outlet);
- Segment 6 – Hardie and Major Creeks;
- Segment 7 - Marion Creek; and
- Segment 8 – Unnamed Creek

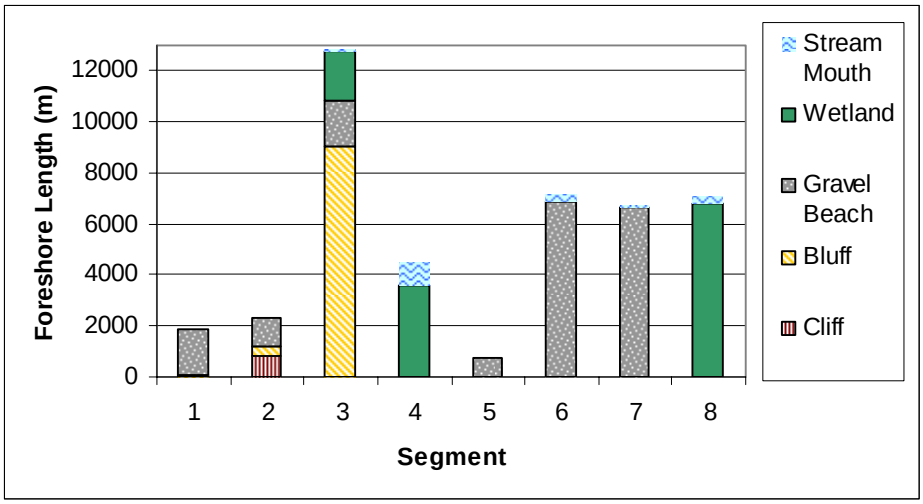


Figure 18. Shore Type extent (m) for each segment.

Figure 19. Marion Creek in Segment 7 entering lake through culvert under the railway. Photo: Porto Sept 2007.

Wetlands are an important Shore Type along Columbia Lake. There are extensive wetlands at the north and south ends of the lake (Segments 4 and 8 respectively) and some along the east shore in the low lying areas between the bluffs (Segment 3) (Figure 20). All of these wetlands are incorporated in the WMA. In Segment 3, wetlands were found along approximately 15% (or 1,932 m) of the shore. Wetlands comprised 80% (or 3,574 m) of Segment 4, and 95% (or 6,767 m) of Segment 8.

Figure 20. View of south end wetland and unnamed creek (left photo: Leschied June 2007), and wetland along eastern shore in Segment 3 (right photo: McPherson 2009).

The cliffs and bluffs were distinguished from one another in this investigation since they provide different habitats and influences along the shoreline (*See* Methods). There was only a small extent of Cliff Shore Type, which was identified in Segment 2 (Figure 21). Conversely, Bluff Shore Type extended along substantial lengths of Segment 3, as well as Segments 6 and 7 (in the upland area beyond the railway).

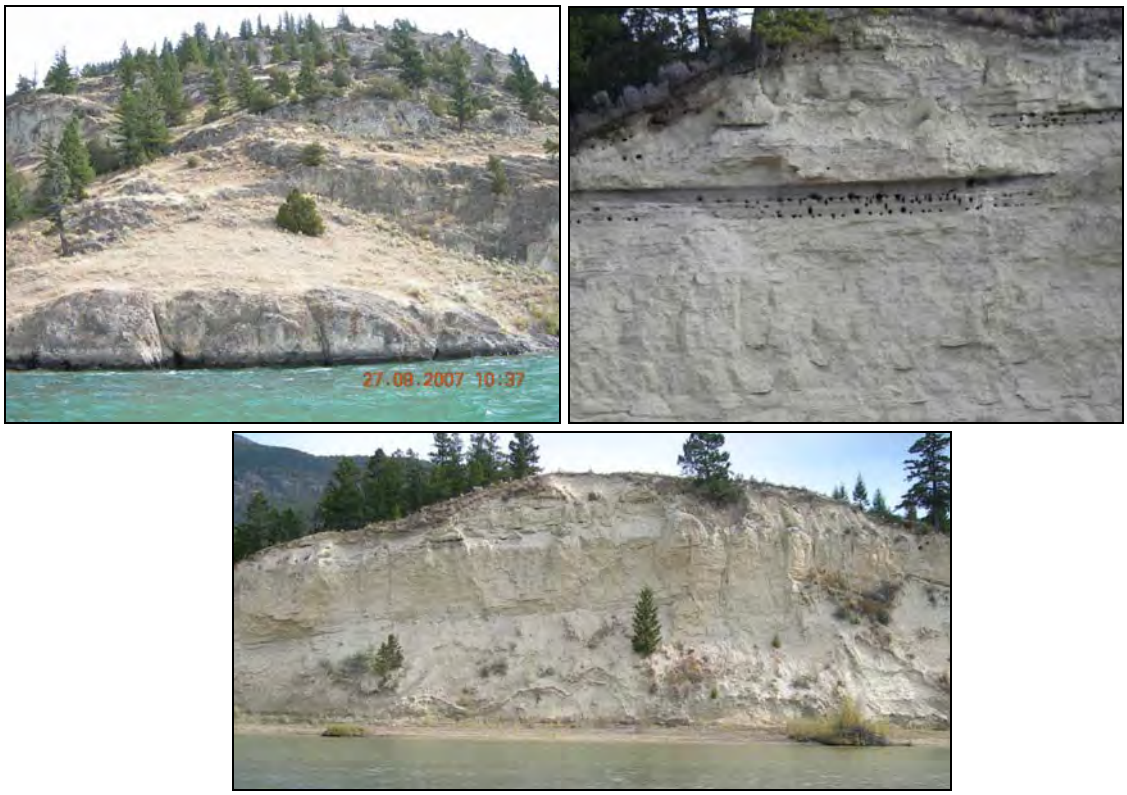


Figure 21. Cliff Shore Type with steep shoreline in Segment 2 (top left, photo: Porto Sept 2007); Bluff Shore Type with swallow nest sites in Segment 3 (top right, photo: McPherson Mar 2009); and Bluff Shore Type with beach in Segment 3 (bottom photo: Porto Sept 2007).

3.2.3 Emergent Aquatic Vegetation

Emergent aquatic vegetation (shallow-water wetlands) was common along the shallow-water habitats of the littoral zone (Figure 22). Our field investigations found the dominant emergent species to be bulrushes (Appendix E). Other species such as floating pondweed, rushes, sedges, grasses (including invasive reed canary grass) were also evident during 2009 site sampling. The emergent aquatic vegetation was mapped on the Foreshore Summary Maps (Appendix A). As Appendix E further reveals, submerged vegetation species were also identified during 2009 site investigations and included species such as coontail, potamogeton species (e.g., submerged pondweed) and charophytes. The percentage of submerged species coverage; however, was not determined during field investigations.

Figure 22. Bulrush above the ice along the shoreline of Segment 3. Photo: McPherson, Mar 2009.

Extent of shoreline with emergent aquatic vegetation is provided in Figure 23. The total lake foreshore with emergent aquatic vegetation was estimated to be 32,360 m (or 75% of the shoreline length). This represents a total area of approximately 300 ha. Segments 3, 4, and 6 and 8 had particularly high coverage (>80%).

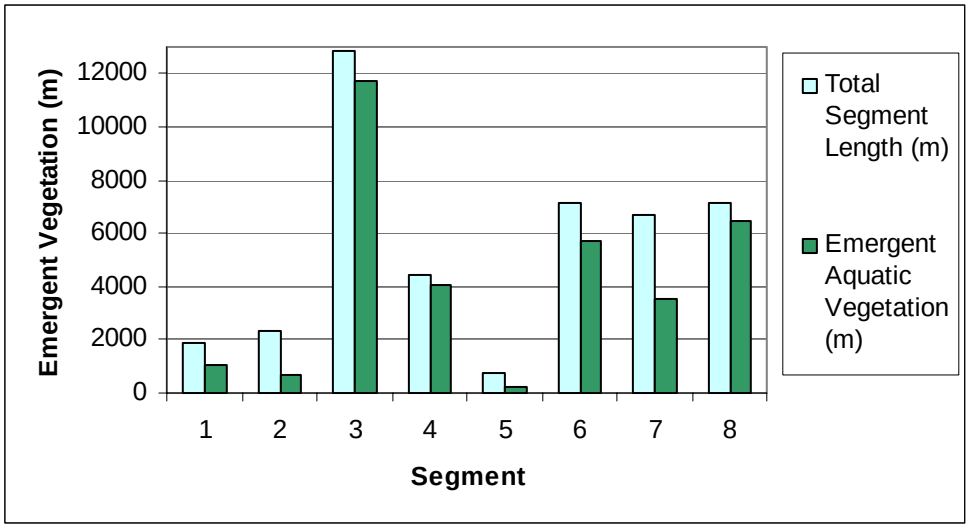


Figure 23. Segment length (m) with emergent aquatic vegetation.

Modifications to the foreshore (such as placement of docks, retaining walls or other structures) could have an impact on natural shoreline vegetation. In order to review potential impacts on the aquatic vegetation from these disturbances a comparison between percent foreshore with emergent vegetation and percent disturbed foreshore for each segment was conducted (Figure 24). From this data and field review observations, urban park and residential developments such as that found in Segment 1 (Canal Flats) and in Segment 5 (Columere) have resulted in a reduction of emergent aquatic vegetation, mostly through clearing for lake access. Most of the natural areas did have a high aquatic vegetation component (Segments 3, 4 and 8); however, some natural areas, such as Segment 2, did not have a high percentage of emergent aquatic vegetation. Physical conditions, such as the deeper shoreline along the cliff area may be a factor behind the lower percentage here. As well, there was variability along the western shoreline segments which were disturbed by the railway, with Segment 6 having a high level of aquatic vegetation (80%) and Segment 7 having less (55%).

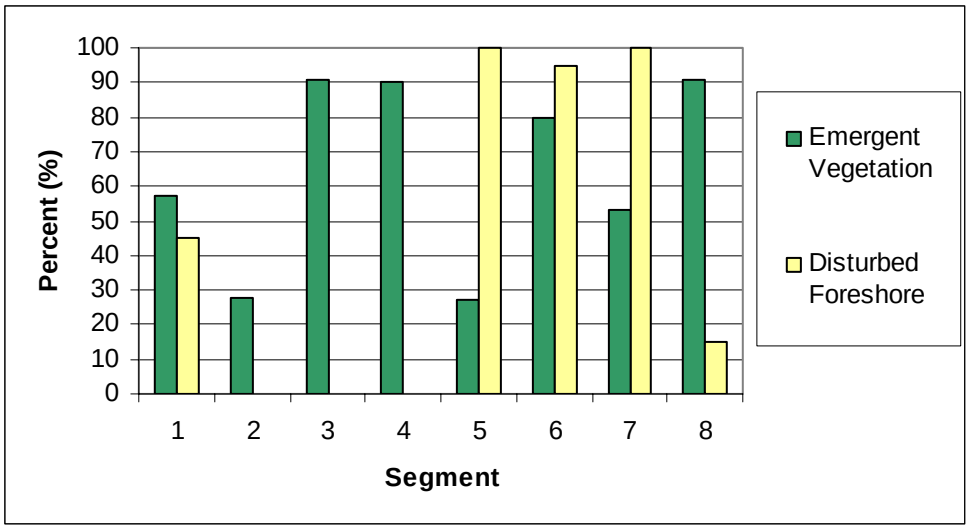


Figure 24. Comparison between percentage of foreshore with emergent aquatic vegetation and percentage of undisturbed land.

3.2.4 Riparian Vegetation

Riparian condition data reveals that generally anthropogenic developments and infrastructure have resulted in the disturbance of riparian vegetation. For instance, Segments 5 (Columere), and Segments 6 and 7 (railway) all had sparse (<5%) or no riparian coverage and had been disturbed (Figure 25). Meanwhile, Segments 3, 4 and 8 which were undisturbed and covered by the WMA or Columbia Lake Provincial Park, had abundant coverage (>20%) with mature species. Segment 1 in Canal Flats, also had abundant coverage with a mature forest; which was positive to see, given that it had experienced some private residential and urban park development (Figure 26). Since further development is likely in this segment, efforts should be taken to minimize or reverse riparian impacts.

Segment 2 had moderate mature forest coverage (5-20%) even though it had not been developed. This is likely a factor of the topography (cliff). However, abundantly vegetated riparian sections did exist in Segment 2 (Figure 26).

Although there were few riparian veteran trees or snags reported during the Sept. 2007 field review, a more detailed assessment may be required. It is worthy to note that the riparian data was collected during 2007 using standards of the time and that the current 2009 FIM standards have become more rigourous and detailed (Schleppe and Mason 2009). For instance, under the current (2009) standards, percent cover would be classified as: ‘Abundant’ if >50%, ‘Moderate’ between 10 and 50% and ‘Sparse’ if less than 10%.

Figure 25. Sparse or no riparian vegetation was evident along the railway, as evidenced by this photo of Segment 6. Photo: Leschied Sept 2007.

Figure 26: Development has impacted some of the riparian area along Segment 1, although it is rated as having a high shore cover (>20%) (Left); while, Segment 2 was reported to be moderately vegetated, although there were areas with dense mature riparian habitat (Right). Photos: McPherson, Mar 2009.

3.2.5 Foreshore Modifications

Columbia Lake shoreline modifications included: retaining walls, docks, groynes, boat launches and transportation infrastructure (i.e., railway and highway) (Figure 27). Riparian vegetation removal, discussed above, was another anthropogenic modification. No shoreline modifications were observed in Segments 2, 3 and 4 (along the east end). Modifications along the east side of the lake were concentrated in Segment 1 (Canal Flats) which had the highest number of docks (nine wooden docks) and groynes (two) around the lake. Potential habitat concerns would be the two retaining walls situated below the high water mark and the one constructed of pressure treated wood.

Along the west end of the lake, Segment 5 (Columere) had the greatest number of modifications, which included: a retaining wall (below high water mark), railway extending along 100% of shore, a dock and a groyne (Figure 29). Segment 5 also has a 78 slip marina. This marina is situated near the outlet of Dutch Creek and the WMA and within the vicinity of the withdrawal point for Columere's drinking water supply (RDEK 1997).The railway is the major modification along the remainder of the west side of the lake. The railway has limited residential and recreational development along the west shore to a large extent. If the railway is ever removed, consideration should be given to maintaining the area as a trail (e.g., similar to Cranbrook – Kimberley trail) to restrict development along the shore (Bisset pers comm.).

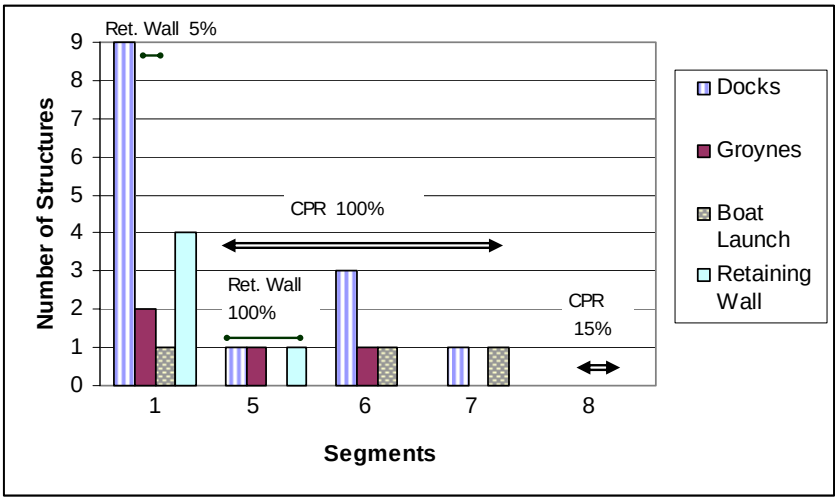


Figure 27. Segment modifications, depicted as numbers of structures, and percent of segment length (for CP Rail & retaining walls).

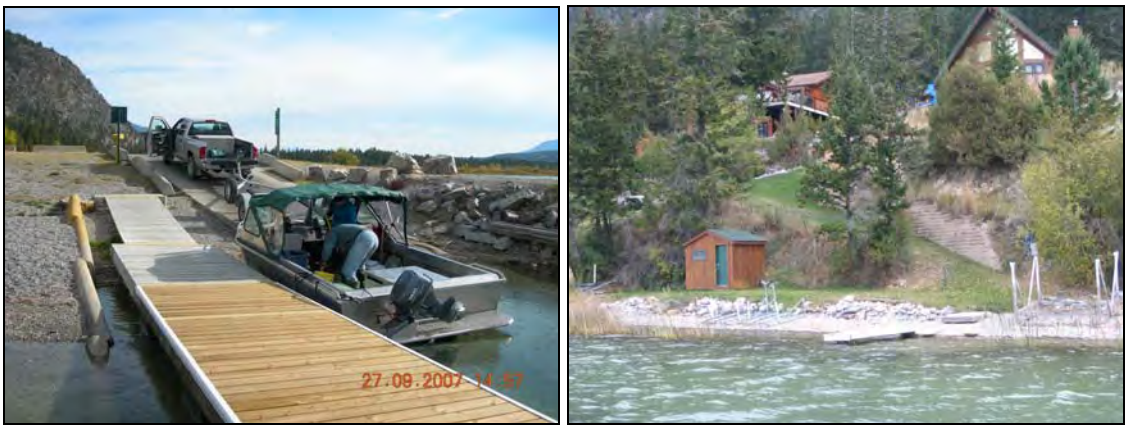


Figure 28. Segment 1 examples of modifications: left photo - boat launch with associated dock and groyne at Canal Flats Park (Porto Sept 2007), right photo: retaining wall, dock and vegetation removal (Leschied Sept 2007).

Figure 29. Shoreline modifications along Segment 5 (Columere) include retaining wall, riparian and aquatic vegetation removal and railway. Photo: Leschied Sept 2007.

Since docks were a prevalent modification, the number of docks per kilometer of shoreline was also determined. Results are as follows:

Segment 1 = 5.3 docks/km;
Segment 5 = 1.5 docks/km;
Segment 6 = 0.4 docks/km; and
Segment 7 = 0.1 docks/km.

Retaining walls were identified in Segment 1 (n=4) and Segment 5 (n=1) along Columbia Lake. Although few in numbers, there were concerns with the retaining walls including that the wall at Segment 5 extended along 100% of the segment and was below the high water mark. Two retaining walls in Segment 1 were also situated below the high water mark and one was constructed of pressure treated wood, which contains toxic substances.

Fish and fish habitat investigations in 2009 found that shoreline boat mooring anchors/chains in Segment 6 contributed to significant scouring of the substrates (+/- 2 m in some locations) (Figure 30). Chains should be eliminated and replaced with lines that float so no scouring occurs (B. MacDonald pers. comm.). There was also evidence of significant overnight mooring, which is illegal according to the Upper Columbia Valley Zoning (Section 1.2).

Figure 30. Boats anchored offshore along Segment 6 (Site 6.3), where cables and anchors noted to be scouring the substrate and vegetation. Photo: Holmes July 2009.

Additional foreshore modifications are anticipated in the future. At the north end of Segment 6 for example, the construction of a CPR berm is currently being planned. The slumping bluff is threatening the tracks and the plans are to build a ballast berm out into the lake to help support it.

3.2.6 Level of Impact (LoI)

Level of Impact (LoI) provides a qualitative indication of the overall health of the foreshore and considers the land use, level of disturbance, and modification information presented above. Generally a High LoI refers to a segment with >40% alteration along its shoreline, a Moderate LoI is between 10 and 40% alteration, and a Low LoI segment is mainly natural with <10% alteration. However, modification density and type, extent of grooming of aquatic vegetation and riparian impacts also play a role in determining LoI. Figure 31 provides a summary of the LoI ratings for Columbia Lake, and reveals that 34% (14,617 m) of the foreshore was determined to have a High LoI, 4% (1,877 m) had a moderate LoI, and 62% (26,797 m) had a low LoI.

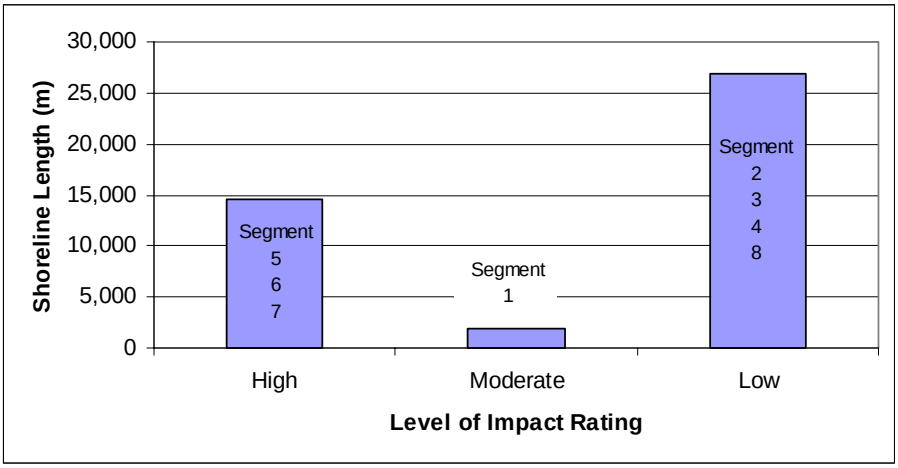


Figure 31. Segment level of impact (LoI) rating (High = >40%, Moderate = 10-40% and Low = <10%) and total shoreline length (m) attributed to each of the LoI ratings.

The Segments 5, 6, and 7 were rated as High LoI since they had been impacted along their full length. At Segment 5 the urban park, riparian and aquatic vegetation removal and the retaining wall all had greatly modified the shoreline characteristics. The fact that the substrates remained as natural gravels was beneficial. The railway running the extent of Segments 6 and 7 also had a high level of impact, particularly related to loss of riparian habitat and connectivity with the terrestrial bluffs.

Segment 1 was determined to have a Moderate LoI. This is because approximately half of the segment has been affected by urban park and residential development. The remaining intact areas could be under development pressure in the future and opportunities to minimize foreshore impacts should be considered.

The great extent of Low LoI shoreline (Segments 2, 3, 4 and 8), was largely attributed to the Crown land which has resulted in little development due to the WMA and protected area.

3.3 Fish Results

Fishing is popular on Columbia Lake year round, with mountain whitefish, burbot, kokanee, rainbow trout, bull trout and cutthroat trout being favoured sport fish (BC Parks 2007). The ecosystem in and around Columbia Lake is known to provide good to excellent habitat for a variety of fish species (RDEK 1997), including the following 15 native species and 2 non-native species (BC MoE 2008):

Native Species

- burbot *(Lota lota);*
- bull trout (*Salvelinus confluentus*);
- kokanee *(Oncorhynchus nerka);*
- longnose dace *(Rhinichthys cataractae);*
- largescale sucker *(Catastomus macrocheilus);*
- longnose sucker *(C. catastomus);*
- mountain whitefish *(Prosopium williamsoni);*
- northern pike minnow *(Ptychocheilus oregonensis);*
- peamouth chub *(Mylocheilus caurinus);*
- prickly sculpin *(Cottus asper);*
- torrent sculpin *(C. rhotheus);*
- redside shiner *(Richardsonius balteatus);*
- westslope cutthroat trout *(O. clarkii lewisi);*

Hatchery Production

- rainbow trout *(O. mykiss);*
- kokanee *(O. nerka);*

Non-Native Species

- largemouth bass (*Micropterus salmoides*); and
- pumpkinseed (*Lepomis gibbosus*)

Columbia Lake provides habitat for many life history stages, which depending on the fish species, include spawning, rearing, feeding, migration and overwintering. The lake outlet, gravel shoals along the shoreline, and in particular, the shallow south end provide suitable spawning habitat for many species (Entech 1978) as does Dutch Creek and the alluvial fan (Westover pers. comm.). Since the majority of streams on the east and west side only run intermittently, they are not known to provide good spawning habitat (Westover pers comm.).

The raw fish data and field notes from sampling on July 15 and September 15, 2009 are provided in Appendix E, and photo documentation for all sites is provided in Appendix D. The results of all sampling techniques employed (snorkel, seine, observations, and trap net) by season are provided in Table 4, and the relative abundance of each species using data from both days are in Table 5. From these qualitative results, redside shiners and cyprinids were found to be most prevalent, comprising 64% and 32% of the population respectively when the data from both days were combined. Cyprinids were dominant during the summer sampling (count 2108) and redside shiners were dominant during the fall sampling (count 4225). In the summer, Sites 1-1 and 2-1 had the most fish, with 48% and 44% of the seasonal sample respectively. In the fall, in addition to Sites 1-1 and 2-1, Sites 3-1 and 7-1 also had high numbers of fish; all with relative abundances of 22%. Overall, fish were prevalent where there was aquatic vegetation (B. MacDonald pers. obs.). The wetlands and shoreline areas with aquatic vegetation are particularly valuable to fish since they provide cover elements and are a source of primary production in the lake (invertebrates) (B. MacDonald pers. comm., Mitsch and Gosselink 2000).

Mountain whitefish were the only native sport fish sampled. Of the 89 mountain whitefish sampled, 77 were adults. Seventy one of the whitefish were observed at Site 3-2, situated along the shoreline of Lot 48, a site under development pressure.

Largemouth bass is a non-native species known to ‘wreak havoc’ with native fishes and their population growth, once they are introduced to a system (McPhail 2007). This species may have only entered the lake in recent years since they were not reported in the Fish Inventory Summary System (BC MoE 2008) or the 1992 fisheries assessment report (RL&L 1993).Adults are typically found around structures both natural (e.g., lily pads and large woody debris) and man-made (particularly docks) (Bisset pers. comm.). At Windermere Lake, adults were often found utilizing modified structures such as boats, docks and retaining walls, where they were observed guarding a territory (Porto pers comm.). Largemouth bass were not found to be as abundant at Columbia Lake (0.0% in the summer and 0.3% of fall population) as at the neighbouring Windermere Lake (represented 7% of the summer and 1% of the fall populations) (McPherson and Hlushak 2008). Columbia Lake had a much lower concentration of docks than Windermere Lake, which may account for the lower abundance. Overall, there were a total of 14 docks at Columbia Lake, which is equivalent to 0.0003 docks/km. Windermere Lake had 202 docks, representing 0.006 docks/km (McPherson and Hlushak 2008). The segment with the highest dock density at Columbia Lake was Segment 1 (total length 1877 m), which had 5.3 docks/km. Comparatively at Windermere Lake, the highest concentration of docks was 12 docks/km along the north east shore (Segments 20-26, total length 9017 m). Cooler water temperatures at Columbia may also be keeping largemouth bass populations lower (except for overwintering habitat due to presence of springs); however, this may change if the lake becomes warmer with time (Bisset pers. comm.).

Table 4. Fish numbers and calculated abundance using various survey techniques on July 15 and September 15 2009*

SUMMER

Site Technique (survey length)	**1-1** snorkel (200m)	**2-1** snorkel (1x175m)	**3-1** seine (1x15m) & from boat	**3-2** seine (2x15m)	**3-4** trap net (15 m)	**5-1** seine (1x15m)	**5-2** snorkel (100m)	**6-1** seine (2x15m)	**6-2** seine (2x15m)	**6-3** snorkel (100m)	**7-1** snorkel (100m)	**Total**
sucker	6	2	2								6	**16**
cyprinid	1000	1000	8						100			**2108**
redside shiner	100			9			10		2			**121**
northern pikeminnow		2					10				2	**14**
sculpin			1					1				**2**
mountain whitefish			3	9		7			2			**21**
pumpkinseed sunfish							1					**1**
unidentified	1		6									**7**
Totals	1107	1004	20	18	0	7	21	1	104	0	8	**2290 fish**
Relative abundance (%)	48.3	43.8	0.9	0.8	0.0	0.3	0.9	0.0	4.5	0.0	0.3	

FALL

Site Technique (survey length)	**1-1** snorkel (100m)	**1-2** snorkel (120m)	**2-1** snorkel (250m)	**3-1** seine (2x20m)	**3-2** seine (50m) & obs. from boat	**3-3** from boat	**5-1** seine (30m)	**5-2** snorkel (150m) & gee trap	**6-1** seine (1x15 m)	**6-2** seine (2x15m)	**6-3** snorkel (200m)	**7-1** snorkel (150 m)	**Total**
sucker	1	10	3		10	4						5	**33**
cyprinid									46	40			**86**
redside shiner	1000	1000	1000	7	15		3	100			100	1000	**4225**
northern pikeminnow			3					2				1	**6**
sculpin		1			1								**2**
mountain whitefish					62		4			2			**70**
pumpkinseed sunfish								24			20		**44**
largemouth bass		12		3							1		**16**
unidentified								1				3	**4**
Totals	1001	1023	1006	10	88	4	7	127	46	42	121	1009	**4484 fish**
Relative abundance (%)	22.3	22.8	22.4	0.2	2.0	0.1	0.2	2.8	1	0.9	2.7	22.5	

*Note: data includes both juvenile and adult of the same species. Data that included '+' signs were rounded to a whole number so that relative abundance calculations could be completed (i.e., 100+ fish was recorded as 100 fish)

Table 5. Relative abundance (%) of fish species sampled on July 15 and September 15, 2009 along the Columbia Lake foreshore.

Species	Relative Abundance (%)
sucker	0.7
cyprinid	32.4
redside shiner	64.2
northern pikeminnow	0.3
sculpin	0.1
mountain whitefish	1.3
pumpkinseed sunfish	0.7
largemouth bass	0.2
unidentified	0.2

In comparison, in 1992 RL&L used gill nets, setlines and minnow traps and captured 415 fish (RL&L 1993). Results from the RL&L study found peamouth chub to be most prevalent (36%), followed by northern pikeminnow (30%), mountain whitefish (18%) and largescale sucker (6%). The remaining species captured contributed less than 5% each and included burbot, rainbow trout, bull trout, kokanee, pumpkinseed (sunfish), longnose sucker and redside shiner. The variations, between our results and those of RL&L are likely largely attributed to sampling location, where RL&L sampled offshore and our sampling was along the shoreline. Nonetheless, RL&L's findings help augment our understanding of fish use in the lake.

Burbot

Burbot has experienced significant declines in the Columbia System including Columbia Lake (Paragamian *et al.* 2000). As a result of these declines, burbot are considered a species of regional concern in the Columbia River System (McPhail 2007) and several studies have been completed on understanding burbot biology in Columbia Lake. Known habitat use in the lake has been detailed since it was used for determination of sensitive spawning and rearing areas in the AHI analysis (2.3.4.2 - Zones of Sensitivity).

Spawning

Burbot are known to spawn in the winter (late January though February) in the Columbia Lake basin. Spawning occurs in relatively shallow water (1-10 m) over sand or gravel bottoms (McPhail 2007). The unnamed spring-fed tributary at the south end of the lake is believed to be one of the more important spawning areas for burbot in the lake (Arndt and Hutchinson 2000). This site was monitored between 1996 and 1999 and 2001 and 2002 with the highest number of spawning burbot counted in 1997 (1,487 fish) (Arndt and Hutchinson 2000, Arndt 2002).

There are additional spawning locations under the ice in the lake itself at the north end, as evidenced by the presence of gravid and recently spent fish (Arndt 2001). Recapture of tagged fish has indicated that burbot change spawning locations year to year (Arndt 2001). A sidechannel along the alluvial fan of Dutch Creek is also a historical burbot spawning area (Arndt 2002, Taylor 2001). Spring freshet gravel deposits in front of the side channel flowing into Columbia Lake where burbot spawning used to take place, have almost completely blocked it off under low flow conditions (Taylor 2001). Although no burbot appear to be spawning on this historical site, a few burbot fry were sampled in the lower reaches of Dutch Creek in 1997 (Baxter 1998), suggesting that some spawning may be occurring in the area or that fry move into the stream from the lake (Taylor 2001).

Because of the known burbot spawning habitat, the wetlands at the north and south end of the lake (Segments 4 and 8) have been identified as important spawning areas in the AHI analysis.

Juvenile Rearing

Taylor (2001) assessed juvenile burbot habitat use at Columbia Lake. He found that juveniles were strongly associated with the bottom and microhabitats providing cover, particularly the interstitial spaces in the substrate. Sites with intermediate sized substrate (gravel and cobble) had mostly age

0 burbot. Shelter size increased with increasing body size, with older juveniles associated with cobbles and boulders (substrate sizes are defined in Table 6). Extensively branching aquatic vegetation, such as bushy pondweed (*Najas flexis*) and undercut banks were also utilized (Taylor 2001).

Table 6. Size ranges for substrates measured in Taylor (2001) habitat use survey.

Category	Size Range
Fines	< =2 mm
Gravel	>2 mm to 64 mm
Cobble	>64 mm to 256 mm
Boulder	>256 mm

Maximum juvenile burbot size in shoreline habitats of Columbia Lake ranged from 39 cm (Taylor 2001) to 50 cm (in as little as 1 m water depth) (Bisset *et. al.* 2002*).* A shortage of large crevices might cause offshore movement of larger juveniles, where they may experience increased predation risks (Taylor 2001). As this 2009 F&W assessment and Taylor (2002) found, other than in the northern and southern wetlands, Columbia Lake tends to have a seam of coarse substrates (gravels, cobbles, boulders) along the foreshore. Substrate size generally decreases with increasing depth. Under high water conditions, coarse substrates are prevalent. Under low lake levels (fall to early spring), there is an increase in the percent composition of fines, and much of the complex shoreline habitat is above water. This elevates the potential for a bottleneck for particularly larger juvenile burbot (Taylor 2002). Taylor (pers comm.) provided the following details which were used to specify optimal rearing locations around the lake in the AHI analysis.

> *Young of the year burbot habitat (gravel and cobble) was found in varying proportions along most of the western shoreline and at the north and south ends of the eastern shoreline. Age 1 and older juvenile habitat (larger cobble and boulders) occurred less frequently and was thus likely more limiting. This habitat was found at a few areas along the western and southeastern shore, and at constructed rubble breakwaters. Along the lake's north and south shorelines and most of the eastern shoreline, sand and silt sized substrates were dominant and juvenile burbot occurred at lower densities, being mainly associated with occasional undercut banks or constructed jetties. Except at the south eastern corner of the lake, where rocky bluffs occur, most of the rocky substrate in which burbot occurred appeared to have been placed in the lake for construction of either the railway (i.e., the western shore) or breakwaters/jetties.*

Kokanee Migration Corridor

Kokanee are not native to the Columbia River basin above the Mica Dam (Oliver pers. comm.). This species has been established in the upper basin and is important to the sport fishery. BC MoE has identified spawning areas as critical habitat and spawning channels as extremely important in the Rocky Mountain (Cranbrook) Forest District (Chirico 2005).

Dutch Creek represents the uppermost distribution of kokanee in the Upper Columbia drainage. Enumeration of spawners was conducted in Dutch Creek between the years of 1996 and 2005 and was summarized by Manson (2006). Total numbers of fish estimated at Dutch Creek ranged from 185 (2004) to 27,660 (2001), with the most recent 2005 data estimating 5,500 fish. Kokanee were observed as far as 8 km up the creek, but the highest concentration of spawners was between the CPR trestle bridge and the Highway 95 crossing (Oliver 1995). Upon emergence, kokanee fry move through Columbia Lake's north end wetland to the Columbia River where they make their downstream migration to the Kinbasket Reservoir, to reside as juveniles and adults (Oliver pers. comm.). For the AHI analysis in this study, Segment 4 was thus considered a ZOS since it is an important migratory corridor during the sensitive life history spawning and post-hatch periods.

3.4 Invertebrate Results

Invertebrates are important to the lake's trophic system since they provide one of the first and key links in the food chain for many animals (Mitsch and Gosselink 2000). Field data from invertebrate sampling and Simpson's Index of Diversity Analysis for the data are provided in Appendix F (Tables I and II). The results of the Simpson's Index of Diversity are summarized in Table 7. This analysis accounts for the richness and evenness of the samples collected at each site and measures the probability that two individuals randomly selected from a sample will belong to different species. The value of this index ranges between 0 and 1, with 0 representing no diversity and 1 representing infinite diversity.

The 2009 Columbia Lake invertebrate sampling results indicate that highest diversity was at Site 3.1 (0.85) and the 6.2 (0.69) and that the lowest diversity was at Site 3.2 (0.44). Sites 5.1 and 6.1 had intermediate values with diversity values of 0.63 and 0.57 respectively. For each invertebrate sampling site, Table 7 also summarizes habitat characteristics. The apparent qualities of the two sites with the highest diversity were that they had a mix of emergent and submergent aquatic vegetation species. The site with the lowest diversity had a high fine substrate (95 % sand/silt) component.

Table 7. Simpson's Index of Diversity results and substrate and aquatic vegetation characteristics of the site.

Site	3.1	3.2	5.1	6.1	6.2
Simpson's Index of Diversity (1-D)	0.85	0.44	0.63	0.57	0.69
Substrate Composition	75% silt, 20% gravel/cobble, 5% boulder	95% sand/silt, 10% gravel	30% sand/silt, 50% gravel, 15% cobble, 5% boulder,	10% silt, 40% gravel, 40% cobble, 10% boulder,	30% silt, 70% gravel
Aquatic Vegetation	Rushes, charophytes, *potamogeton* spp (e.g., stuckenia)	Hardstem rush and arrowgrass	none	none	*Potamogeton* spp. (Richardson's pondweed, floating pondweed and stuckenia)
Disturbance Indicators	none	none	Marina, manicured vegetation and beach.	Riparian disturbed by presence of railway	Riparian disturbed by presence of railway

3.5 Wildlife Results

Wildlife field notes from 2009 site investigations are provided in Appendix G.

3.5.1 Sensitive Plant Species

The BC CDC sensitive species listing (Table 8) for the IDFxk zone indicates that there are three vascular plant species potentially occurring in the Columbia Lake area that are considered sensitive. All of these species are provincially blue-listed meaning that they are sensitive to disturbance. These species are also provincially designated as imperiled (S2) or vulnerable (S3) (BC CDC 2009). Habitat information and occurrence data for each of these species is provided below and has been obtained from the E – Flora BC (Atlas of Plants of BC, Klinkenberg 2008) and the BC Species and Ecosystems Explorer (BC CDC 2009).

Table 8 Vascular plant species at risk that occur in the Columbia Lake area (Interior Douglas Fir –very dry cool Biogeoclimatic Zone (IDFxk) (Source: BC CDC 2009).

Scientific name	Common name	Habitat Type	Global Rank[1]	Prov Rank[1]	BC CDC[2]	Conservation Goals[3]		
						Goal 1	Goal 2	Goal 3
Calamagrostis montanensis	plains reedgrass	Terrestrial	G5	S3	Blue	6	4	4
Carex lenticularis var. *dolia*	Enander's sedge	Lacustrine Palustrine Riverine Terrestrial terrestrial	G5	S2S3	Blue	3	6	3
Pellaea gastonyi	Gastony's cliff-brake		G2G3	S2S3	Blue	2	6	3

Column acronyms: BC CDC: British Columbia Conservation Data Centre (provincial); IWMS: Identified Wildlife Management Strategy (under BC *Forests and Range Practices Act*); COSEWIC: Committee on the Status of Endangered Wildlife in Canada (federal); SARA: *Species at Risk Act* (federal).

[1] Rank codes: **G = Global** rank; **S = Sub-national** (provincial/state) rank; 1= **Critically Imperiled**—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors. **2 = Imperiled**—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors; **3 = Vulnerable**—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors; **4 = Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.; **5 = Secure**—Common; widespread and abundant; **H = extirpated**—considered no longer in British Columbia. **NR = not ranked.** A **numeric range rank** (e.g., S3S4) is used to indicate the range of uncertainty in the status of a species; **Q = questionable taxonomy**—taxonomic existence is uncertain. Source: NatureServe (2008).

[2] **Red-listed** species and ecological communities are considered to be extirpated, endangered or threatened (at risk of becoming endangered) in British Columbia. **Blue-listed** species and ecological communities are considered "particularly sensitive to human activities or natural events". Neither listing provides any legal protection to the animals or their habitat.

[3] Conservation Framework Goals (available: http://www.env.gov.bc.ca/conservationframework/index.html):
Goal 1 Contribute to global efforts for species and ecosystem conservation
Goal 2 Prevent species and ecosystems from becoming at risk
Goal 3 Maintain the diversity of native species and ecosystems

Plains reedgrass (*Calamagrostis montanensis)*

This species occurs on dry slopes and open forests in the steppe and montane zones. It has specifically been located at Radium Hot Springs, south of the highway viewpoint. It was documented on the lacustrine silt terrace in almost pure *Stipa curtiseta* stands; and on the gentle west slopes at the edge of the lacustrine terrace, on the eroding silt face of a very steep drop-off.

Enander's sedge (*Carex lenticularis* var. *dolia)*

This species is known to occur in marshes and wet meadows in the lowland zone (var. *limnophila*), streamsides and ponds in the subalpine and alpine zones (var. *dolia*), wet meadows, sandy beaches and marsh edges in the lowland zone (var. *lenticularis*), and bogs and wet sites in all but the alpine zone (var. *lipocarpa*). It has been documented at Fairmont Hot Springs around the hotsprings pool on 1% old travertine slope (west aspect) with active seepage, dominated by *Muhlenbergia asperifolia* and *Eleocharis rostellata*, with *Epipactis gigantea* and *Lobelia dortmanna*. It was also found in sparsely vegetated, drier areas adjacent to hot pool seepage with *Muhlenbergia andina*. It occurs in a few patches with several heads, likely 10 plants over 2 square meters.

Gastony's cliff-brake

This plant is known to inhabit dry calcareous cliffs and crevices in the montane and subalpine zones (Douglas *et al.* 2000) and not necessarily a riparian species. At Columbia Lake it is known from Columbia Lake Provincial Park, Armstrong Bay, and Columbia Lake Ecological Reserve.

3.5.2 Sensitive Wildlife Species

We identified 22 sensitive species potentially inhabiting the area (Table 9) including, insects (2 species), gastropods (2), fish (2), amphibians (2), reptiles (2), birds (9) and mammals (3). Following are detailed descriptions about most of these species with notes specific to Columbia Lake. Other species that are not necessarily formally listed as at risk, but sensitive to foreshore development and disturbance and/or key components of foreshore habitats of Columbia Lake are also discussed.

Pronghorn Clubtail, *Gomphus graslinellus*

Proghorn clubtails are dragonflies closely associated with foreshore habitats. The larvae burrow in sand and silt of wave-washed shores, and then metamorphose slightly back from the water's edge. Adults often bask on beaches and clearings near water. Their recorded flight dates (when adults are present) range from 3 June to 20 July (Cannings *et al.* 2000). For management considerations, Cannings *et al.* (2000) note that "Marina developments, pollution from power boats and popular swimming beaches all have potential impact on larval survival."

They are only known in the Kootenays from Wasa Lake (Cannings *et al.* 2000) and Kikomun Creek Provincial Park (D. Nicholson pers. comm.). Initially, red-listed, it was down-listed to be blue-listed when additional occurrences were found throughout the Okanagan. Although not known from Columbia Lake, suitable habitat is found at Columbia and wide-spread inventory for the species has not been conducted.

Vivid Dancer, *Argia vivida*

Vivid dancers are bright blue and black damselflies with a close association with spring-fed pools and hot springs. They are known from nearby Fairmont Hot Springs, as well as other hot springs and other sites in the Kootenays (Cannings *et al.* 2000). Their presence is taken to be an indicator of spring-sourced water (Ramsay and Cannings 2000). They are not known from Columbia Lake but evidence of spring-sourced water at Columbia, particularly at the south end of the lake, suggests that they could occur there. Management considerations require protection of the spring water quality and ensuring that "vegetation and especially flow of water are not significantly disturbed" (Cannings *et al.* 2000).

Pale Jumping-Slug, *Hemphillia camelus*

A large, pale brown slug that "found in dry to moist coniferous forests where it lives on and around mossy stumps, rocks and logs; also in leaf litter" (BC CDC 2009). The species is not necessarily associated with riparian areas, but could be found in moist conditions close to the shoreline, particularly in Armstrong Bay where wetter conditions are found. Pale jumping-slugs are known from Dutch Creek near Whitetail Lake in or under decayed logs in old-growth or second growth forest (Ovaska and Sopuck 2007).

Glossy Valvata, *Valvata humeralis*

This fresh water snail was collected once from Columbia Lake in 1883 (BC CDC 2009). The BC CDC considers it as "possibly extirpated". Though limited, if any, search effort targeting the species has been extended. A 2007 survey of freshwater mussels in the area included one sampling site at Columbia Lake, but snails were not target species (Moore and Machial 2007). The NatureServe (2009) account for the species notes debate surrounding the species taxonomy and that some authorities consider *V. humeralis* to be a "Mexican endemic with US populations". The 1883 Columbia Lake record is the only Canadian record and was quite possibly misidentified.

Amphibians

No provincially listed amphibians occur in the Columbia Lake area. Western Toad (*Bufo boreas*) is listed as a Species of Concern by COSEWIC, but its status in BC is uncertain (Ohanjanian *et al*. 2006). However, significant global declines in amphibians (Houlahan *et al.* 2000 and others) suggests that a cautious approach to their management is warranted.

At some point in their life cycle, all amphibians require a reliable water source and disturbance to foreshore communities can affect amphibians (Woodford and Meyer 2003). Typical amphibian

habitat includes smaller wetlands and ponds, rather than large open-water lakes such as Columbia Lake. However, more protected areas at the north and south end of the lake, and possibly Armstrong Bay are capable of supporting breeding amphibian populations. Most species require at least a moist environment for much of their lifespan and are incapable of surviving in hot, dry environments. As such, the predominantly dry upland forests and grasslands around Columbia Lake are not particularly hospitable to amphibians.

An amphibian survey of the East Kootenay (Ohanjanian *et al.* 2006) did not sample Columbia Lake itself, but did search Duckfoot Lake and pothole just to the west. Only Columbia spotted frog (*Rana luteiventris*) was found there. Amphibians that may utilize protected wetland areas at the north and south end of Columbia Lake include: Columbia spotted frog; western toad; and long-toed salamander (*Ambystoma macrodactylum*). Pacific tree frog (*Pseudacris regilla*), which prefers smaller, often ephemeral ponds, occurs further south in the Rocky Mountain Trench and may be found at Columbia Lake (BC Frogwatch 2009). Red-listed and federally endangered northern leopard frogs (*Rana pipiens*) are historically known from the Columbia River system (COSEWIC 2000), but are currently only known from Creston, BC and Bummer's Flats, 60 km to the south. There are no current plans for future re-introductions of Leopard Frogs (Adama and Beaucher 2006).

Western Painted Turtle, *Chrysemys picta*

Painted turtles inhabit shallows of lakes and ponds with muddy substrate and abundant aquatic plants. Available basking sites are important as are nearby sandy, open sites suitable for nesting (BC Reptiles 2008). Turtles are found as far north as Golden in the East Kootenay (BC Reptiles 2008; Ferguson 2004) and are commonly seen around the Invermere area including Dorothy Lake and numerous ponds in the Columbia wetlands. At Columbia Lake, painted turtles are known from the small section of Columbia Lake in the southwest corner, isolated from the main lake by a CPR railway berm (I. Adams pers. obs.). Turtles are known from the Columbia River between Columbia Lake and Lake Windermere (L. Halverson pers. comm.) but have not been confirmed in the wetland complex at the north end or in Columbia Lake Provincial Park (BC Parks 2004a), however they likely do occur where suitable habitat is available.

Protecting wetland habitats and directing roadways away from potential nesting sites are important management features for this species (Ovaska *et al*. 2004). Maintaining populations in sites where they currently are found is important and turtles have limited dispersal capabilities. The turtle habitat in the south end wetland (Segment 8) has contributed to the ZOS value in the AHI analysis (Section 2.3.4.2 Zones of Sensitivity).

Table 9. Lacustrine and palustrine associated animal species at risk that known to, or may occur in the Columbia Lake area (Source: BC CDC 2009).

Common name	Global Rank[1]	Prov Rank[1]	BC CDC[1]	Conservation Goals[1]			IWMS	COSEWIC	SARA Schedule[4]
				Goal 1	Goal 2	Goal 3			
Odonates (dragonflies and damselflies)									
Pronghorn Clubtail	G5	S2S3	Blue	6	6	2		not assessed	na
Vivid Dancer	G5	S2	Red	6	6	2		not assessed	na
Gastropods (slugs, snails)									
Pale Jumping-slug	G3G4	S3	Blue	4	4	4		not assessed	na
Glossy Valvata	G5Q	SH	Red	6	6	1		not assessed	na
Fish									
Westslope Cutthroat Trout	G5	S2S3	Blue	2	2	3	✓	Special Concern	Sched. 1
Bull Trout	G5	S2	Blue	2	2	3	✓	not assessed	na
Amphibians									
Western Toad	G4	S4	Yellow	3	2	4		Special Concern	Sched. 1
Leopard Frog (extirpated)	G5	S1	Red	4	6	1	✓	Endangered	Sched. 1
Reptiles									
Painted Turtle	G5	S2S3	Blue	6	2	3		Special Concern	Sched. 1
Rubber Boa	G5	S4	Yellow	5	3	4		Special Concern	Sched. 1
Birds									
Western Grebe	G5	S1S2	Red	6	6	1		not assessed[2]	na
Horned Grebe	G5	S4B	Yellow	4	4	5		Special Concern	not listed
Great Blue Heron	G5	S3S4	Blue	6	2	3		not assessed	na
American Bittern	G4	S3	Blue	5	2	3		not assessed	na
American White Pelican	G3	S1	Red	4	6	1	✓	Not at risk	na
American Avocet	G5	S2	Red	4	6	2		not assessed	na
Common Nighthawk	G5	S4	Yellow	6	2	4		Threatened	Sched. 1
Lewis' Woodpecker	G4	S2	Red	3	6	2	✓	Special Concern	Sched. 1
Barn Swallow	G5	S3S4	Blue	6	2	3		April, 2011[3]	na
Mammals									
Townsend's Big-eared Bat	G4	S3	Blue	5	2	3		not assessed	na
Badger	G5	S1	Red	6	6	1	✓	Endangered	Sched. 1
Bighorn Sheep	G4	S2S3	Blue	4	6	3	✓	Not assessed	na

[1] For codes and column acronyms, *see* Table 8
[2] Western Grebe is on COSEWIC's priority 1 list for status assessment (no timeline for when it will be assessed).
[3] A COSEWIC status report for Barn Swallow is in preparation; Assessment is scheduled for April 2011.
[4] Schedule 1 is the "official" species at risk list approved by federal cabinet under the SARA.

Western Grebe, *Aechmophorus occidentalis*

Western Grebes are large waterfowl which migrate through the East Kootenay, primarily in May and October (Ferguson and Halverson 1997). They are colonial nesters, with colonies near Creston and Salmon Arm. In migration they can form very large flocks (over 1000 individuals on Columbia and Windermere Lakes [Ferguson 2004]) and regularly stage on lakes to rest and feed for several days before moving on. While staging, they feed on small fish and aquatic invertebrates, while generally avoiding areas with human activity (Burger 1997). Western Grebes are known to stage on Columbia Lake for up to a week and may be found foraging close to shore especially in areas with emergent vegetation. Western grebe diet is predominantly small fish, but also includes aquatic insects and crustaceans (Burger 1997).

Great Blue Heron, *Ardea herodias herodias*

Herons are regularly observed foraging along Columbia Lake shorelines and in sloughs and wetlands in the area. The north end of the lake is particularly important because of its proximity to an active nesting colony situated in the Dutch Creek fan. This is one of the most productive and successful colonies in the East Kootenay, though under pressure from Bald Eagle predation (Machmer 2008).

Herons stalk prey in shallow waters with abundant small fish (Butler 1992). Maintaining the integrity and wetland characteristics of foraging areas that are close to nest colonies is especially important (Machmer and Steeger 2003). Management actions that ensure prey availability are therefore essential. For these reasons, the wetland segment at the north end of the lake has contributed to the ZOS value in the AHI analysis (Section 2.3.4.2 Zones of Sensitivity).

American Bittern, (*Botaurus lentiginosus*)

Bitterns are highly secretive birds that inhabit marshes with dense emergent vegetation. Individuals and their nests are very difficult to locate, but their presence is readily detected by a distinctive “pumping” call. They require wetlands with water shallow enough for them to stand in (<10 cm deep) and are thought to be highly sensitive to water fluctuations, and human disturbance (Gibbs *et. al.* 1992).

Bitterns have been historically recorded at the south end of Columbia Lake (Cooper and Beauchesne 2003; Campbell *et al.* 1990a), but no bitterns were recorded at twelve call stations in 2003 (Cooper and Beauchesne 2003). They were detected at wetlands west of Columbia Lake at Lavington Flats and Bear Lake during that year. A bittern was heard calling in 2009 on the Lot 48 shoreline of Columbia Lake (R. Hopkins pers. comm.).

American White Pelican, *Pelecanus erythrorhynchos*

The American White Pelican is one of only four species formally listed as Endangered under the provincial *Wildlife Amendment Act*, and subject to protections under this legislation. In the East Kootenay, the pelican is an occasional migrant, staging on lakes and sloughs in late April to early May. The only known breeding colony in BC is at Stum Lake in the Fraser Plateau (BC CDC 2008). There are numerous colonies on lakes in the prairies and aspen parklands east of the Rocky Mountains. Pelicans are considered as ‘occasional’ in the Upper Columbia (Ferguson and Halverson 1997) with irregular and infrequent occurrences on lakes and larger wetlands, including Columbia (Ferguson 2004).

Swallows

Several species of swallow are known in the Columbia Lake area (Table 10; Campbell *et al.* 1997). The silt bluffs common to much of Columbia Lake shoreline are ideal for supporting burrowing swallow nests, other species are secondary tree cavity nesters. Lacustrine and palustrine habitats are an important aspect to swallow ecology, as they regularly forage over water, hunting aerial insects which hatch from aquatic larvae.

Only Barn Swallows are provincially blue listed (BC CDC 2009). However, most swallows have suffered major declines across North America. For example, Bank Swallows have had statistically significant annual declines of 7.5% from 1986 – 2006 in Canada, based on breeding bird survey data (McCracken 2008).

Figure 32. Swallow burrow nests in silt bluff on north shore of Columbia Lake at Columere.

Table 10. Swallow species known or likely to occur at Columbia Lake, BC, the type of nest each constructs and characteristics of breeding colony. Source: Campbell *et al.* (1997).

Swallow species	Nest type
Barn, *Hirundo rustica*	Open cup mud nest usually built on human structures
Cliff, *H. pyrrhonota*	Enclosed mud nest on cliff faces or human structures
Bank, *Riparia riparia*	Excavates burrows in bank / cliff faces of silt, clay or sand with very specific soil stability requirements.
Tree, *Tachycineta bicolor*	Cavity nester – trees, cavities, crevices, rarely on vertical faces
Violet-Green, *T. thalassina*	Primarily cavity nester, occasionally on cliffs; highly adaptable
Northern Rough-winged, *Stelgidopteryx serripennis*	Burrows in banks, occasionally in cliff crevices. Rarely excavates its own burrow, relying on Bank Swallows and kingfishers.

Bats

Bats are crepuscular mammals that feed on aerial insects. Many species of bat prey on airbone insects that emerge from aquatic larval stages. Riparian zones around lakes, ponds and wetlands are well recognized as key habitat attributes for many bat species (Grindal et al 1999). In the interior montane of British Columbia, bats occur much more commonly at valley bottom elevations than higher up (Grindal et al. 1999).

Eight species of bats are known to occur or probably occur at Columbia Lake (Appendix G). Maintaining water quality that will support bat prey species is key for bat conservation.

Badger, *Taxidea taxus jeffersonii*

Badgers are mid-sized fossorial carnivores. Fine scale habitat associations include glaciofluvial, fine sandy-loam textured and well-drained soils on south-facing slopes (Apps *et al.* 2002). Badgers are often observed near Columbia Lake. The Findlay Creek burn southwest of Columbia Lake was the site of translocations of badgers from Montana in early 2000's (Kinley and Newhouse 2008) which has enhanced the number of badgers in the area.

Badgers may be expected to occur occasionally along the Columbia Lake and associated wetland shorelines, either sourcing drinking water or as part of their general movements. Elsewhere in BC, badgers are often associated with wetlands (Packham and Hoodicoff 2004) so may be more likely to occur in these areas of the lake at both the north and south end.

Bighorn Sheep, *Ovis canadensis*

Bighorn sheep are not considered riparian or wetland species and likely have little interaction with the foreshore of Columbia Lake. However, they are a species of significant interest in the area and do occasionally occur at the lake level. The east side of Columbia Lake is considered high value winter range for bighorn sheep, although the Columbia Lake herd concentrate most of their activity on the southeast corner of the lake (Figure 33). The cliffs above Eagle Nest Estates on the south-facing slopes of Mt Sabine provide excellent escape terrain immediately adjacent to high quality foraging areas that are often snow-free during winter. The close proximity to Canal Flats also provides some measure of protection from predators, especially wolves. Summer range for Columbia Lake herd is at higher elevations east of Fairmont Hot Springs.

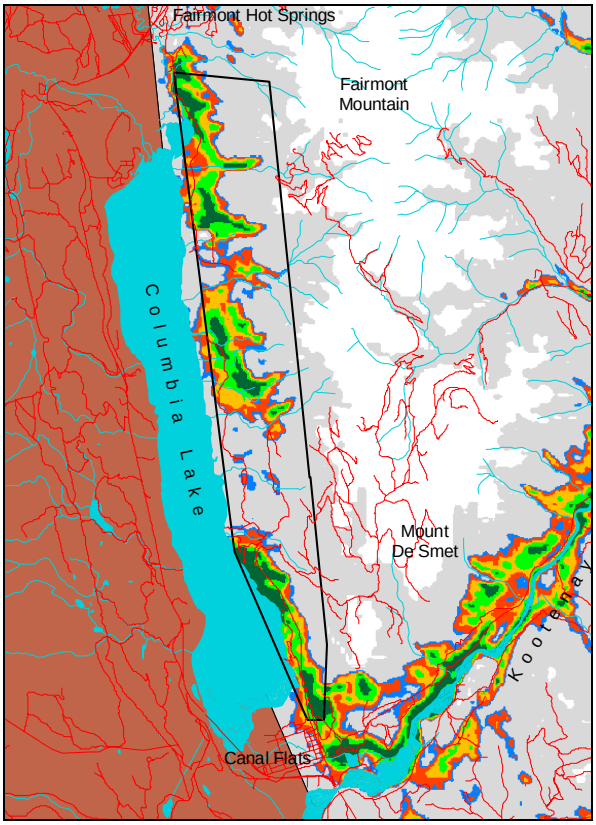


Figure 33: Regional bighorn ewe winter habitat model applied to Columbia Lake winter range and surrounding area. Habitat of decreasing predicted value in 7 classes from dark green (highest value) through light green, yellow, orange, blue and grey and white. Black polygon is composite winter home range of radio collared ewes. Source: Kinley 2007.

3.5.3 Additional Biodiversity Values

In addition to providing habitat for sensitive species, the shoreline of Columbia Lake is valued for its general wildlife biodiversity. For example, Appendix G – Table II provides a listing of all birds known or presumed to occur at Columbia Lake or in shoreline habitats immediately adjacent to Columbia Lake. Additional details on species utilizing the lake are provided below.

Freshwater Mussels

Mussels provide important ecological functions. As filter-feeders, they help clean water and they provide a food source to a variety of animals including otters (*Lontra canadensis*), muskrats (*Ondontra zibethica*), many ducks and fish. The BC CDC (2009) notes that "general threats that apply to mollusks of freshwater habitats include infilling, shoreline development, agricultural runoff, industrial inputs, sediment inputs from adjacent or upstream activities such as range and forest practices, and changes to native fish fauna." Due to their limited dispersal abilities as adults, freshwater mollusks are particularly sensitive to threats to foreshore and littoral zone disturbances. Similar to Windermere Lake, mussel bed occurrences contributed to the ZOS value in the AHI analysis (Section 2.3.4.2 Zones of Sensitivity).

A survey for freshwater mussels was conducted throughout the Okanagan and Kootenay regions in 2007 (Moore and Machial 2007). One site was sampled at Columbia Lake at Canal Flats Provincial Park. The winged floater (*Anodonta nuttaliana / californiensis*) was identified. More mussel beds were observed during the 2009 field surveys.

Waterfowl

Columbia Lake is an important staging area for many migrating waterfowl and supports a diverse array of breeding waterfowl. The wetland areas at the north and south ends of the lake are particularly important. Apart from the greater food resources available in the wetlands, the remainder of the lake is much less utilized because of the frequent winds and high wave activity that greatly reduce habitat quality. Armstrong Bay also provides shelter from wind and supports several species of waterfowl. Ground water either from Kootenay River or springs is thought to contribute to ice-free conditions at the south end of the lake much earlier than the rest of Columbia Lake (Thurber Consultants Ltd 1980 *In* RDEK 1997). Species of note include Tundra Swans and Trumpeter Swans.

Canadian Wildlife Service conducted breeding waterfowl surveys in the late 1990s on the small section of Columbia Lake in the southwest corner, isolated from the main lake by a CPR railway berm. Data from the surveys were unavailable, but most ducks known to the area (see Ferguson and Halverson 1997) were observed there (I. Adams pers. obs.).

Raptors

Several raptor species occur in the Columbia Lake area, including Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*). Osprey and Bald Eagles are especially dependent on foreshore and aquatic habitats. Bald Eagle nesting begins in April, with young usually fledged by late July (Campbell *et al.* 1990b). Ospreys arrive soon after the lake is ice-free, with nesting beginning in late April. Young are fledged by late July (Campbell *et al.* 1990b). Bald Eagles and Osprey are known to nest in the area. A Bald Eagle pair has a nest on the Dutch Creek alluvial fan (Machmer 2008), and are regularly observed around the lake. Bald Eagles are both hunters and scavengers, often feeding on dead fish at the lake shore. Ospreys (Figure 34) also nest nearby, though not necessarily in foreshore habitats, but feed on live fish. Both species are highly visible and recognizable to residents and visitors and highly valued.

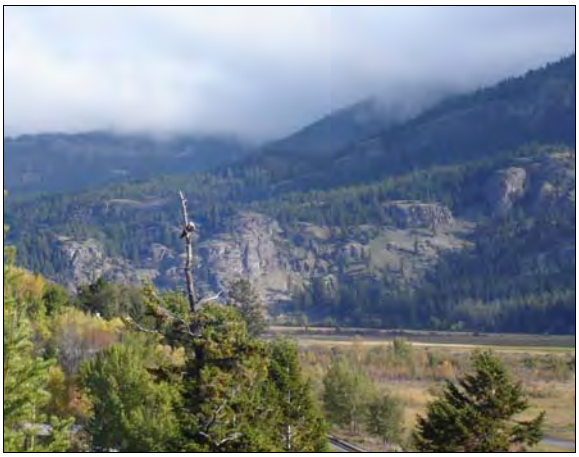


Figure 34. Osprey in a class 2 Wildlife Tree (dead top) at north end of Columbia Lake.

Shorebirds

Numerous shorebird species stage on mudflats and beaches of Columbia Lake and surrounding sloughs and wetlands during spring and fall migrations. Spring migration occurs, approximately, from mid-April to mid-May, and fall migration occurs in mid-August to early September. Birds are found primarily on sand/mud beach and shallow water areas where they forage for aquatic invertebrates. Birds may spend up to a week in the area, depending on the weather. Shorebirds are typically small to medium-sized birds that may occur alone (e.g. Semi-palmated Plovers, dowitchers) or in large flocks.

Few species nest in the East Kootenay. Those that do include Spotted Sandpiper (*Actitis macularia*), which probably nest on Columbia Lake shoreline and Solitary Sandpiper (*Tringa solitaria*) which is relatively unique among shorebirds as a species that utilizes abandoned songbird nests in trees and shrubs close to the shoreline (Moskoff 1995).

Mammals

Several species of mammals inhabit Columbia Lake and associated wetlands. Beaver (*Castor canadensis*) is found at both ends of the lake where suitable food sources (primarily aspen, birch and willow trees and shrubs) are found close to water and where water levels are deep enough to avoid freezing to the bottom during winter. Armstrong Bay has also been identified as important beaver habitat (RDEK 1997). Beavers are especially important to ecosystem functions through water containment by dam building. All these species are moderately tolerant of human activity; however, their habitat can be limited by shoreline development and reduced water quality.

Muskrats are abundant throughout the wetland areas (McPherson and Hlushak pers. obs.; RDEK 1997). They feed on aquatic and emergent vegetation as well as occasional animal sources including mussels. Otters feed on a variety of prey including fish and mussels.

Several other species of mammals likely inhabit the foreshore and riparian habitats along Columbia Lake's shoreline and associated wetlands (Appendix G). Numerous species of small mammals (rodents, shrews) are particularly reliant on riparian habitat for food and cover. Numerous other species not listed in (Appendix G) also likely occur in these areas, but are more generalist in habitat associations and are therefore not listed here.

Lower elevation riparian habitats are also important areas for bats (Grindal *et al.* 1999). Emergent insects from adjacent water bodies are often more abundant over warmer lakes and wetland areas. Adjacent roosting opportunities in cliff fissures, dead or dying trees or human-built structures likely makes wetland areas, Armstrong Bay and other parts of Columbia Lake's foreshore important bat habitat. A list of all bats likely to occur in the Columbia Lake area are included in (Appendix G)

Armstrong Bay

As identified throughout this report, Armstrong Bay, located in Segment 3 (Site 3.3), provides unique habitat for plants and animals along the east side of the lake. Site investigation data Appendix G revealed that it was unique for sites investigated. It had a closed canopy old Douglas fir forest, abundant coarse woody debris, abundant wildlife trees and adjacent wetlands. This area is likely important to waterfowl seeking shelter from wind and wave action, that is known to be considerable along the long axis of the lake. The sensitive plant, Gastony's Cliff Brake, was identified here (CDC 2009), and the bay is known to be important beaver habitat (RDEK 1997). Although not confirmed, this bay's moist environment may also provide habitat for sensitive species such as mollusks, breeding amphibians and bats. Because of these unique habitat values Armstrong Bay has been identified as a ZOS value in the AHI analysis (Section 2.3.4.2 Zones of Sensitivity).

Figure 35. Armstrong Bay (photo by P. Holmes 2009)

Grasslands

Grasslands are one of Canada's most endangered ecosystems (Fish and Wildlife Compensation Program 2008) and BC's grasslands are known to be home to over 30 percent of the species at risk in the province (Grasslands Conservation Council of BC 2009). Making up less than one percent of British Columbia, grasslands account for over 30% of the province's rare and endangered species (Grasslands Conservation Council of BC 2009). Remaining grasslands have been heavily altered by livestock grazing, off-road recreation, invasive exotic plants and encroachment of adjacent forests. A northern extension of Great Basin grasslands in the United States and different from the prairie grasslands east of the Rocky Mountains, the species found in BC Grasslands are largely at their northern range limit and uniquely adapted to an often harsh environment. In the East Kootenay, there are 20 red-listed and an additional 20 blue-listed vascular plant species and six red-listed plant communities (Grasslands Conservation Council of BC 2009). However, not all of these occur at Columbia Lake and/or they do not necessarily occur in close association with lacustrine or palustrine ecosystems.

Extensive grasslands are known to the IDFxk biogeoclimatic zone. The IDFxk summary document provided the following details pertaining to grassland areas in this zone (Government of BC 2006). Undisturbed areas are dominated by rough fescue and blue-bunch wheatgrass; while areas which have been heavily grazed typically have less palatable species such as cheatgrass, Sandberg's bluegrass, Kentucky bluegrass, needlegrass and weeds. The grasslands and open stands that potentially support the bunchgrasses are important to the ranching industry and are critical winter forage for bighorn sheep, elk and, to a lesser extent, deer.

Wildlife Trees

As a veteran tree deteriorates, it can support up to 80 wildlife species, or 15% of the province's birds, mammals and amphibians (BC Wildlife Tree Committee 2009). Wildlife trees provide many kinds of critical habitats including nest cavities and platforms, nurseries, dens, roosts, hunting perches, foraging sites and display stations (Backhouse 1993). Loss of this habitat is a concern for many dependant wildlife species and the most effective wildlife management practices is to retain wildlife trees (BC Wildlife Tree Committee 2009). The decline in Lewis' Woodpecker numbers in the

Fairmont and Dutch Creek burn areas between 2000 and 2007 was primarily attributed to loss of wildlife trees for nesting (Beauchesne and Cooper 2007).

Vertebrate species known to the Columbia Lake area that are cavity nesters and that would thus utilize wildlife trees include: Bufflehead (*Bucephala albeola*); Goldeneyes (*Bucephala* spp.); Wood Duck (*Aix sponsa*); Lewis' Woodpecker xand several other woodpeckers, Saw-whet owl (*Aegolius acadicus*), Northern Pygmy-owl (*Glaucidium gnoma*), Flammulated Owl (*Otus flammeolus*) chickadees (*Parus* spp.), nuthatches (*Sitta* spp.), bluebirds (*Sialia* spp.) northern flying squirrel (*Glaucomys sabrinus*), red squirrels (*Tamiasciurus hudsonicus*). Wildlife trees located along foreshore, riparian habitats, deciduous patches, gullies and ravines are known to be used the most (Backhouse 1993).

High value wildlife trees take a long time to generate so maintaining those present is the preferred management option. Wide diameter trees are best and these are often centuries old. Dead trees are often removed for either aesthetic or safety reasons, as well as firewood collection. The current mountain pine beetle outbreak may result in the death of any mature ponderosa pine trees. We strongly recommend that wildlife trees in the foreshore area be retained and that a Wildlife Tree Assessment be completed for the foreshore wherever development is close by. Options should be explored for maintaining as many of these trees as safely possible. The Wildlife Tree Assessment should be ongoing for any trees protected, to help ensure public safety.

3.6 Aquatic Habitat Index Results

The Current Ecological Value and Ecological Potential, determined through the AHI are depicted on the GIS map (Appendix A). The AHI calculations are detailed in the AHI Tables (Appendix H). Table 11 and Table 12 below, respectively summarize the results by comparing the two analyses and breaking down the Current Ecological Value for the different the shore types. Figure 36 portrays the Current rankings for the shoreline.

The AHI results for Columbia Lake reveal that the majority of the shoreline has a Very High (27%) or High (35%) Current Ecological Value. This extent of healthy and important areas for fish and wildlife is attributed to the largely undeveloped east shore (Segments 2 and 3) and intact north and south end wetlands (Segments 4 and 8). Segments with development or transportation infrastructure had Low (Segments 6 & 7) or Very Low (Segment 5) rankings. Segment 1 was ranked as Moderate since development to date has not been extensive and has not overly affected the shoreline habitat.

Table 11. AHI analysis results following current ecological value analysis (with in-water structures) and ecological potential analysis (without in-water structures).

Ecological Value	Current Ecological Value			Ecological Potential		
	Segments	Total Shoreline Length (%)	(m)	Segments	Total Shoreline Length (%)	(m)
Very High	4,8	26.8	11591.1	4,8	26.8	11591.1
High	2, 3	35.1	15206.6	2,3	35.1	15206.6
Moderate	1	4.3	1876.7	1,6,7	36.4	15738.7
Low	6, 7	32.0	13862.0	5	1.7	755.1
Very Low	5	1.7	755.1	0	0.0	0
			43291.5			**43291.5**

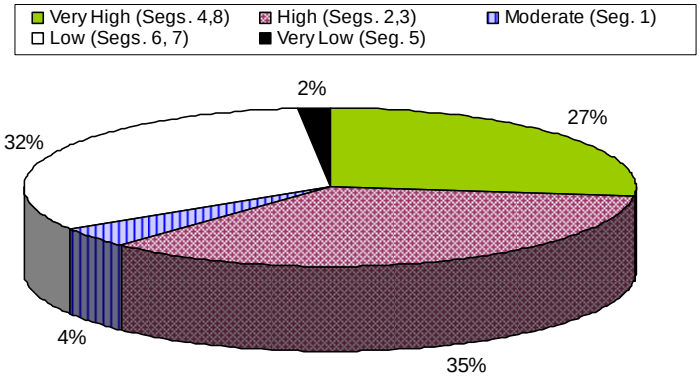


Figure 36. Current Ecological Value rankings and associated percentage (%) of shoreline.

Table 12. Summary of Current Ecological Value AHI results for the different shore types at Columbia Lake.

Current Ecological Value	Cliff		Bluff		Gravel Beach		Stream Mouth		Wetland	
	Length (m)	%	Length (m)	%	Length (m)	%	Length (m)	%	Length (m)	%
Very High	0.0	0.0	0.0	0.0	0.0	0.0	1249.7	2.9	10341.4	23.9
High	815.1	1.9	9363.7	21.6	2967.3	6.9	128.8	0.3	1931.7	4.5
Moderate	0.0	0.0	93.8	0.2	1782.9	4.1	0.0	0.0	0.0	0.0
Low	0.0	0.0	0.0	0.0	13508.3	31.2	353.7	0.8	0.0	0.0
Very Low	0.0	0.0	0.0	0.0	755.1	1.7	0.0	0.0	0.0	0.0

The **Ecological Potential** analysis shows that with restoration shoreline areas impacted with retaining walls, docks, groynes, boat launches and marinas would see an improvement in their ranking. With restoration, the moderate ranked segments could potentially increase by a factor of 8 or length of 13,862 m. This analysis did not consider riparian habitat improvements. Additional benefits could be realized at all disturbed segments (i.e., those not ranked as High or Very High) with riparian restoration.

4 State of the Foreshore

The physical analysis of Columbia Lake's foreshore revealed Gravel Beach (43%) to be the most prevalent shore type, followed by Wetland and Bluff shore types (29% and 22%, respectively) and Stream Mouth and Cliff shore types (4% and 3%, respectively). These shore types provided a diversity of habitats for numerous plants, fish and wildlife species, including several sensitive species. Generally all shore types contributed to important ecological functions for the lake area, and where disturbance was low the environmental values of the foreshore were high. Intact gravel beach areas and stream mouths were important habitat for fish, wetlands were important for primary production and waterfowl, and bluffs were important for wildlife (e.g., swallows). The presence of emergent aquatic vegetation along extensive stretches of the shoreline (75% of length and total area equaling approximately 300 ha) and natural mature riparian forest (along the east side) also contributed to increasing ecological value of the shoreline.

Over half (63% or 27 km) of the shoreline was found to be in a natural condition. This high extent of natural area is unique and significant for southern interior lakes, especially given that disturbances are mainly limited to the railway at Columbia Lake (Holmes, pers com.). With good management strategies in the WMA and the provincial parks (approximately 24 km) most of the natural area should remain intact into the future. However, there still are private lands along the eastern shore (approximately 3 km, in Segments 1, 2 and 3) which should be carefully planned in a way to minimize foreshore impacts. As well, care needs to be taken with existing developed areas (approx. 16 km) to minimize further disturbance. Some of the residential lots in the Canal Flats area (Segment 1) appear to have been developed in a way that minimized foreshore disturbance (e.g., riparian areas intact and minimal shoreline structures). Figure 37 provides and example, which can be contrasted to Figure 26a. Good development examples should be sought and used as templates for future planning. At Okanagan Lake (RDCO 2005), Windermere Lake (McPherson and Michel 2007), and Wasa Lake (McPherson *et al*. 2009), foreshore modifications tended to be similar for adjacent properties. To help alleviate and isolate negative shoreline impacts, nodal development is highly recommended; where landowners for instance would cooperate and share one dock (B. MacDonald pers. comm.).

Figure 37. Residence set back on the bluff with minimal foreshore disturbance evident. Photo: Leschied Sept. 2007.

Approximately 37% (or 16 km) of the foreshore was assessed to be disturbed. The disturbances were mainly transportation infrastructure (33%), which was mostly the railway along the west side of the lake. Losses of riparian vegetation and connection between the shoreline and the upland (e.g., culverted streams) were the apparent disturbance indicators. Most of the residential areas along Columbia Lake were situated on the bluffs of the western shore and thus did not directly impact the foreshore environment. The private/residential areas along low elevation areas next to the shoreline and urban parks such as Columere and Eagle Nest Estates (Canal Flats area), contributed equally to the remaining disturbed length (4% combined). A comparison of these developed areas to adjacent undeveloped segments showed that developed areas had reduced emergent aquatic vegetation and riparian vegetation. This was particularly apparent in Columere Park which had 27% emergent vegetation and only sparse riparian vegetation

Shoreline modifications have the potential to degrade sensitive freshwater habitats in many ways including changing the lakebed and water column, shading vegetation, introducing pollutants from motors (as observed at two marina slips in 2009), causing damage from boat propellers, and altering fish dynamics (e.g., disrupt shoreline migration and modifying predator prey relationships) (BC MoE 2006). Construction of these structures may also cause sediment and contaminants to enter the water column where they may interfere with rearing fish and insects, plants and algae. Shoreline structures including docks, groynes, retaining walls, boat launches and a marina were situated in developed areas along the lake. The practice of importing sands to create artificial beaches was not common around the lake. Dock densities were relatively low when compared to

other lakes. For example, Segment 1 at Columbia Lake had the highest density of 5.3 docks/km, while Wasa Lake had dock densities ranging from 16 to 28 docks per km (McPherson *et. al.* 2009), and Windermere Lake ranged from 7 to 12 docks/km (McPherson and Michel 2007). As a result increased development pressures such as this Wasa and Windermere Lakes have experienced greater shoreline impacts such as reduced aquatic vegetation and high abundances of non-native fish species (e.g., largemouth bass).

The CPR tracks have a significant impact on the western shore. In many respects this is a negative impact ecologically (alteration of riparian habitat, etc). In other ways it's positive as the tracks limit development on the immediate shoreline and have contributed to course substrate in the lake for burbot rearing. CPR should be an important partner in Columbia Lake management direction because of their presence.

As the AHI analysis revealed, restoration could improve the disturbed foreshore areas, through removal of foreshore modifications (e.g., docks and retaining walls) and vegetating riparian areas with native species. Retaining walls of concern should be reviewed, including the walls noted in Segments 1 and 5 situated below the high water mark and constructed of toxic pressure treated wood. The chains used for boat mooring should be eliminated and replaced with lines that float so that the substrates are not scoured in Segment 6. Overnight mooring is an illegal activity which could also contribute to shoreline impacts and thus should also not be occurring.

5 Shoreline Management Guidelines for Columbia Lake

This study has revealed that significant parts of the lake are protected. Development, where appropriate, should be consistent with the intent of protecting and maintaining the cultural and biological diversity of the area, and where possible, restoring continuity, physical and ecological (and hence social) functions (Bisett pers. comm.). This is particularly important in ecologically sensitive areas.

Clearly defined principles and associated policies and strategies will help guide future decisions and promote a coordinated approach to foreshore management among regulatory agencies. The science-based methods employed at Windermere Lake (EKILMP and Interior Reforestation 2009) and subsequently at Moyie Lake (Schleppe 2009), included the development of Shoreline Management Guidelines for Fish and Wildlife Habitats (Guidelines). These templates were used in preparing the Guidelines for Columbia Lake. This approach has been adopted from the lake management protocols being developed by BC MoE in the Okanagan Region (BC MoE 2008b). These Guidelines will help EKILMP in meeting their objectives of maintaining environmental attributes of the foreshore while facilitating human requirements.

A colour scheme has been developed which delineates the shoreline based on habitat values determined through the AHI analysis in the Fish & Wildlife Habitat Assessment report. The scheme has coloured shoreline areas as red, orange, yellow or grey zones. These zones are defined in the following Section and have been mapped in Appendix A. The risks for specific activities in each color zone (*See* Step 2) and the associated review process (*See* Step 3) have also been outlined. The coloured zones, activity risk table and the process flow chart form the basis of the Guidelines.

The How-to Guide below provides a step-wise process to help direct applicants/reviewers through the Guidelines (including the maps, risk table and flow chart):

How-to Guide for Development Planning in the Fish and Wildlife Shoreline Colour Zones

Step 1: Determine the colour zone that your application is situated in using the maps in Appendix A. Note that Red Zones are designated Conservation Areas. No development should be considered or approved in these zones.

Step 2: Determine what the risk is for your specific activity using the Activity Risk Table (Table 1). If your activity is not listed, assume high risk, and contact FrontCounter BC for advice.

Step 2a: If a species at risk has been identified in the area, the risk increases as identified in the Modifier Column of the Activity Risk Table.

Step 2b: If your activity is identified as being High risk, determine if you can move to a colour zone with less sensitive habitat (e.g., move to a yellow or grey zone) or select a lower risk activity.

Step 3: Use the Flow Chart to determine application review needs based on your given activities risk.

Step 1. Shoreline Color Zones

To determine the appropriate shoreline colour zone, the property or area that would be subject to application must be located on the maps found in Appendix A.

The AHI Values (or Current Ecological Value) as defined in the Fish and Wildlife Habitat Assessment were used to determine the color zone (red, orange, yellow and grey) of a shoreline area. The specific designation methods and guidelines for each color zone are provided below. With the methods utilized, fish and wildlife values and associated levels of sensitivity to development are highest in red and orange zones, lower in a yellow zone and lowest in a grey zone. Risks for specific activities have been identified for each colour zone and are provided in the subsequent section.

Red Shoreline

Defined by: Very High Current Ecological Values in the Aquatic Habitat Index.

Background:
These areas have been identified as essential for the long term maintenance of fish and/or wildlife values through the Habitat Index Analysis. This zone includes most creek mouths and wetland areas at Columbia Lake. These areas are essential for fish and/or wildlife populations. EKILMP recommends that these areas be designated for conservation use, and that no development that can impact these sensitive communities occur within them. Low impact water access recreation and traditional First Nation uses are permissible in these areas, but permanent structures or alteration of existing habitats is not considered to be acceptable. Habitat restoration may be appropriate in these areas where warranted. Invasive aquatic plant removal is acceptable, provided there is an approved aquatic plant removal program including trained persons. Please contact a plant specialist if uncertain of a plant species. Red zones account for 26.8% of the total shoreline length of Columbia Lake.

Orange Shoreline

Defined by: High Current Ecological Values in the Aquatic Habitat Index.

Background:
These shoreline segments have been identified as High Value Habitat Areas for fish and/or wildlife through the AHI Analysis. These are made up of areas that are relatively natural; possessing high value areas for fish and/or wildlife. These areas are sensitive to development, continue to provide important habitat functions, but may be at risk from adjacent development pressures. Restoration opportunities potentially exist in these areas. Proponents should consider moving high risk activities to other areas if possible, or pursuing activities that have lower associated risks. Orange zones account for 35.1% of the total shoreline length of Columbia Lake.

Yellow Shoreline

Defined by: Moderate Current Ecological Values in the Aquatic Habitat Index.

Background:
These areas have experienced a moderate amount of development disturbance and pressures. At Columbia Lake the AHI found that although these areas have been impacted to some degree, they still contain sensitive areas for burbot rearing and are also important general living habitats for other fish and wildlife species. These values should be considered when changes to land uses are proposed.

Development is more appropriate on these shorelines than on red or orange coloured areas; however activities should incorporate protection of habitat features that remain, be well above the high water mark, and and/or be situated outside of the riparian area. Restoration may be an option in some areas that have experienced past developments. Development may proceed for low risk activities provided a Best Management Practice (BMP) or Regional Operating Statement (ROS) is followed. High risk activities without a BMP or ROS will require a report from a Qualified Professional (QP). Yellow zones account for 4.3% of the total shoreline length of Columbia Lake.

Grey Shoreline

Defined by: Low and Very Low Current Ecological Values in the Aquatic Habitat Index.

Background:
These are shorelines identified during the Habitat Index Analysis as having lower ecological value. However, they still may contain valuable habitats requiring some protection, such as in-lake wetlands, or gravel/cobble substrate areas.

Human development has been concentrated in these areas and has resulted in disturbances to the natural fish and wildlife habitat. In keeping with the objective of concentrating development in areas that are already disturbed or of low value, new developments may be considered in these areas. Redevelopment will also be considered. New developments or redevelopment proposals shall incorporate fish and wildlife habitat restoration or improvement features where feasible and practicable. Obtain advice from a QP for habitat restoration techniques. For example, a retaining wall redevelopment may be moved back from the HWM and/or incorporate re-vegetation or other fish and wildlife features in the design. Grey zones account for 34% of the total shoreline length of Columbia Lake.

Step 2. Activity Risk Analysis

Typical shoreline activities have been assigned risk ratings based on the potential level of risk that they may have on fish and wildlife habitat values (*See* Table 13). Recognizing that the different shore zones have different habitat values and levels of sensitivity, the risk of each activity has been identified for each shoreline colour zone. In the table, each colour zone/activity combination has been rated as either: Not Acceptable (NA), High (H) or Low (L). A species at risk modifier column has also been provided, which should be used if a species at risk has been identified in the project area.

Please be aware that where several activities with differing risk factors occur on a site, then the combined risk may increase and move the activity into a higher risk category. A Qualified Professional may be required to determine if the overall risk has increased. If your activity is not listed, contact FrontCounter BC for advice. Note also, that the Activity Risk Table often distinguishes between activities above the high water mark (HWM) and below the HWM. The HWM as opposed to the 'natural lake boundary' is the standard practice used by DFO when considering impacts to fish and wildlife values.

Risk Rating Descriptors

This section provides background, description and examples for the Activity Risk Ratings. Overall, the risk ratings reflect the potential impacts on fish and wildlife, with a Not Acceptable or High activity risk rating posing the greatest potential concern and the Low Risk rating a lower level of possible concern. This process recognizes that there is a greater possibility that High Risk activities may not be approved by regulators. The process also identifies that important habitats do exist in degraded and developed areas and that at least minimal standards are required to protect fish and wildlife habitat in the grey zone areas.

Not Acceptable Activities

Several activities have been rated as not acceptable. These activities are primarily in Red and Orange zones that have very high or high ecological ratings. The activities listed are known to have significant negative impacts to fish and wildlife habitats and are extremely difficult or impossible to mitigate or compensate. Applications for these types of development in the zones identified will not be considered.

High Risk Activities

Proposals within the High Risk category are known to have significant challenges related to providing adequate mitigation or compensation to address the loss of fish and/or wildlife habitat values. Acceptable mitigation measures would likely be very costly to implement. In addition, there is a high likelihood that a request for a Harmful Alteration, Disruption or Disturbance of Fish Habitat (HADD) authorization under the *Fisheries Act* would be triggered. Applicants are thus encouraged to avoid activities with a High Risk, consider activities that are a lower risk, or relocate the activity to an area where the environmental sensitivity is less. If the applicant wishes to proceed with a High Risk activity, a qualified professional should be retained to determine if there is a HADD &/or other environmental impacts which can be mitigated through design and relocation. The application will be reviewed by the applicable agencies. As identified in the Activity Risk Table, certain activities are rated High Risk for all shore colour zones and should be avoided if at all possible.

Low Risk Activities

With appropriate design and planning, Low Risk activities could be incorporated along the foreshore with minimal impacts on fish and wildlife habitat values. These activities are to follow BMP/ROS, where available (Appendix I). Where BMP/ROS are not available, or a deviation to the BMP/ROS is proposed, a QP is to be hired to determine if there is a HADD and design the project to minimize environmental impacts. The application will be reviewed by the applicable

agencies. Examples of activities which have Low risk along most/all of the shoreline are: maintenance dredging (previously approved) and erosion protection (soft-bioengineered).

Step 3. Decision Process Flow Chart

A flow chart is provided which outlines the decision-making process for the High and Low risk activities. The chart is a tool to help depict the Guideline requirements outlined in the previous sections. Note that this process provides Guidelines on only the initial planning stages of development. There are other legal requirements that are not covered through this process (such as approvals/notifications through RDEK, Transport Canada, BC *Water Act*, BC *Lands Act*), which are the responsibility of the applicant (Appendix J). If these Guidelines are followed, the intent is that the subsequent permitting process(es) should be more streamlined for the applicant.

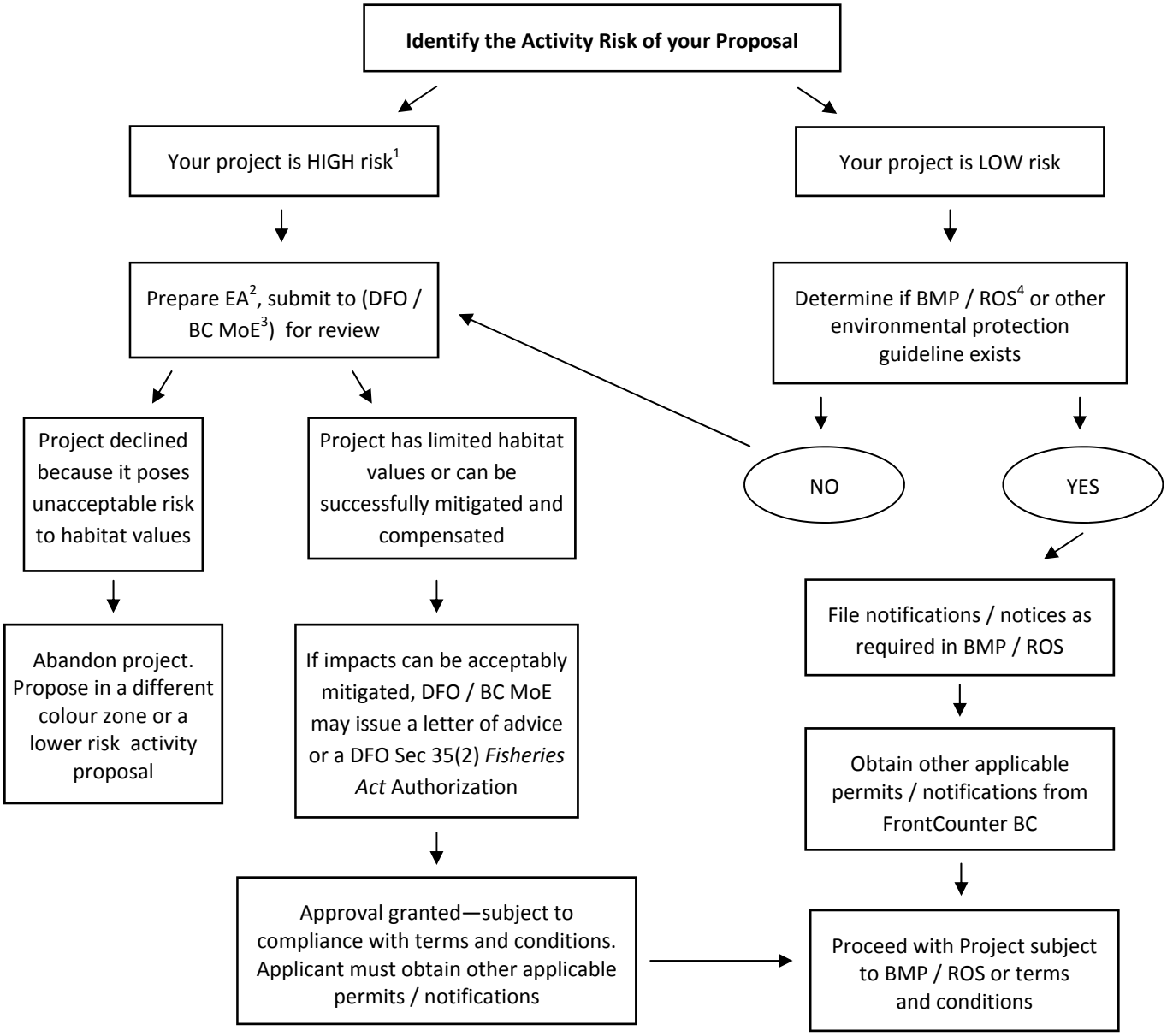
Contact FrontCounter BC to determine which permits, approvals or authorizations you need, in addition to fish and wildlife habitat authorizations.

Table 13. Activity Risk Table (NA = Not Acceptable, High = H, Low = L).

Activity	Shore Zone Colour and Activity Risk				Modifier
	Red	Orange	Yellow	Grey	Zone has Species at Risk
Over water piled structure (i.e. building, house, etc.)	NA	NA	NA	NA	NA
Boat house (below HWM)[1]	NA	NA	NA	NA	NA
Dredging (new proposals)	NA	NA	NA	NA	NA
Beach creation above HWM	NA	NA	H	H	H
Beach creation below HWM	NA	NA	H	H	H
Aquatic vegetation removal	NA	NA	H	H	H
Upland vegetation removal	NA	NA	H	H	H
Marina[2]	NA	H	H	H	H
Breakwater	NA	H	H	H	H
Boat launch upgrade	NA	H	H	H	H
New boat launch	NA	H	H	H	H
Infill	NA	H	H	H	H
Groynes	NA	H	H	H	H
Fuel facility[3]	NA	H	H	H	H
Boat house (above HWM with vegetation removal)[1]	NA	H	H	H	H
Mooring Buoys	NA	H	H	H	H
Waterline trenched	NA	H	H	L	H
Erosion protection hard-joint planted	NA	H	H	L	H
Erosion protection vertical wall or retaining wall[4]	NA	H	H	L	H
Milfoil & invasive weed removal	H	H	H	L	H
Boat house (above HWM without vegetation removal)[1]	NA	H	L	L	H
Permanent rail launch system	NA	H	L	L	H
Removable rail launch system	NA	H	L	L	H
Dock[1]	NA	H	L	L	H
Erosion protection (soft-bioengineered)	NA	H	L	L	H
Elevated boardwalk below HWM	NA	H	L	L	H
Maintenance dredging (previously approved)	NA	H	L	L	H
Boat lift - temporary	NA	H	L	L	H
Geothermal loops - open[5]	NA	H	L	L	L
Geothermal loops - closed	NA	H	L	L	L
Habitat restoration[6]	H	H	L	L	H
Public beach maintenance	NA	L	L	L	H
Waterline drilled	NA	L	L	L	L

[1] These Guidelines are to be used in the initial development planning stage and do not cover all legislative requirements. Docks and boathouses are an example of an activity that could require additional approval process through Transportation Canada or Ministry of Agriculture and Lands.
[2] Marinas or marina expansions in orange zones may not be acceptable depending on the habitat attributes.
[3] Fuel facilities are inherently high risk, and if approved will be subject to all other regulations.
[4] Retaining wall redevelopment should be designed to restore fish and wildlife values where feasible and practical.
[5] Geothermal loops open (water) versus closed (glycol) and associated risk must also be assessed and ranked for physical habitat and water quality aspects.
[6] Habitat restoration proposals are listed as high risk in red and orange zones because individual objectives and proposals must be reviewed.

Flow Chart: Decision-making process for High and Low Risk Activities for Fish and/or Wildlife Habitat authorizations



[1] Activities within the High Risk category raise significant concerns. These activities have significant challenges related to providing adequate mitigation or compensation to address the loss of fish and/or wildlife habitat values and could be costly to implement acceptable mitigation measures. With High Risk activities, there is a high likelihood that a request for a Harmful Alteration Disruption or Destruction of fish habitat (HADD) authorization under Sec 35(2) of the *Fisheries Act* would be triggered. Proponents are encouraged to avoid activities with a High risk, revise activities to a lower risk option, or relocate the activity to a less sensitive colour zone.

[2] Environmental Assessment

[3] DFO- Fisheries and Oceans Canada; BC MoE- Ministry of Environment

[4] BMP – Best Management Practice; ROS – Fisheries and Oceans Canada Regional Operating Statement

5.1 Mitigation and Compensation Considerations

In order to assess impacts of a proposed project, it may be necessary to retain a Qualified Professional who could assess habitat values and sensitivities in the area. The Columbia Lake Fish & Wildlife Habitat Assessment Report report is a tool available to help with this task; however, further studies may be necessary, due to limitations of currently available information. The DFO principle of "no net loss" within the Policy for the Management of Fish Habitat (1986) applies to all proposals where there is the potential for a Harmful Alteration Disruption or Destruction of fish habitat (HADD) under Section 35(2) of the federal *Fisheries Act*. This involves following a sequence of mitigation alternatives. Mitigation is a process for achieving conservation through the application of a hierarchical progression of alternatives, which include: (1) avoidance of impacts; (2) minimization of unavoidable impacts; and (3) compensation for residual impacts that cannot be minimized. These alternatives are described as follows:

1. Avoidance of Impacts

The first step, avoidance, involves the prevention of impacts, either by choosing an alternate project, alternate design or alternate site for development. It is the first and best choice of mitigation alternatives. Because it involves prevention, the decision to avoid a high value area or to redesign a project so that it does not affect a high value area must be taken very early in the planning process. It may be the most efficient, cost effective way of conserving important habitats because it does not involve minimization, compensation or monitoring costs. Avoidance may include a decision of not to proceed with the project.

2. Minimization of Unavoidable Impacts

Minimization should only be considered once the decision has been made that a project must proceed, that there are no reasonable alternatives to the project, and that there are no reasonable alternatives to locating the project within high value habitats. Minimization involves the reduction of adverse effects of development on the functions and values of the habitat at all project stages (including planning, design, implementation and monitoring), to the smallest practicable degree. Considering any planning efforts, DFO must deem a HADD to be acceptable before work can commence.

3. Compensation

Compensation is the last resort in the mitigation process, an indication of failure in the two earlier steps. It should only be considered for residual effects that were impossible to minimize. Compensation refers to a variety of alternatives that attempt to replace the loss of, or damage to habitat functions and values. Habitat compensation may be an option for achieving "no-net-loss" when residual impacts of projects on habitat productive capacity are deemed harmful after relocation, redesign, or mitigation options have been implemented. After reviewing the project proposal and the potential impacts to fish habitat, DFO may determine that the impacts are not acceptable if the habitat to be affected is critical habitat or compensation is not feasible. In addition, compensation for deposit of a deleterious substance into water frequented by fish is not acceptable. Habitat compensation involves replacing the loss of fish habitat with newly created habitat or improving the productive capacity of some other natural habitat. Depending on the nature and scope of the compensatory works, habitat compensation may require, but not be limited to, several years of post-construction monitoring and remediation or redevelopment of the compensation works in the event the habitat is not meeting the compensation objectives. There is no guarantee that projects in high value fish habitats that result in HADD will be authorized under Section 35(2) if application is submitted.

5.2 Restoration

A variety of techniques have been developed to restore productive habitat (aquatic and terrestrial) and maintain/enhance productivity and biodiversity. There are a variety of groups' currently leading/undertaking restoration activities within the East Kootenay, using proven restoration

techniques and concepts. For information contact local environmental groups, local government, or provincial government offices.

6 Recommendations

The Central Okanagan Lake FIM (RDCO 2005) and Windermere Lake FIM (McPherson and Michel 2007) were used as templates in completing this assessment. Due to their relevance, the following recommendations are based largely on these reports. Relevant recommendations from the Columbia Lake Management Strategy (RDEK 1997), were also presented in this report. The EKILMP also contributed to the recommendations. Recommendations to help further understand and protect the natural integrity of Columbia Lake are as follows:

1. **Conduct inventories to determine current status of sensitive species and habitats associated with the foreshore.**
   - Conduct additional species and habitat inventories (e.g., fish, reptiles, amphibians, birds, mammals and plants) in undisturbed foreshore areas, to identify whether listed “at risk” or “sensitive” species or ecosystems are present.
   - Complete a Wildlife Tree Assessment for the foreshore and protect wildlife trees during development, where safely possible.

2. **Identify and protect environmentally sensitive areas**
   - Consider implementing a Development Permit Area (DPA) for Environmentally Sensitive Areas (ESA) similarly to the RDEK Lake Windermere Official Community Plan (RDEK 2008). The Village of Canal Flats already has established ESAs, through its OCP, covering the south end of the lake (Village of Canal Flats 2005; *See* Section 1.2), and these areas have development limitations (e.g., setbacks of 30 m from high water mark and limited use).
   - At the same time as implementing the ESA DPA, the boundary of the Fairmont Hot Springs Area OCP should be expanded to include the entirety of that portion of Columbia Lake in the RDEK.
   - In addition to development permit areas and zoning bylaws, restrictive covenants can be used as a tool in development approvals to protect environmentally sensitive habitats. For example, to enact buffer leave strips to protect riparian vegetation (e.g., riparian areas regulations or as per Shoreland Management Policy [Caribou Regional District 2004]).
   - Red shoreline zones should be designated for conservation use, where no development can occur that has the potential to impact their sensitive communities. These areas could be protected with permanent map reserves, property purchase by conservation groups or restrictive covenants. Low impact water access recreation and traditional First Nation uses would be permissible, but permanent structures or alteration of existing habitats would not be acceptable. Habitat restoration may be appropriate in these areas where warranted, such as invasive aquatic plant removal, provided there is an approved program and trained persons conducting the work.
   - Where the habitat is sensitive, boat launches should remain closed during critical periods (e.g., during bird breeding/nesting and rearing/fledgling periods).
   - Restrict high horsepower boats/jet skis in sensitive areas (e.g., wetlands, WMA), particularly during critical periods. Determine the most appropriate setback distance based on other examples and types of sensitivities (e.g., 100 m). Consider requesting ‘a year-prohibition on the operation of power-driven vessels in the wetlands of the Columbia Lake’ to Transport Canada, similarly to the amendment currently under review for the Columbia Wetlands Wildlife Management Area Transport Canada 2009.

- Enact buffer leave strip policy protecting riparian vegetation for all new developments (e.g., riparian areas regulations or as per Shoreland Management Policy [Caribou Regional District 2004]).
- Provide technical guidance to agencies and the public regarding alternatives to traditional foreshore modifications. This could include advice on nodal development where docks are shared so that the density/length of shoreline disturbance is minimized; as well continue to create applicable Best Management Practices and Regional Operating Statements.
- Prepare and enact a storm-water management plan along the length of the railway corridor.
- Prepare an emergency spill response plan for the railway corridor.

3. Address modification impacts

- Remove mooring buoys and their anchors in all areas with aquatic vegetation, since they and associated props cause damage and erosion. In areas where there is no aquatic vegetation, replace mooring buoy chains with lines that float so not scouring occurs.
- Identify areas where restoration or enhancement would likely benefit habitat quality.
- Rate habitat conditions that would allow for re-introduction of any extirpated species.
- Develop and implement a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts (e.g., overnight mooring).

4. Monitor habitat losses and gains to measure success

- Re-run the AHI analysis during the planning stages of a development to determine what the changes to the Ecological Values for the shoreline segment would be with the alteration. Similarly, run the AHI analysis if restoration is planned.
- Initiate a habitat monitoring program. Compare results from the monitoring program to the original inventory data to determine compliance with best management practices and effectiveness of Guidelines.
- Establish a water quality monitoring program with the cooperation of area citizens.
- Conduct a hydrological assessment to understand nutrient cycling and water budget in the lake.
- Establish a water level monitoring program.

5. Educate developers and property owners on the foreshore values

- Re-establish the community based steering committee with representatives from developments and Canal Flats.
- Prepare an educational program for developers and existing lakeshore owners and users. This will assist stakeholders to: 1) understand the value of retaining natural foreshore features; 2) ensure existing sewage systems are properly operated and maintained; 3) develop lots in a way that minimizes impact on the environment and; 4) understand the economic value inherent in protecting the ecological integrity of the lake.
- Establish education panels at all boat launches.
- Marina to establish a code of practice to reduce potential for pollutant and invasive plant introduction (e.g., aquatic plants such as Eurasian milefoil, lustrife).
- Monitor and enforce boating regulations that outline that no person shall operate a power-driven vessel or a vessel driven by electrical propulsion in excess of the 10 km/h maximum speed in the part of the channel connecting Columbia Lake to Mud Lake and within 100 m from the shore on the east side of Columbia Lake (Transport Canada 2001). Use the environmental values described and mapped in this document to help support this action.

6. Continue to make inventory data and habitat information available

- Provide federal, provincial, local jurisdictions with inventory data.
- Inventory data available to the public should be provided via the Internet through continued partnership with the Community Mapping Network.

7. **Develop a Lake Management Plan.** Upon final completion of the Lake Windermere Lake Management Plan, determine if a similar process and planning document would be beneficial and feasible to update the Columbia Lake Management Strategy (RDEK 1997). Many of the above mentioned items would be applicable to include in a Lake Management Plan. Additional items that this plan could include are:

   - An outline of joint community/agency objectives, established through open houses and surveys;
   - Environmental protection regulations and guidelines (e.g., riparian area regulations and environmental development permit areas) for new development, re-development and management of existing developments;
   - Links between foreshore and upland activities;
   - Determination of carrying capacity[1] of foreshore modifications and activities;
   - Other issues resolution such as potential hazardous spills and occurrence of side casting with CPR; and.
   - A memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities.

7 Conclusions

Overall, conservation of the intact ecosystems along Columbia Lake is critical in maintaining the environmental, social, aboriginal and economic values that have drawn people to the East Kootenay Region. The simplest way to keep the shoreline environment healthy and functioning for fish and wildlife is to disturb it as little as possible and leave it as natural as possible. Shoreline Management Guidelines provided here along with Best Management practices and Regional Operating Statements will help ensure proposed structures and activities protect the valuable shoreline habitat along Columbia Lake. Federal and provincial legislation and local policies also protect the environment from irresponsible and illegal activities.

Regulatory agencies should aim to keep assessment information and planning documents updated, to ensure that individual lot-by-lot impacts (or cumulative effects) that may seem insignificant on their own do not collectively interact in complex ways to alter fish and wildlife growth and production rates (Jennings *et al.* 2003 and Radomski and Goeman 2001); thereby keeping the existing highly valuable habitats around the lake intact.

[1] The carrying capacity of a lake with respect to development is defined as *a 'lake's ability to accommodate recreational use (e.g. boating, skiing, bathing) and residential occupation of the foreshore and adjacent upland areas without excessive overcrowding, pollution and consequent danger to human health and safety'* (RDCO 2005).

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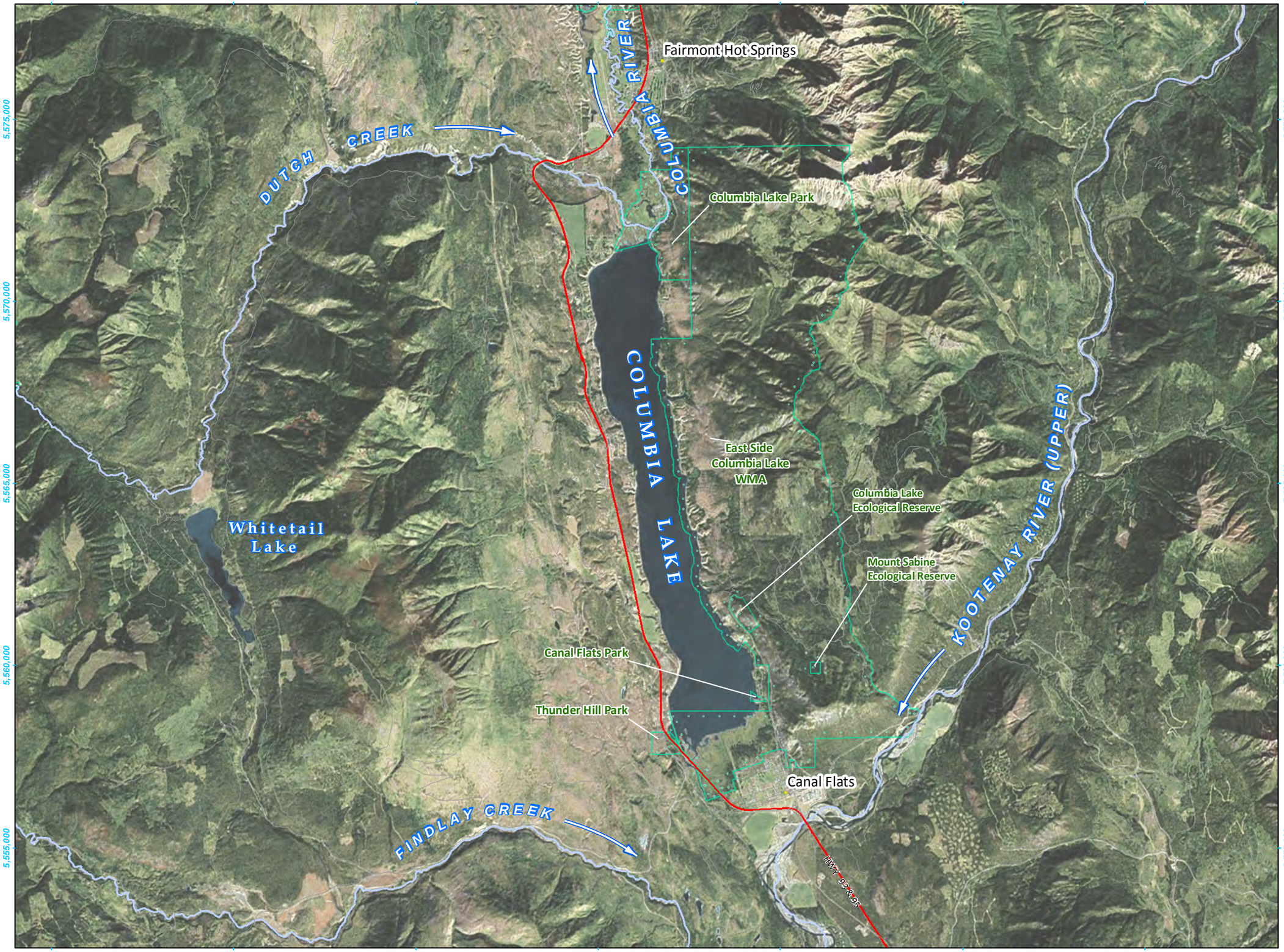
Appendix A. Foreshore Summary Maps

COLUMBIA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Overview Map



Features

- Community
- Highway
- Major Road
- Local road
- Stream Network (50k)

1:100,000

0 1 2 3 4 5 Km

Data Sources

50k Stream Network derived from CWB - Macroreach, GeoBC Main/Overview Base Map provided by Bing Maps licence.

Map Information	Cartographic Information
Map Projection: UTM 11	Created By: D.Hlushak
Map Datum: NAD 1983	Reviewed By: S.McPherson
Scale: 1:100,000	Map Document: 10WILD6A\ MXD_Data\App1_Overview
Issue Date: May 11, 2010	

GIS Standard Map Disclaimer:

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Created for:

EAST KOOTENAY INTEGRATED LAKE MANAGEMENT PARTNERSHIP

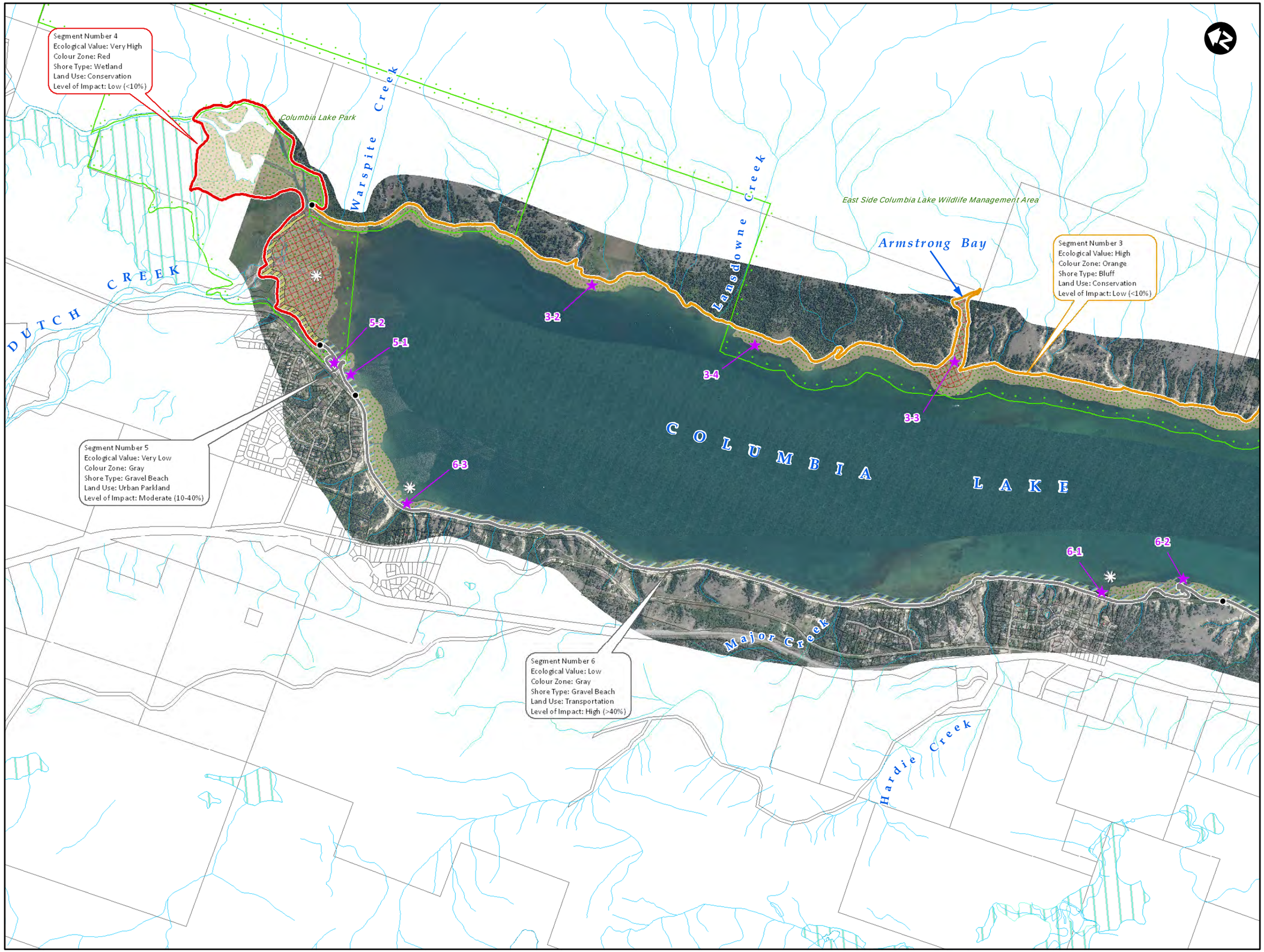
Created by:

INTERIOR REFORESTATION CO. LTD.

Overview Map

COLUMBIA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Columbia Lake North



Features

- Sample Site
- Wetlands
- Park/Protected Area
- Legal Boundaries

Shoreline Colour Zone

- Red
- Orange
- Yellow
- Gray

Zones of Sensitivity

- Biologically Productive
- Wildlife
- Burbot Spawning
- Emergent Vegetation
- Burbot Rearing

1:25,000

0 250 500 750 1,000 *Meters*

Data Sources

- Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 meters)
- Columbia Lake 2008 Orthophoto: Provided by RDEK (20 cm res.)
- Parks/Protected Areas: GeoBC, Province of BC
- Shoreline Segments: Modified from TRIM Lake data (1:20,000)
- CWB Wetlands: GeoBC, Province of BC
- Emergent Vegetation: Digitized from 2008 Orthophoto (20 cm res.) in conjunction with Field verification/GPS mapping - March 2009

Map Information	**Cartographic Information**
Map Projection: UTM 11	Created By: D.Hlushak
Map Datum: NAD 1983	Reviewed By: S.McPherson
Scale: 1:25,000	Map Document: 10WILD6A\ MXD_Data\AppA_FIM_N.mxd
Issue Date: June 01, 2010	

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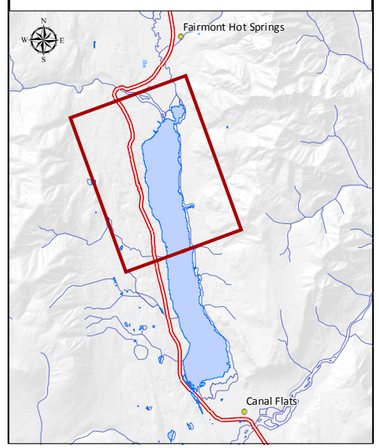
Created for:
EAST KOOTENAY
INTEGRATED LAKE
MANAGEMENT PARTNERSHIP

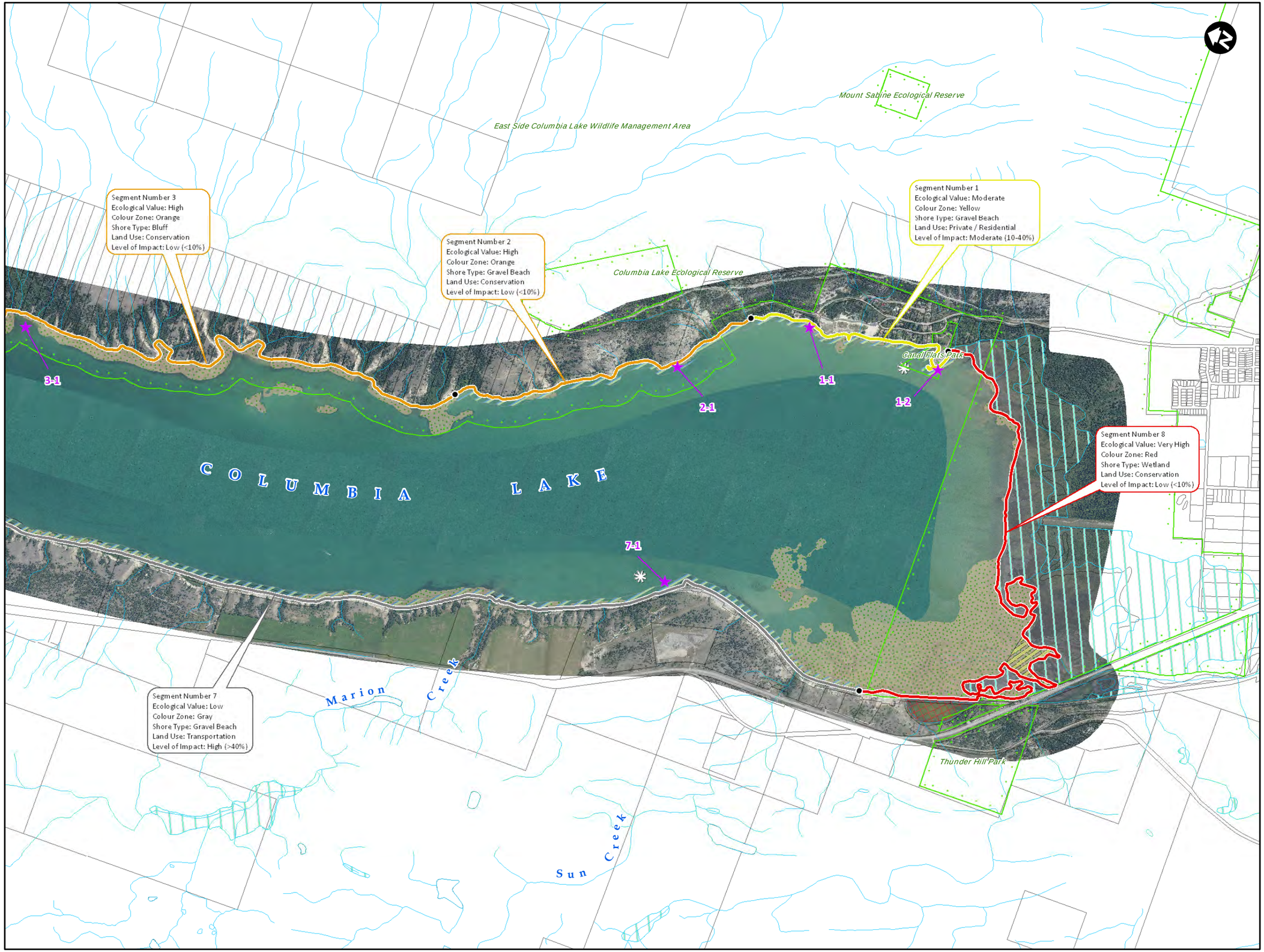
Created by:
INTERIOR REFORESTATION CO. LTD.

Overview Map



COLUMBIA LAKE - 2010 FORESHORE INVENTORY AND MAPPING

Appendix A - Columbia Lake South



Features

- Sample Site
- Wetlands
- Park/Protected Area
- Legal Boundaries

Shoreline Colour Zone

- Red
- Orange
- Yellow
- Gray

Zones of Sensitivity

- Biologically Productive
- Wildlife
- Burbot Spawning
- Emergent Vegetation
- Burbot Rearing

1:25,000

0 250 500 750 1,000 *Meters*

Data Sources

- Regional District Base Map and Legal Plans: Regional District of East Kootenay (Accuracy +/- 10 meters)
- Columbia Lake 2008 Orthophoto: Provided by RDEK (20 cm res.)
- Parks/Protected Areas: GeoBC, Province of BC
- Shoreline Segments: Modified from TRIM Lake data (1:20,000)
- CWB Wetlands: GeoBC, Province of BC
- Emergent Vegetation: Digitized from 2008 Orthophoto (20 cm res.) in conjunction with Field verification/GPS mapping - March 2009

Map Information

Map Projection: UTM 11
Map Datum: NAD 1983
Scale: 1:25,000
Issue Date: June 01, 2010

Cartographic Information

Created By: D.Hlushak
Reviewed By: S.McPherson
Map Document: 10WILD6A\MXD_Data\AppA_FIM_S.mxd

GIS Standard Map Disclaimer:

This product is for illustrative purposes only. Information shown on this map may be compiled from numerous sources and may not be complete or accurate. Interior Reforestation Co. Ltd. is not responsible for any interpretation or conclusions based on these data made by those who acquire or use it.

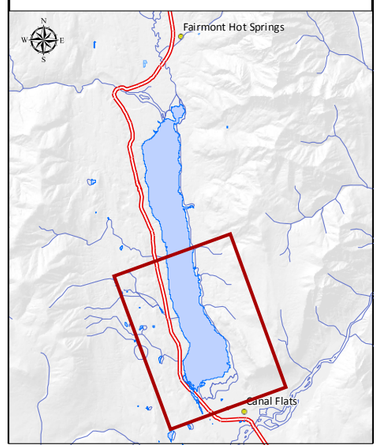
Created for:

EAST KOOTENAY
INTEGRATED LAKE
MANAGEMENT PARTNERSHIP

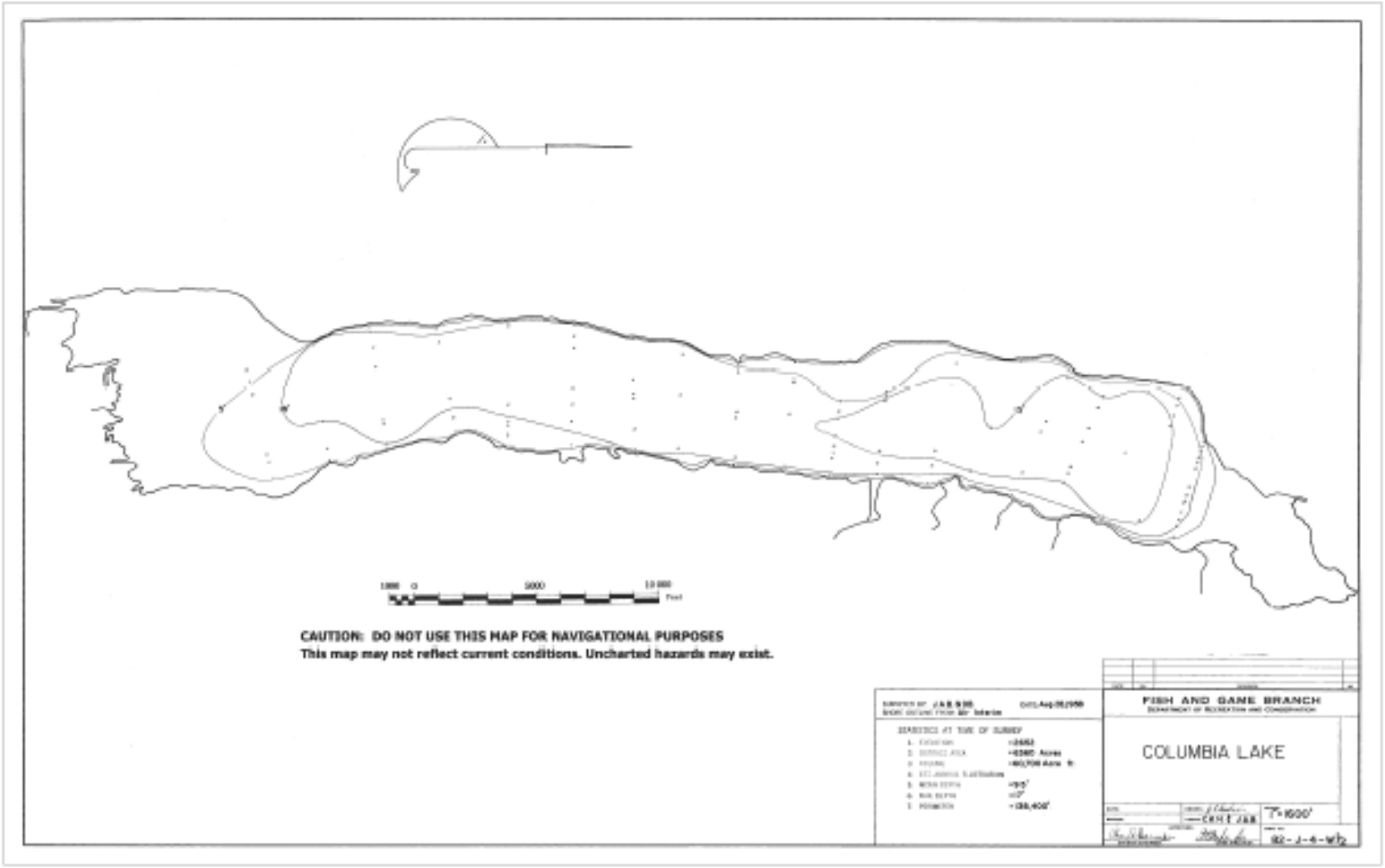
Created by:

INTERIOR REFORESTATION CO. LTD.

Overview Map



Appendix B. Bathymetric Map of Columbia Lake



Appendix C. Segment Database

							Land Use (%)											Shore Type (%)									Substrates (%)											
Segment Number	Segment Length (m)	Lot #	Photo Number (LP and HL's cameras)	Predominant Shore Type	Predominant Land Use	Level of Impact	Natural	Disturbed	Crown Land	Private / Residential	Agricult-ural	Park	Urban Park-land	Transport ation	Conservatio n (WMA)	Livestock Access	Land Use Comments	Cliff	Bluff	Gravel Beach	Sand Beach	Low Rocky Shore	Wet-land	Stream Mouth	Shore Type Comments	Fines	Gravel	Cobble	Boulder	Bedrock	Substrate Compaction	Substrate Comments	Riparian Class	Riparian Qualifier	Riparian Stage	Shore Cover	Riparian Veteran	Riparian Snag
1	1876.7	Lots 8533-8211	LP: 0917 d/s start, 0918 East. HL: 1 to 10	Gravel Beach	Private / Residential	Moderate	55	45	0	90	0	0	10	0		No	Canal Flats Provincial Park	0	5	95	0	0	0	0		83	17	0	0	0	Unknown	some artificial substrates	Mixed forest	Natural	mature forest	Abundant (>20%)	No	No
2	2328.8	DL 4596	LP: 01919 d/s start, 0920 waterfall (pt 2), 0921 cliff/bluff (pt 3), 0922 eroding bank (pt 4), 0923 u/s end. HL: 11 waterfall, 12 cliff/bluff	Gravel Beach	Conservation	Low	100	0	0	10	0	0	0	0	90	No	Columbia Lk. WMA/ Columbia Lk. Ecol Res.(upland); section within Canal Flats District	35	15	50	0	0	0	0	All gravel beach sections are backed by vegetated areas.	45	5	33	12	5	Low		Mixed forest	Natural	mature forest	Moderate (5-20%)	No	No
3	12877.7	DL 4596, SL 9 (Columbia Lake Provincial Park), DL 48	LP: 0924 (pt 5), 0925 u/s end. HL: 13 campsite, 14 cliff/bluff, 15 bald eagle	Bluff	Conservation	Low	100	0	0	15	0	15	0	0	70	No	Private area is zoned for resort; Crown is WMA; and Park is Columbia Lk. Prov. Park. WMA is situated on land that is zoned A-1 (rural resource) .	0	70	14	0	0	15	1	Wetland areas are found in lowlying areas (valleys) between the bluffs. Landsdown and Warspite Creeks	72	23	3	2	0	Unknown		Mixed forest	Natural	mature forest	Abundant (>20%)	>=5	>=5
4	4467.6		LP: 0926. HL: 16	Wetland	Conservation	Low	100	0	0	0	0	35	0	0	65	No	WMA; Park is Col. Lk. Prov. Park.	0	0	0	0	0	80	20		100	0	0	0	0	Unknown		Natural wetland	Natural	mature forest	Abundant (>20%)	No	No
5	755.1	DL 16931, DL 16932, DL 12574	HL: 17	Gravel Beach	Urban Parkland	Mod	0	100	0	0	0	0	93	0	7	No	WMA and Columere. WMA section has had riparian vegetation removal	0	0	100	0	0	0	0		65	25	8	2	0	Unknown		Herbs/ grasses	Urban Residential	Herbs/grasses	Sparse (<5%)	No	No
6	7167.7	DL12572 to end of DL 7558	LP:0927 boat launch (pt 6), 0928 dock/marina (pt 7); HL: 18 & 19	Gravel Beach	Transportation	High	5	95	5	5	0	0	0	90	0	No	Railway transport. Small crown/private pockets btwn lake and railway (beaches used by public-docks, canoes etc)	0	0	96	0	0	0	4	Railway and then bluffs are situated upslope from the gravel beaches. Hardie and Major Creeks.	35	53	10	3	0	Unknown		Shrubs	Disturbed	low shrubs <2m	None	No	No
7	6694.2	DL 4596 to DL 12564	LP: 0929 inflow @ Hwy 93/95	Gravel Beach	Transportation	High	0	100	0	0	0	0	0	100	0	No	Railway transportation.	0	0	99	0	0	0	1	Marion Creek.	0	100	0	0	0	Unknown		Shrubs	Disturbed	low shrubs <2m	Sparse (<5%)	>=5	>=5
8	7123.5	DL 12564, 16433	LP: 0930	Wetland	Conservation	Low	85	15	0	0	0	0	0	15	85	No	WMA; ThunderHill Provincial Park in SW corner beyond railway. Highway runs along portion of	0	0	0	0	0	95	5	Wetland on inland side of road; unnamed creek in SW corner.	100	0	0	0	0	Unknown		Natural wetland	Natural	low shrubs <2m	Abundant (>20%)	No	No

	Riparian												Littoral Zon		Shoreline Modifications														
Segment Number	Band 1 Riparian (m) (GIS)	Riparian Band 1 Score	Vegetation Quality Band 1 (GIS)	Vegetation Quality Band 1 Score	Band 2 Upland (m) (GIS)	Riparian Band 2 Score	Vegetation Quality Band 2 (GIS)	Vegetation Quality Band 2 Score	Riparian Bankslope	Riparian Overhang	Overhanging Vegetation (GIS)	Riparian Comment	Emergent Vegetation % (GIS)	Littoral Zone	Retaining Wall	Retaining Wall Material	# Ret. Wall Below High Water Mark	% of shoreline with Ret. Wall	Docks	Dock Material	Groynes	Groyne Material	Railway	Marine Railway	Marinas	Boat Launch	Other / Comments	Fauna Observed and General Comment
1	15	0.8	Mixed forest	0.8	20	1.0	Lawn	0.3	30	0	30		57	Shallow	4	3-rock, 1 pressure treated wood	2	5	9	Wood	2	Stone (pt 9), Mixed (pt 1)	No	0	0	1		mergansers
2	15	0.8	Mixed forest	0.8	20	1.0	Coniferous Forest	0.8	40	1	60		28	Shallow	0				0		0		No	0	0	0		Sept: king fisher, gulls, crow.
3	7.5	0.4	Mixed forest	0.8	20	1.0	Coniferous Forest	0.8	45	0	40	mature cotton wood patch	91	Shallow	0				0		0		No	0	0	0		Sept: bald eagle, mergansers, geese, coots, king fisher. March: mass of eagles in middle of lake around deer carcass; beaver house in wetland; cliff swallow nests in bluffs, muskrat homes on ice all around lake (every 100 m or so), mussel shells evident in muskrat diggings. Includes Armstrong Bay, a significant bay within the WMA with potentially unique ecological features. An Amercian bittern, a blue-listed species, (BC CDC 2009) was heard calling on the Lot 48 shoreline in 2009 (R. Hopkins pers comm.)
4	20	1.0	Natural wetland	1.0	20	1.0	Mixed forest	0.8	0	0	35	lake outlet	90	Shallow	0				0		0		No	0	0	0		
5	10	0.6	Lawn	0.3	0	0.0		0.0	0	0	10		27	Shallow	1	rock	1	100	1	Wood	1		Yes	0	1	0	Marina has 78 boat slips. Oil noted on water's surface at 2 slips (Sept 2009). Includes a canoe storage facility.	
6	2	0.2	Shrubs	1.0	20	1.0	Coniferous Forest	0.8	45	0	10		80	Shallow	0				3	Wood	1	Other	Yes	0	0	1	Railway on edge of lake. Mooring anchors/chain noted in Sept 2009, that had significant scour (+/- 2m in some locations)	Sept: merganser.
7	2	0.2	Shrubs	1.0	20	1.0	Coniferous Forest	0.8	45	0	5	railway on edge of lake , cotton wood areas behind have riparian veg	53	Shallow	0				1	Wood	0		Yes	0	0	1		
8	20	1.0	Natural wetland	1.0	20	1.0	Mixed forest	0.8	0	0	0		91	Shallow	0				0		0		Yes	0	0	0		Sept: geese+gulls. The isolated pond west of the railway is an important area for waterfowl, painted turtles, beaver and other wildlife.

	Confirmed Sensitive Species / Zones of Sensitivity				
Segment Number	**Burbot Spawning**	**Kokanee Staging and Rearing**	**Burbot Rearing**	**Mussel Beds**	**Wildlife**
1			Taylor (2001) found that juveniles were strongly associated with the bottom and microhabitats providing cover, particularly the interstitial spaces in the substrate. Sites with intermediate sized substrate (gravel and cobble) had the most age 0 burbot. Shelter size tends to increase with increasing body size, with older juveniles associated with cobbles and boulders.	The winged floater (Anodonta nuttaliana / californiensis) was sampled at Columbia Lake at Canal Flats Provincial Park (Moore and Machial 2007).	
2			Taylor 2001 - see comment above		
3					Armstrong Bay provides unique habitat (moist, old growth, CWD, protection from wave and wind along long axis of lake, important to beaver, adjacent wetlands). Gastony's cliff-brake (blue-listed plant) also occurs on east side of Armstrong Bay.
4	The sidechannel of Dutch Creek's alluvial fan is a historical burbot spawning area (Arndt 2000 and Taylor 1997). There are additional spawning locations under the ice in the lake itself at the north end, as evidenced by the presence of gravid and recently spent fish (Arndt 2001).	Dutch Creek is an important tributary for kokanee spawning in the Upper Columbia Basin (Manson 2006 and Oliver 1995). The wetlands at the north end of the lake (Segment 4) are important for fish migrating upstream to Dutch Creek to spawn and for the fry as they move downstream to their rearing grounds in the Kinbasket reservoir.			One of the most productive and successful Great Blue Heron nesting colonies in the East Kootenay is situated in the Dutch Creek fan at the north end of Columbia Lake (Machmer 2008). Herons stalk prey in shallow waters with abundant small fish (Butler 1992). Maintaining the integrity and wetland characteristics of foraging areas that are close to nest colonies is especially important (Machmer and Steeger 2003).
5			Taylor 2001 - see comment above		
6			Taylor 2001 - see comment above	Mussels observed in July 2009 at site 6.1 and 6.3	
7			Taylor 2001 - see comment above	Extensive mussel beds observed in July 2009 at site 7.1	
8	The unnamed spring-fed tributary at the south end of the lake is believed to be one of the more important spawning areas for burbot in the lake (Arndt and Hutchinson 2000).				Painted turtles (blue-listed species) are known from the small section of Columbia Lake in the southwest corner, isolated from the main lake by a CPR railway berm (I. Adams pers. obs.).

Appendix D. Segment Descriptions and Site Photos

Segment Descriptions and Site Photos

This appendix provides a description and photos for each of the shoreline segments. It also provides photo-documentation for each of the sites investigated through the F&W surveys. Segment and site locations are mapped in Appendix A. Site descriptions are provided in Appendix E - Fish Data and Appendix G - Wildlife Data.

Segment 1 (1876.7 m) – LoI Moderate

Segment 1 starts at the Canal Flats Provincial Park. This park comprises approximately 10% of the shoreline and was classified as 'Urban Parkland' due to the fact that it is has been modified for recreation purposes (parking lot, boat launch and grassy area). The remainder of the segment is private land. In terms of shore types this segment is predominantly Gravel Beach (95%), with some Bluff Shore Type (5%). The substrates were estimated to be 83% fines and 17 % gravels, with some artificial substrates placement (beach grooming) evident. The riparian area was identified as a mixed mature forest (containing both coniferous and broadleaf trees) with abundant (>20%) shore cover. Emergent vegetation was found along 57% of this segment. Approximately 45% of this segment was identified as being disturbed. Four retaining walls were observed, extending along approximately 5% of the shoreline. Three of the retaining walls were constructed of rock and one of pressure treated wood; two were located below the high water mark. There were also nine wooden docks and two groynes (one each of stone mixed material) identified. Mergansers were observed during the September field review.

Segment 1. View to the south from the north end of Canal Flats Provincial (left), area under development) (right). Photos: McPherson, Mar 2009.

Segment 1. Emergent vegetation along bluff area (left photo: Porto Sept 2009), and developed foreshore property (right photo: Leschied, Sept 2009).

Site 1.1: 2009 Fish (snorkel) survey and wildlife observation site (photo: Holmes July 2009)

Site 1.2: 2009 Boat launch at Canal Flats Provincial Park (photo: Holmes July 2009)

Segment 2 (2328.8 m) – LoI Low

Segment 2 was undisturbed, with no modifications evident. 90% of the shoreline falls into the East Side Columbia Lake Wildlife Management Area (zoned Rural Resource (A-1) by the RDEK). A small section (approximately 10%), located at the southern end of the segment is undeveloped private land. Half of this segment (50%) was Gravel Beach Shore Type, characterized by a narrow beach backed by a well-vegetated area. The remainder of the shore was typed as Cliff (35%), the only cliff along the lake's foreshore and Bluff (15%) shore types. Substrates were mainly cobbles (33 %) with the remainder being a mix of boulder, bedrock and gravel components. The riparian area was mainly a mixed mature forest with moderate cover (5-20%). Emergent vegetation was measured to extend along 28% of the segment.

Segment 2: Cliff Shore Type alongside Gravel Beach in Segment 2. Photo: McPherson, Mar 2009.

Site 2.1: Fish (snorkel) and wildlife observation site (photo: Holmes July 2009)

Segment 3 (12,877.7 m) – LoI Low

Segment 3 is situated along the remainder of the eastern shore and is the longest segment on the lake. The foreshore along this segment has generally not been developed and remains in a natural condition. Seventy percent of the land falls in the East Side Columbia Lake Wildlife Management Area (zoned Rural Resource), 15% is a private/residential area (DL 48 includes resort lodge and resort recreation and single family), and 15% is in the Columbia Lake Provincial Park (north end of segment). Most of this segment is Bluff Shore Type (70%). Wetland Shore Type (15%) areas are typically found in the low lying depressions between the bluff sections. Other shore types include: Gravel Beaches (14%) and Stream Mouth (1% - Landsdown and Warspite Creeks). The riparian area was contiguous with that of the previous segments, and was comprised of mixed mature forest with abundant shore cover. Numerous (≥5) riparian veteran and snag trees were noted as well as a mature cottonwood patch. Most of the foreshore length (91%) was lined with emergent vegetation. There were several wildlife observations: bald eagle, mergansers, geese, coots and a kingfisher in September 2007; and: bald eagles, beaver lodge, swallow burrows, muskrat dens on ice (actually observed all around the lake), and mussel shells in the muskrat diggings in March 2009. Segment 3 includes Armstrong Bay, a significant bay within the East Side Columbia Lake Wildlife Management Area with potentially unique ecological features.

Segment 3. Bluff (left: Leschied, Sept 2007) and wetland Shore Types (right: McPherson, Mar 2009).

Site 3.1: Fish (seine), invertebrate sampling and wildlife observation site (photo: Holmes July 2009)

Site 3.2: Fish (seine), invertebrate sampling and wildlife observation site (off Lot 48); right photo grizzly bear print in September (photos: Holmes 2009)

Site 3.3: Armstrong Bay, Wildlife observation site (photo: Holmes July 2009)

Segment 4 (4467.6 m) – LoI Low

This segment includes the Columbia Lake outlet, located at the lake's north end. The foreshore here is in a natural condition; and is situated within the Columbia Lake Provincial Park (35% of segment) and East Side Columbia Lake Wildlife Management Area (65%). The shore type is comprised of 80% Wetland[1] and 20% Stream Mouth Shore Types. The riparian vegetation is classified as natural wetland, which is mature and provides abundant coverage. Emergent vegetation was mapped along 90% of this segment.

Segment 4. Overhead photo of wetland at north end of Columbia Lake. Photo: July 2008.

Segment 5 (755.1 m) – LoI High

Segment 5 is situated along the low-lying section of the Columere Park Development on the north-west shore of Columbia Lake. The northern extent of this segment lies within the Wildlife Management Area (7%) and the remainder is on urban parkland, which is an open recreational beach access area for the community. This Segment has been 100% disturbed by means of a rock retaining wall which extends along the total extent of shoreline, riparian vegetation removal, dock (1), groyne and presence of a railway. Gravel Beach Shore Type extends along the length of this segment. The riparian area is comprised of manicured herb/grasses. Emergent aquatic vegetation was found along 27% of the shoreline.

[1] Geo BC. BC's geographic gateway. Accessed 2009 http://www.geobc.gov.bc.ca/

Segment 5. Columere shoreline, which has been largely altered from its natural condition (Photo: Leschied Sept 2007)

Sites 5.1 (left): fish (seine) survey, wildlife observation and invertebrate sampling site; Site 5.2 (right): snorkel site (photos: Holmes July 2009).

Segment 6 (7167.7 m) – Lol High

Segment 6 is located to the south of Segment 5, starting at the point where the bluff topography initiates along the west side of the lake. The shore type is mostly gravel beach (96%), with the high bluffs lying just beyond the narrow bench upon which the railway has been constructed. The Stream Mouth Shore Type makes up a small proportion (4%) of shore as well, as demarcated by the outlets of Hardie and Major Creeks. These creeks enter the lake via culverts under the railway. Most (95%) of the area has been disturbed by the presence of the railway. A few narrow crown and private land pockets buffer the shoreline from the railway. These pockets were utilized by the public (e.g. presence of 3 wood docks, 1 groyne and canoes on shore). The riparian area was disturbed and was comprised of low shrubs (<2 m), providing no cover. Emergent aquatic vegetation was found along a great extent of the shoreline (80%). Three wooden docks, one groyne and a boat launch were additional modifications observed along the shoreline. The bluff at the northern end of Segment 6 (below Columere) is slumping and threatening the CPR railway. The CPR is seeking approval to counter the slumping bluff with a large deposit of coarse material on the foreshore (including in the lake).

Segment 6. The cross section of the shoreline up from the lake in this segment is gravel beach, railway and then bluffs. Photos: left - Leschied Sept 2007, right - McPherson, Mar 2008.

Site 6.1: Fish (seine) survey, invertebrate and wildlife observation site (photos: Holmes July 2009)

Site 6.2: Fish (seine), invertebrate and wildlife observation site (photo: Holmes Sept. 2009)

Site 6.3: Fish (snorkel) survey and wildlife observation site (photo: Holmes Sept. 2009)

Segment 7 (6694.2 m) – Lol High

Segment 7, extends along the southern half of the west side of the lake. Similar to Segment 6, the railway runs along the gravel shoreline and bluffs form the terrestrial backdrop. The segment has been 100% disturbed as a result of the railway. The shore type is predominantly Gravel Beach (99%), with 1% being Stream Mouth (Marion Creek – culvert opening to lake). The riparian area along this segment was disturbed and limited to low shrubs providing sparse coverage. Some riparian veteran trees and snags (equal or greater to 5 for both) were noted in the cottonwood stands behind the railway. Emergent aquatic vegetation was determined to extend along 53% of this segment. Additional modifications noted were a wooden dock, a groyne and a boat launch.

Segment 7. Marion Creek flow entering into the lake through a culvert under the railway. Photo: Porto Sept 2007.

Site 7.1: Fish (snorkel) survey and wildlife observation site (photo: Holmes Sept. 2009)

Segment 8 (7123.5 m) – LoI Low

This segment incorporates the south end of the lake, which is primarily situated in the East Side Columbia Lake Wildlife Management Area. The railway and highway runs along the western edge of this segment, owing to 15% of shoreline disturbance. The shore type here is mostly Wetland (95%; as provided by GeoBC), with some Stream Mouth influence (5%) on from the unnamed spring fed creek in the south western corner. Emergent aquatic vegetation is prevalent throughout, extending along approximately 91% of the shoreline and infilling much of the southern area. The riparian area is classified as natural wetland and is abundantly covered with low shrubs. Wetland shore type is also found on the upland side of the highway. Geese and gulls were observed utilizing this segment during the September, 2007, survey. The isolated pond west of the railway is an important area for waterfowl, painted turtles, beaver and other wildlife and is partially bordered by Thunder Hill Provincial Park.

Segment 8. Looking east across highway towards the southern wetlands. Photo: Leschied, June 2007.

Appendix E. Fish Field Data

TABLE I: FISHERIES FIELD DATA FROM FORESHORE SAMPLING IN JULY AND SEPTEMBER OF 2009

Segment	Site	Sampling Season	Sampling Date	Start Time	End Time	Substrate Type (%)	Aquatic Vegetation	Air Temp. (°C)	Water Temp.(°C)	Photo No.	Sample Type	Channel Distance (m)	Species	Number of Fish	Life Stage	Fish Comments	General Site Observations
1	1	Summer	15-Jul-09	13:35	14:00	100 silt	rushes, coontails, chara	20	18.9	n	snorkel	200	sucker	6	adults		Wind 15-20km/h; snorkelled large reed bed and one dock
1	1	Summer	15-Jul-09	13:35	14:00	100 silt	rushes, coontails, chara	20	18.9	n	snorkel	200	unidentified	1	adults	20"	
1	1	Summer	15-Jul-09	13:35	14:00	100 silt	rushes, coontails, chara	20	18.9	n	snorkel	200	cyprinids	1000+	mixed ages		
1	1	Summer	15-Jul-09	13:35	14:00	100 silt	rushes, coontails, chara	20	18.9	n	snorkel	200	red sided shiner	100	adults		
2	1	Summer	15-Jul-09	13:05	13:25	90 silt, 10 boulder cobble	coontail, richardson's pondweed, floating pondweed, northern milfoil	23.3	18.9	n	snorkel	175	northern pike minnow	2	adults		Shore type: cliff; small trib coming in at south end of segment; heavy aquatic plants; visibility 2-3m
2	1	Summer	15-Jul-09	13:05	13:25	90 silt, 10 boulder cobble	coontail, richardson's pondweed, floating pondweed, northern milfoil	23.3	18.9	n	snorkel	175	sucker	2	adults		
2	1	Summer	15-Jul-09	13:05	13:25	90 silt, 10 boulder cobble	coontail, richardson's pondweed, floating pondweed, northern milfoil	23.3	18.9	n	snorkel	175	cyprinids	1000+	mixed ages		
3	1	Summer	15-Jul-09	9:00	9:30	20 gravel cobble, 75 silt, 5 boulder	spike rushes, chara, potamogetan spp (stuckenia)	12.8	17.9	n	seine	15	cyprinids	8	juv		Observed 6 large 18-20 inch fish on approach to beach in red beds (species Unknown); small bay sorounded by spike rushes
3	1	Summer	15-Jul-09	9:00	9:30	20 gravel cobble, 75 silt, 5 boulder	spike rushes, chara, potamogetan spp (stuckenia)	12.8	17.9	n	Seen from boat	15	sculpin	1	adults		
3	1	Summer	15-Jul-09	9:00	9:30	20 gravel cobble, 75 silt, 5 boulder	spike rushes, chara, potamogetan spp (stuckenia)	12.8	17.9	n	Seen from boat	15	whitefish	3	adults		
3	1	Summer	15-Jul-09	9:00	9:30	20 gravel cobble, 75 silt, 5 boulder	spike rushes, chara, potamogetan spp (stuckenia)	12.8	17.9	n	Seen from boat	15	sucker	2	adults		
3	1	Summer	15-Jul-09	9:00	9:30	20 gravel cobble, 75 silt, 5 boulder	spike rushes, chara, potamogetan spp (stuckenia)	12.8	17.9	n	Seen from boat	15	unidentified	6	adults	large 18-20" fish	
3	2	Summer	16-Jul-09	10:10	10:35	5 sand, 10 gravel, 85 silt	hardstem rush, arrow grass	16.7	17.2	n	seine	2 x 15	whitefish	9	adults		Shallow silty bay with abundant rushes
3	2	Summer	16-Jul-09	10:10	10:35	5 sand, 10 gravel, 85 silt	hardstem rush, arrow grass	16.7	17.2	n	seine	2 x 15	red sided shiner	9	adults		
3	3	Summer	16-Jul-09	n	n	n	no record	n	n	n	n	n				no fish	
3	4	Summer	16-Jul-09	18:00	9:30	50 gravel, 50 silt	no record	16.1	18.9	n	trap net	15	none	0		observed 6 dead suckers segments 3,5,6,8	Shallow trap net set
5	1	Summer	16-Jul-09	9:30	9:50	50 gravel, 15 cobble, 5 boulder, 30 silt/sand	nil	16.1	18.9	n	seine	15	mountain whitefish	7	juvenile		Columere Park Marina beach front-private beach
5	2	Summer	16-Jul-09	13:55	14:19	100 silt	reed canary grass, sedges	25	20	n	observed from dock	100	shiners	10+	juvenile		Columere Park Marina beach front-private beach; canary reed grass, sedges along the edge of marina; one water scorpion (photo HL)
5	2	Summer	16-Jul-09	13:55	14:19	100 silt	reed canary grass, sedges	25	20	n	observed from dock	100	northern pike minnow	10 +	adults		
5	2	Summer	16-Jul-09	13:55	14:19	100 silt	reed canary grass, sedges	25	20	n	observed from dock	100	pumpkinseed sunfish	1	adults	water scorpion observed and photographed.	
6	1	Summer	15-Jul-09	10:00	10:30	40 gravel, 40 cobble, 10 boulder, 10 silt	nil	16.7	17.8	n	seine	2 x 15	sculpin	1	adults	mussel scattered 1.5 meters deep in silt	Mussels scattered approx. 1.5m deep in silt
6	2	Summer	15-Jul-09	11:10	11:25	gravel 70, silt 30	richardson's pondweed, floating pondweed, pondweed-stuckenia,	22.2	18.9	n	seine	2 x 15	red sided shiner	2	adults		Heavy macrophyte bed just off of smaple site; 7 species of macrophytes (Richardson pondweed, floating pond weed, pondweed- stuckenia); mussel shells present
6	2	Summer	15-Jul-09	11:10	11:25	gravel 70, silt 30	richardson's pondweed, floating pondweed, pondweed-stuckenia,	22.2	18.9	n	seine	2 x 15	whitefish	2	adults	mussel shells present	
6	2	Summer	15-Jul-09	11:10	11:25	gravel 70, silt 30	richardson's pondweed, floating pondweed, pondweed-stuckenia,	22.2	18.9	n	seine	2 x 15	cyprinids	100+	adults		

Segment	Site	Sampling Season	Sampling Date	Start Time	End Time	Substrate Type (%)	Aquatic Vegetation	Air Temp. (°C)	Water Temp.(°C)	Photo No.	Sample Type	Channel Distance (m)	Species	Number of Fish	Life Stage	Fish Comments	General Site Observations
6	3	Summer	16-Jul-09	13:00	13:15	silt 100	hard stemmed bullrush, chara	21.1	18.9	n	snorkel	100	none	0		poor visibility due to wind	Bella Vista dock with 10 boats moored; poor visibilty likely due to wind; prop wash along whole bay; chains scour bottom (tying boats to bouys); bay is approx. 4 feet deep
7	1	Summer	15-Jul-09	15:00	15:30	gravel 50, silt gravel	robinson pondweed, coontail, floating pondweed	27.9	19.4	n	snorkel	n	sucker	6	adults	100 gravel 0-1 m, 100 silt below drop off	Extensive mussel beds
7	1	Summer	15-Jul-09	15:00	15:30	gravel 50, silt gravel	robinson pondweed, coontail, floating pondweed	27.9	19.4	n	snorkel	n	northern pike minnow	2	juvenile	extensive mussel beds	
1	1	Fall	15-Sep-09	14:12	14:25	no record	no record	20	14.5	n	snorkel	100	shiners	1000+	juvenile		
1	1	Fall	15-Sep-09	14:12	14:25	no record	no record	20	14.5	n	snorkel	100	sucker	1	adults		
1	2	fall	15-Sep-09	14:30	14:50	rip rap with silt and organics at toe	typical types of plants	21	15	n	snorkel	120	sculpin	1	adults		South boat launch at Provincial park; new segment created in fall
1	2	fall	15-Sep-09	14:30	14:50	rip rap with silt and organics at toe	typical types of plants	21	15	n	snorkel	120	red sided shiner	1000+	mixed ages	south boat launch at Provincial park	
1	2	fall	15-Sep-09	14:30	14:50	rip rap with silt and organics at toe	typical types of plants	21	15	n	snorkel	120	largemouth bass	12	juvenile		
1	2	fall	15-Sep-09	14:30	14:50	rip rap with silt and organics at toe	typical types of plants	21	15	n	snorkel	120	sucker	10	juvenile		
2	1	fall	15-Sep-09	13:40	13:57	no record	no record	19	15	n	snorkel	250	sucker	3	adults		Cliffs don't lead to deep water, below surface bottom flattens; heavy aquatic macrophytes; 3 piles of mussel shells, perhaps from otters eating them
2	1	fall	15-Sep-09	13:40	13:57	no record	no record	19	15	n	snorkel	250	northern pike minnow	3	adults	approx 50 cm	
2	1	fall	15-Sep-09	13:40	13:57	no record	no record	19	15	n	snorkel	250	red sided shiner	1000 +	mixed ages	dense aquatic macropyhtes	
3	1	Fall	15-Sep-09	9:45	9:50	silt/organics	chara	14	14	n	seine	2 x 20	largemouth bass	3	juvenile	no fish on first seine, remainder caught on second pull.	
3	1	Fall	15-Sep-09	9:45	9:50	silt/organics	chara	14	14	n	seine	2 x 20	red sided shiner	7	adults		
3	2	Fall	16-Sep-09	11:05	11:10	silt organics	rushes	23	16	n	seine	50	whitefish	12	adults	50+ whitefish spotted from the boat; 10 adult suckers	Shallow bay off Lot 48; scattered rushes;
3	2	Fall	16-Sep-09	11:05	11:10	silt organics	rushes	23	16	n	seine	50	shiners	15	adults		
3	2	Fall	16-Sep-09	11:05	11:10	silt organics	rushes	23	16	n	seine	50	sculpin	1	adults		
3	2	Fall	16-Sep-09	11:05	11:10	silt organics	rushes	23	16	n	observed	n	whitefish	50	adults		
3	2	Fall	16-Sep-09	11:05	11:10	silt organics	rushes	23	16	n	observed	n	sucker	10	adults		
3	3	Fall	16-Sep-09	n	n	n	n	n	n	n	observed	n	sucker	4	adults	no fish habitat assessed, only wildlife; 4 adult suckers amongst reed bed (spotted from boat)	Armstrong Bay
5	1	Fall	16-Sep-09	11:55	12:05	gravel, cobble, silt	chara	20	16.5	PH	seine	30	whitefish	4	juvenile	schools of unidentified juveniles present- viewed from boat	
5	1	Fall	16-Sep-09	11:55	12:05	gravel, cobble, silt	chara	20	16.5	PH	seine	30	red sided shiner	3	juvenile		
5	1	Fall	16-Sep-09	11:55	12:05	gravel, cobble, silt	chara	20	16.5	PH	observed	30	schools of unidentified juveniles	n	juvenile		
5	2	Fall	16-Sep-09	12:37	13:00	silt organics	milfoil, chara	23.5	17.5	HL	snorkel	150	shiners	100	juvenile	one unidentified 20 cm-NPM?	Oil film on surface at 2 slips;
5	2	Fall	16-Sep-09	12:37	13:00	silt organics	milfoil, chara	23.5	17.5	HL	snorkel	150	pumpkinseed sunfish	4	adults	oil film at 2 slips	
5	2	Fall	16-Sep-09	12:37	13:00	silt organics	milfoil, chara	23.5	17.5	HL	snorkel	150	unidentified	1		20 cm	
5	2	Fall	24-Sep-09	14:00	10:00	silt organics	milfoil, chara	20	17.5	n	gee trap		pumpkinseed sunfish	20	juvenile		
5	2	Fall	24-Sep-09	14:00	10:00	silt organics	milfoil, chara	20	17.5	n	gee trap		northern pike minnow	2	juvenile		
6	1	Fall	15-Sep-09	10:55	11:00	gravel/cobble	nil	17.5	15	PH	seine	1x15	cyprinids	6	juvenile		
6	2	Fall	15-Sep-09	11:20	11:30	gravel, organics, silt	floating pondweed, chara	19.5	14.5	n	seine	2x15	whitefish	1	juvenile		Unusual gravel deposit of unknown origin, possibly glacial
6	2	Fall	15-Sep-09	11:20	11:30	gravel, organics, silt	floating pondweed, chara	19.5	14.5	n	seine	2x15	whitefish	1	adults		
6	2	Fall	15-Sep-09	11:20	11:30	gravel, organics, silt	floating pondweed, chara	19.5	14.5	n	seine	2x15	cyprinids	40+	mixed ages	Odd gravel deposits of unknown origin	

Segment	Site	Sampling Season	Sampling Date	Start Time	End Time	Substrate Type (%)	Aquatic Vegetation	Air Temp. (°C)	Water Temp.(°C)	Photo No.	Sample Type	Channel Distance (m)	Species	Number of Fish	Life Stage	Fish Comments	General Site Observations
6	3	Fall	16-Sep-09	13:10	13:35	n	reed beds	21	17	HL	snorkel	200	largemouth bass	1	adults		Mooring chains create scouring 1-2 m . Short chains that don't sag don't have scouring; guidelines should specify no chains for anchoring mooring bouys
6	3	Fall	16-Sep-09	13:10	13:35	n	reed beds	21	17	HL	snorkel	200	pumpkinseed sunfish	20	juvenile		Mussels scattered throughout the bay
6	3	Fall	16-Sep-09	13:10	13:35	n	reed beds	21	17	HL	snorkel	200	shiners	100+	mixed ages		
7	1	Fall	15-Sep-09	13:05	13:20	gravel, silt, organics	floating pondweed, richardsons pondweed, northern milfoil	20.5	14.5	PH	snorkel	150	red sided shiner	1000+	juvenile		Greater abundance of fish than usual in bull rush habitat
7	1	Fall	15-Sep-09	13:05	13:20	gravel, silt, organics	floating pondweed, richardsons pondweed, northern milfoil	20.5	14.5	PH	snorkel	150	sucker	5	adults		
7	1	Fall	15-Sep-09	13:05	13:20	gravel, silt, organics	floating pondweed, richardsons pondweed, northern milfoil	20.5	14.5	PH	snorkel	150	northern pike minnow	1	adults		
7	1	Fall	15-Sep-09	13:05	13:20	gravel, silt, organics	floating pondweed, richardsons pondweed, northern milfoil	20.5	14.5	PH	snorkel	150	unidentified	3	adults		

Appendix F. Aquatic Invertebrate Field Data and Analysis

Table I. Aquatic Invertebrate Sampling along the Columbia Lake Foreshore (July 15/16, 2009)

Site	Number	Order	Common Name
3.1	1	Odonata	Dragonfly
	4	Hemiptera	Water Boatman
	6	Ephemeroptera	Mayfly
	1	Coleoptera	beetle
	10	Hydrachnida	Water Mite
	20	Amphipoda	Scud
	2	Diptera	True Fly
	5	Plecoptera	Stonefly
	1	Copepoda	Copepod
	9	Trichoptera	Caddisfly
	1	Odonata	Damsel fly
	1	Megaloptera	unknown
	3	Gastropoda	snail
3.2	5	Amphipoda	Scud
	3	Ephemeroptera	Mayfly
	6	Hydrachnida	Water Mite
	100+	Copepoda	Copepod
	10+	phylum annelida	worms
	1	Gastropoda	snail
	2	Veneroida	clams (shell only)
	8	Diptera	
5.1	50+	Ephemeroptera	Mayfly
	10+	Amphipoda	Scud
	3	Hydrachnida	Water Mite
	3	Copepoda	Copepod
	1	Diptera	Midge
	1	Odonata	Damsel fly
	50	Diptera	chiromid casings
	4	Hemiptera	Water Boatman
	7	Amphipoda	Scud
6.1	10	Diptera	Midge
	5	Hydrachnida	Water Mite
	100	Copepoda	Copepod
	40	phylum annelida	worms
	4	Hemiptera	Water Boatman
	100+	Copepoda	Copepod
	2	Branchiobdellida	leech
6.2	50+	Amphipoda	Scud
	100+	Hydrachnida	Water Mite
	10+	phylum annelida	worms
	2	Ephemeroptera	Mayfly
	1	Odonata	Damsel fly

Table II. Simpson's Index of Diversity, for Aquatic Invertebrate Data.

	Site 3.1		Site 3.2		Site 5.1		Site 6.1		6.2	
Order	**n**	**n(n-1)**	**n**	**n(n-1)**	**n**	**n(n-1)**	**n**	**n(n-1)**	**n**	**n(n-1)**
Odonata	2	2		0	1	0		0	1	0
Hemiptera	4	12	3	6		0	4	12	4	12
Ephemeroptera	6	30		0	50	2450		0	2	2
Coleoptera	1	0	6	30		0		0		0
Hydrachnida	10	90	5	20	3	6	5	20	100	9900
Amphipoda	20	380	8	56	10	90	7	42	50	2450
Diptera	2	2		0	51	2550	10	90		0
Plecoptera	5	20	100	9900		0		0		0
Copepoda	1	0		0	3	6	100	9900	100	9900
Trichoptera	9	72		0		0		0		0
Megaloptera	1	0	1	0		0		0		0
Gastropoda	3	6	10	90		0		0		0
phylum annelida		0	2	2		0	40	1560	10	90
Veneroida		0		0		0		0		0
Branchiobdellida		0		0		0		0	2	2
Sum	**64**	**614**	**135**	**10104**	**118**	**5102**	**166**	**11624**	**269**	**22356**

Analysis

Site	**3.1**	**3.2**	**5.1**	**6.1**	**6.2**
N	64	135	118	166	269
Sum n(n-1)	614	10104	5102	11624	22356
N(N-1)	4032	18090	13806	27390	72092
Simpson's Index D= Sum n(n-1)/N(N-1)	0.15228	0.558541	0.36955	0.424388	0.3101
Simpson's Index of Diversity (1-D)	0.84772	0.441459	0.63045	0.575612	0.6899
Species Richness	12	8	6	6	8

Appendix G. Wildlife Data

Table I. 2009 Field Notes, Summarizing Site Characteristics and Wildlife Data

Habitat Type	Site									
	1.1	**2.1**	**3.1**	**3.2**	**3.3**	**5.1**	**6.1**	**6.2**	**6.3**	**7.1**
Forest Canopy - Age/Canopy - Species	Mid, 1/2 little; 1/2 Open -Fd	mod-to nil along cliff; closed along shore -Fd, Sp	Mature/closed - some open - Sp, Bp, Fd	Sparse, open-closed Fd, At, Sp.	Closed, moderate, old, Fd	Sparse Ct. young		Gravel bar mid -open/closed -Ct	Closed, mature Fd, Sp, Ct	Mature Ct, Bp, Fd
Wildlife Trees	Few	Few	Few	Yes, adjacent	Abundant			1 Ct	Few	Few Ct
CWD/LOD	Some CWD	Yes, yes	CWD	Adjacent	Abundant			CWD Abundant LOD few	CWD	
Shrub Cover – Amount - Species	Abundant Willow, alder	Sparse Juniper, alder, willow	Abundant Alder, juniper, soopolallie, rose	Sparse Willow, rose, saskatoon, alder, juniper, sage, red osier dogwood	Willow, red osier dogwood, alder, rose, snow berry	Sparse; west end - Soopolallie, alder, willow, saskatoon	Sparse Saskatoon, willow, alder	Sparse/abundant Soopalalie, red osier dogwood, rose, kinnikinnick, saskatoon, alder, willow, juniper	Abundant Alder, red osier dogwood, saskatoon, willow	Abundant juniper, hawthorn, raspberry, saskatoon, gooseberry, red osier dogwood, soopolallie, kinnikinnick, chokecherry
Grasslands	Introduced			Yes	Yes	Introduced				No
Clay Banks	Removed by developers	Cliff		Yes	Yes	Yes	Above (cave)		Yes	gravel bank behind tracks
Adjacent Wetlands				No	Yes	Yes		Yes		
Littoral Zone			Shallow							
Emergent/submergent aquatic vegetation	Both	Emergent	Both	Both	Both				Both	Submergent
Wildlife Observations - July	Swallows, yellow warbler, red-winged blackbird	Bald eagle, violet green swallow	Dark-eyed junco, song sparrow, night hawk, sandpiper, varied thrush, red-winged blackbird, warbler, swallows, waxwing.	N. flicker, crow, kingfisher, sparrow, swallow, elk tracks (lots), immature eagle, robin, sandpiper, cow tracks, osprey	Mallard, goldeneye, A. widgeon, red-winged blackbird, swallows, song sparrow, common yellow throat warbler, c.w. swallow.	Swallows, immature eagle, sparrow, gull, osprey, red-winged blackbird.	Black-capped chickadee, kingfisher, pine siskin, swallows	Merganser family, red-winged blackbird, loon, ring-necked grebe, humming bird, waxwing, song sparrow, yellow warbler, s. sandpiper, swallows, black-capped chickadee, dark-eyed junco, elk pellets (lots), heavy browse, mussels, crow, osprey, gulls	Swallows, immature bald eagle, ravens, song sparrow, sandpiper.	Osprey, kingfisher, swallows, sandpiper, robin, mussel beds

Habitat Type	Site									
	1.1	2.1	3.1	3.2	3.3	5.1	6.1	6.2	6.3	7.1
Wildlife Observations - September				Grizzly tracks	Northern shoveler, marsh wren, kingfisher, sharp-shinned hawk, raven, mountain chickadee, pine siskin, red-breasted nuthatch, common goldeneye, finch, song sparrow, gull, heron tracks, elk tracks, beaver channel	Dark-eyed junco, osprey, house finch, red garter snake			Bonapartes gulls, osprey, raven	
Notes		Stream outlet to the south	Campsite, harrier killed blackbird	Lot 48	Armstrong Bay	Columere Beach, Windy	mullein	beaver lodge	Bella Vista	knapweed, outhouse

List of amphibian species known or thought to occur at Columbia Lake or in shoreline habitats immediately adjacent to Columbia Lake. Sources: Klinkenberg 2010; Corkran and Thoms 1996.

Common Name	Scientific Name	Occurrence[9]
Long-toed Salamander	*Ambystoma macrodactylum*	probable
Western Toad	*Bufo boreas*	probable
Pacific Tree Frog	*Pseudacris regilla*	possible
Columbia Spotted Frog	*Rana luteiventris*	probable
Leopard Frog	*Rana pipiens*	extirpated

List of reptile species known or thought to occur at Columbia Lake or in shoreline habitats immediately adjacent to Columbia Lake. Sources: BC Reptiles 2008.

Common Name	Scientific Name	Occurrence[9]
Western Painted Turtle	*Chrysemys picta bellii*	confirmed
Rubber Boa	*Charina bottae*	probable
Western Terrestrial Garter Snake	*Thamnophis elegans*	confirmed
Common Garter Snake	*Thamnophis sirtalis*	probable

List of bird species known or thought to occur at Columbia Lake or in shoreline habitats immediately adjacent to Columbia Lake. Sources: Campbell et al. 1990a, 1990b, 1997, 2001; Ferguson and Halverson 1997.

Common Name	Scientific Name	Breeding Status[10]	Occurrence[11]
Common Loon	*Gavia immer*	breeds	common
Red-necked Grebe	*Podiceps grisegena*	breeds	common
Western Grebe	*Aechmophorus occidentalis*	non-breeder	common to abundant seasonally
Eared Grebe	*Podiceps nigricollis*	breeds	uncommon
Horned Grebe	*Podiceps auritus*	breeds	uncommon
Pied-billed Grebe	*Podilymbus podiceps*	breeds	common
American White Pelican	*Pelecanus erythrorhynchos*	non-breeder	occasional
American Bittern	*Botaurus lentiginosus*	breeds	uncommon
Great Blue Heron	*Ardea Herodias*	breeds	common
Tundra Swan	*Cygnus columbianus*	non-breeder	seasonally abundant
Trumpeter Swan	*Cygnus buccinators*	non-breeder	seasonally uncommon
Snow Goose	*Chen caerulescens*	non-breeder	rare
Canada Goose	*Branta canadensis*	breeds	common to abundant
Wood Duck	*Aix sponsa*	breeds	common
Mallard	*Anas platyrhynchos*	breeds	abundant
Northern Pintail	*Anas acuta*	breeds	common
Gadwall	*Anas strepera*	non-breeder	rare

[9] Occurrence order for amphibians, reptiles and mammals: confirmed > probable > possible > extirpated.

[10] Breeding Status – species indicated as 'breeds' are known to breed in the East Kootenay, though not necessarily at Columbia Lake.

[11] Occurrence order for birds: Abundant > Common > Uncommon > Rare > Occasional > Accidental

Common Name	Scientific Name	Breeding Status[10]	Occurrence[11]
American Wigeon	*Anas americana*	breeds	common to seasonally abundant
Eurasian Wigeon	*Anas penelope*	non-breeder	rare
Northern Shoveler	*Anas clypeata*	breeds	uncommon
Green-winged Teal	*Anas crecca*	breeds	common
Blue-winged Teal	*Anas discors*	breeds	common
Cinnamon Teal	*Anas cyanoptera*	breeds	common
Canvasback	*Aythya valisineria*	breeds	uncommon
Redhead Duck	*Aythya americana*	breeds	common
Ring-necked Duck	*Aythya collaris*	breeds	common
Greater Scaup	*Aythya marila*	non-breeder	uncommon
Lesser Scaup	*Aythya affinis*	breeds	common
Surf Scoter	*Melanitta perspicillata*	non-breeder	occasional
White-winged Scoter	*Melanitta deglandi*		rare
Common Goldeneye	*Bucephala clangula*	breeds	common
Barrow's Goldeneye	*Bucephala islandica*	breeds	uncommon
Bufflehead	*Bucephala albeola*	breeds	common
Ruddy Duck	*Oxyura jamaicensis*	breeds	common
Common Merganser	*Mergus merganser*	breeds	common to seasonally abundant
Red-breasted Merganser	*Mergus serrator*	non-breeder	rare
Hooded Merganser	*Lophodytes cucullatus*	breeds	uncommon
Osprey	*Pandion haliaetus*	breeds	common
Bald Eagle	*Haliaeetus leucocephalus*	breeds	common
Northern Harrier	*Circus cyaneus*	suspected to breed	uncommon
American Coot	*Fulica americana*	breeds	abundant
Sora	*Porzana carolina*	breeds	uncommon
Virginia Rail	*Rallus limicola*	probable breeder	rare
Black-bellied Plover	*Pluvialis squatarola*	non-breeder	rare
Semipalmated Plover	*Charandrius semipalmatus*	non-breeder	rare
Killdeer	*Charandrius vociferous*	breeds	common
Black-necked Stilt	*Himantopus mexicanus*	non-breeder	occasional
American Avocet	*Recurvirostra americana*	non-breeder	rare
Greater Yellowlegs	*Tringa melanoleuca*	non-breeder	uncommon
Lesser Yellowlegs	*Tringa flavipes*	non-breeder	uncommon
Solitary Sandpiper	*Tringa solitaria*	breeds	uncommon
Spotted Sandpiper	*Actitis macularia*	breeds	common
Semipalmated Sandpiper	*Calidris pusilla*	non-breeder	occasional
Western Sandpiper	*Calidris mauri*	non-breeder	occasional
Least Sandpiper	*Calidris minutilla*	non-breeder	occasional
Baird's Sandpiper	*Calidris bairdii*	non-breeder	rare
Pectoral Sandpiper	*Calidris melanotos*	non-breeder	uncommon
Long-billed Dowitcher	*Limnodromus scolopaceus*	non-breeder	occasional to seasonally common
Wilson's Snipe	*Gallinago gallinago*	breeds	common
Wilson's Phalarope	*Phalaropus tricolor*	breeds	rare

Common Name	Scientific Name	Breeding Status[10]	Occurrence[11]
Red-necked Phalarope	*Phalaropus lobatus*	non-breeder	occasional
Bonaparte's Gull	*Larus philadelphia*	non-breeder	uncommon
Ring-billed Gull	*Larus delawarensis*	non-breeder	uncommon
California Gull	*Larus californicus*	non-breeder	uncommon – rare
Herring Gull	*Larus argentatus*	non-breeder	uncommon
Common Tern	*Sterna hirundo*	non-breeder	occasional
Black Tern	*Chlidonias niger*	breeds	common
Belted Kingfisher	*Megaceryle alcyon*	breeds	common
Violet-green Swallow	*Tachycineta thalassina*	breeds	common
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	breeds	common
Tree Swallow	*Tachycineta bicolor*	breeds	common
Bank Swallow	*Riparia riparia*	breeds	common
Cliff Swallow	*Petrochelid on pyrrhonota*	breeds	common
Marsh Wren	*Cistothorus palustris*	breeds	common
American Dipper	*Cinclus mexicanus*	breeds at higher elevations	common
Gray Catbird	*Dumetella carolinensis*	breeds	uncommon
Warbling Vireo	*Vireo gilvus*	breeds	common
Red-eyed Vireo	*Vireo olivaceus*	breeds	common
Common Yellowthroat	*Geothlypis trichas*	breeds	common
Northern Waterthrush	*Seiurus noveboracensis*	breeds	common
American Redstart	*Setophaga ruticilla*	breeds	common
Black-headed Grosbeak	*Pheucticus melanocephalus*	breeds	uncommon
Song Sparrow	*Melospiza melodia*	breeds	common
Red-winged Blackbird	*Agelaius phoeniceus*	breeds	common
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	breeds	common
Brewer’s Blackbird	*Euphagus cyanocephalus*	breeds	common

List of mammal species known or thought to occur at Columbia Lake or in shoreline habitats immediately adjacent to Columbia Lake. Sources: Klinkenberg 2010, Nagorsen and Brigham 1993.

Common Name	Scientific Name	Occurrence
Water Shrew	*Sorex palustris*	probable
Vagrant Shrew	*Sorex vagrans*	probable
California Myotis	*Myotis californicus*	probable
Western Long-eared Myotis	*Myotis evotis*	confirmed
Little Brown Myotis	*Myotis lucifugus*	confirmed
Long-legged Myotis	*Myotis volans*	probable
Hoary Bat	*Lasiurus cinereus*	confirmed
Siver-haired Bat	*Lasionycteris noctivagans*	confirmed
Big Brown Bat	*Eptesicus fuscus*	probable
Townsend's Big-eared	*Plecotus townsendii*	confirmed
Long-tailed Vole	*Microtus longicaudus*	probable
Northern Bog Lemming	*Synaptomys borealis*	possible
Muskrat	*Ondatra zibethica*	confirmed
Western Jumping Mouse	*Zapus princeps*	probable
Beaver	*Castor canadensis*	confirmed
River Otter	*Lontra canadensis*	confirmed
Mink	*Neovison vison*	possible

Appendix H. Aquatic Habitat Index Tables

Biophysical - As per Moyie						Zones of Sensitivity - As per Moyie/Sherri					Riparian - Moyie		Modifications - As per Windermere/DH				
Segment #	Shore Type	Substrate	% Natural	Emergent Vegetation	Overhanging Vegetation	Burbot Spawn	Kokanee Stage/Rear	Burbot Rear	Mussel	Wildlife	Band 1 (Riparian)	Band 2 (Upslope)	Retaining Walls	Docks	Groynes	Boat Launch	Marina
1	14.75	4.68	8.25	4.56	1.8	0	0	5	3	0	6.4	1.8	-0.25	-0.9	-1	-3	0
2	12.5	6.32	15	2.24	3.6	0	0	5	0	0	6.4	4.8	0	0	0	0	0
3	12.3	5.14	15	7.28	2.4	0	0	0	0	5	3.2	4.8	0	0	0	0	0
4	20	4	15	7.2	2.1	5	5	0	0	5	10.0	4.8	0	0	0	0	0
5	15	5.52	0	2.16	0.6	0	0	5	0	0	1.8	0.0	-3.5	-0.1	-0.5	0	-6
6	15.2	6.75	0.75	6.4	0.6	0	0	5	3	0	2.0	4.8	0	-0.3	-0.5	-3	0
7	15.05	8	0	4.24	0.3	0	0	5	3	0	2.0	4.8	0	-0.1	0	-3	0
8	20	4	12.75	7.28	0	5	0	0	0	5	10.0	4.8	0	0	0	0	0

Summary Table

Segment #	Biophysical Total	Zones of Sensitivity Total	Riparian Total	Modifications Total	Current Value	Current AHI Rank	Potential Value	Potential AHI Rank
1	34.04	8	8.20	-5.15	45.09	Moderate	50.24	Moderate
2	39.66	5	11.20	0	55.86	High	55.86	High
3	42.12	5	8.00	0	55.12	High	55.12	High
4	48.3	15	14.80	0	78.1	Very High	78.1	Very High
5	23.28	5	1.80	-10.1	19.98	Very Low	30.08	Low
6	29.7	8	6.80	-3.8	40.7	Low	44.5	Moderate
7	27.59	8	6.80	-3.1	39.29	Low	42.39	Moderate
8	44.03	10	14.80	0	68.83	Very High	68.83	Very High

Max	Min	Range	Class	Break(VH)	Break(H)	Break(M)	Break(L)
78.1	19.98	58.12	11.624	66	54	42	30

Appendix I. Best Management Practices and Regional Operating Statements

Many provincial and federal agencies have developed Best Management Practices (BMP) in order to provide consistent direction to the public on acceptable development methods. The BMPs provide information to help ensure that proposed development activities are planned and carried out in compliance with the various applicable legislation, regulations, and policies. The range of activities that associate BMPs is broad.

The province of BC has, over a period of many years, developed a series of BMPs. These have evolved into "Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia." The Develop with Care Guidelines have links to several provincial BMPs related to shoreline development activities. Examples are as follows:

- Standards and Best Management Practices for Instream Works;
- Best Management Practices for Small Boat moorage on Lakes
- Timing and Terms and Conditions for Changes In and About a Stream Specified by BC MoE Habitat Officers, Kootenay Region
- Small Boat Moorage
- Boat Launch Construction and Maintenance on Lakes
- Lakeshore Stabilization
- Installation and Maintenance of Water Line Intakes
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia
- Best Management Practices for Amphibians and Reptiles in Urban and rural Environments in BC

The Regional Operating Statements (ROS) developed by DFO, provide information regarding several low risk activities associated with shoreline development, including but not limited to:

- Aquatic Vegetation Removal in Lakes
- Bridge & Culvert Maintenance
- Dock and Boathouse Construction in Freshwater Systems
- Routine Maintenance Dredging for Navigation
- Public Beach Maintenance
- Clear Span Bridges
- Culvert Maintenance
- Directional Drilling
- Small Moorings
- Underwater Cables in Freshwater Systems
- Overhead Line Construction
- Maintenance of Riparian Vegetation in Existing Rights of Ways
- Dry Open Cut Stream Crossing
- Isolated Ponds

Appendix J. Legal Requirements

Laws and regulations provide the regulatory 'teeth' to uphold environmental protection and management. Applicable legislative requirements must be met for a project to be in compliance with the law. Legal requirements have been presented here in the following categories: Federal, Provincial, Regional District and District of Invermere. For each of these jurisdictions, a list of pertinent legislation bylaws and/or plans; and contact information (web site links) has been provided. The reader is cautioned that other legislation (not listed) may apply to their development, and they are encouraged to consult with the appropriate agency prior to proceeding with any proposed works.

1. Federal Legislation

All federal legislation is administered by the parliament of Canada (federal government).

Canada Migratory Birds Convention Act

This Act implements an internationally recognized Convention between Canada and the United States to protect various species of migratory game birds, migratory insectivorous birds and migratory non-game birds including herons. The taking of nests or eggs of these birds is prohibited, except for permitted scientific or propagating purposes.

Fisheries Act

The *Fisheries Act* is administered by the federal Department of Fisheries and Oceans and is one of the most important pieces of legislation for managing aquatic resources in Canada. The fish habitat provisions of this Act enable the federal government to protect marine and freshwater habitats supporting those species that sustain fisheries, namely fish, shellfish, crustaceans and marine mammals.

Navigable Waters Protection Act

This act is administered by Transport Canada and is primarily applicable to protecting, maintaining, and developing opportunities for the public to access and use waterbodies for navigation and recreation. Any activities that may affect movement of people or goods, near or on water are affected (i.e. dock/marina construction, dredging, shoreline development).

Pesticides Act

The *Pesticides Act* is intended to 1) prevent and mitigate harmful effects to the environment and human health, and 2) rationalize and reduce the use of pesticides. The Act promotes the analysis, assessment and control of the effects of the use of pesticides through specific activities intended to widen knowledge about these products (environmental monitoring, for example).

Species at Risk Act

This act prevents Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, provides for the recovery of endangered or threatened species and encourages the management of other species to prevent them from becoming at risk.

Canadian Environmental Assessment Act (CEAA)

The CEAA requires federal departments to conduct environmental assessments (EA) for prescribed projects and activities before providing federal approval or financial support. The EA is a planning tool used to identify potential effects of projects or activities on the environment. This includes the air, water, land and living organisms, including humans.

Indian Act

The *Indian Act* provides legislation relating to Indians and Lands Reserved for Indians. The Indian Act is administered by the Minister of Indian Affairs and Northern Development.

2. Provincial Legislation

All provincial government legislation within BC is administered by the legislative assembly of British Columbia (provincial government).

Land Act

The *Land Act* is the main legislation governing the disposition of provincial Crown (i.e. public) land in British Columbia. Crown land is any land owned by the Province, including land that is covered by water, such as the foreshore and the beds of lakes, rivers and streams. The *Land Act* is administered by the Ministry of Sustainable Resource Management.

Wildlife Act

The provincial Ministry of Environment administers the *Wildlife Act*, which includes legislation relating to the conservation and management of wildlife populations and habitat, issuing licenses and permits for fishing, game hunting, and trapping. A provision of the Wildlife Act, which may be pertinent to shoreline development is the prohibition, to take, injure, molest, or destroy a) a bird or its egg; b) the nest of an eagle, peregrine falcon, gyrafalcon, osprey, heron, or burrowing owl; c) or the nest of any other bird species when the nest is occupied by a bird or its egg.

Water Act

The *Water Act* is the primary provincial statute regulating water resources. Under the Water Act, a stream is defined as "*a natural watercourse or source of water supply, whether usually containing water or not, and a lake, river, creek, spring, ravine, swamp and gulch*." Section 9 of the *Water Act* requires that a person may only make "changes in and about a stream" under an Approval or Notification where required; or under a Water License or Order.

Weed Control Act

The B.C. *Weed Control Act* imposes a duty on all land occupiers to control designated noxious plants. The purpose of the Act is to protect our natural resources and industry from the negative impacts of foreign weeds.

3. Regional District of East Kootenay

The Regional District of East Kootenay (RDEK) provides local government services to rural areas outside municipal boundaries. The RDEK functions as a partnership of the municipalities and electoral areas (unincorporated areas) within its boundaries. These local governments work together through the RDEK to provide and coordinate services in both urban and rural areas. Regional districts are governed by the *Local Government Act* and other provincial legislation.

Fairmont Hot Springs Area Official Community Plan (OCP), Bylaw No. 1734, 2004

The OCP is a long term strategic planning document intended to guide and direct decision making with respect to the change or conservation of land uses. The OCP includes the northern portions of the lake and much of the west and east sides.

Upper Columbia Valley Zoning Consolidation, Bylaw No. 900, 2009.

This bylaw provides regulations on zoning. Zoning is concerned with use of land, density of use, siting, size and dimensions of buildings and structures and area, shape and dimensions of parcels of land.

4. Village of Canal Flats

The Village of Canal Flats provides local government services to the Village of Canal Flats. The village is located at the south end of Columbia Lake.

Village of Canal Flats OCP, Bylaw No. 50, 2005

The Official Community Plan serves as a guide to municipal Councils when making decisions regarding zoning, development and servicing requirements to accommodate growth.

Appendix K. Digital Copy of Report