LOTIC ENVIRONMENTAL

Tie Lake Sensitive Habitat Inventory and Mapping (SHIM)

Final Report
June 2012

Prepared for
Ministry of Forests, Lands and Natural Resource Operations
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Suggested Citation

McPherson[1] S.M., D.G. Paton[2] and M.D. Robinson[1]. 2012. Tie Lake Sensitive Habitat Inventory and Mapping. Consultant report prepared for Ministry of Forests Lands and Natural Resource Operations. Prepared by Lotic Environmental Ltd[1] and Anatum Ecological Consulting Ltd[2].

Acknowledgments

We would like to thank Ministry of Forests Lands and Natural Resource Operations staff Paul Rasmussen (Director Resource Management) and Mike Knapik (acting Habitat Section Head) for their valued contributions in management of this project and review of the draft report.

We wish to give a special thanks to Al Soobotin, former Habitat Section Head, who will be missed.

Finally, we would like to acknowledge Guy Duke of L.A. Mapping Inc. for his professional expertise in completing the GIS mapping components of this project.

Disclaimer

The results contained in this report are primarily based upon data collected during a two-day field survey. The data were augmented with orthophoto interpretation, and existing scientific literature. In some cases, results were determined through qualitative assessment involving professional opinion. Use or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Lotic Environmental Ltd or Anatum Ecological Consulting Ltd, nor the authors of this report are liable for errors or omissions made in its preparation because best attempts were made to verify the accuracy and completeness of data collected and presented.

Executive Summary

Tie Lake is located in the East Kootenay region of British Columbia (BC), near Jaffray, BC. The Ministry of Forests, Lands and Natural Resource Operations commissioned Lotic Environmental Ltd. to complete this project which includes: 1) Foreshore Inventory and Mapping (FIM), 2) Fish and Wildlife Assessment, and 3) Shoreline Management Guidelines for Fish and Wildlife Habitats. This process will identify and maintain valuable shoreline habitats for fish and wildlife and facilitate their protection.

The FIM project provides baseline information on foreshore condition and environmental values to aid in future decision-making. This was achieved by following FIM standards (Schleppe and Mason 2009) which included the collection of field data and a literature review of known environmental values. Field reviews were completed on November 7th and 8th, 2011. Data were collected on shoreline morphology, land use, riparian condition and anthropogenic alterations. The 11.9 km foreshore of Tie Lake was delineated into 16 segments based on contiguous characteristics. The most prevalent shore type was gravel beach (70%). The 12 wetlands situated around the lake, were also an important contributor (24%) and were estimated to cover a total area of 79.2 ha. Sand Beach resulting from modification (5%) and stream mouth (1%) shore types were also present. The seven inlet streams were limited in their contribution to fish habitat, due to their ephemeral nature, while the outlet stream flow was managed via a weir and observed to be dry at the time of survey. Emergent aquatic vegetation was common and extended along 48% of the shoreline. Emergent aquatic vegetation was mainly composed of bulrush (*Scirpus spp.*) and cattails (*Typha latifolia*). A narrow shrub band was evident along undeveloped riparian areas. In association with this band, riparian vegetation was either composed of mature coniferous forest (32%) or natural wetland (27%). In developed areas, lawn was the main riparian feature (31%). Over half (64%) of the shoreline was determined to be in a natural condition[1]. Land use related to levels of disturbance; Crown land in particular (44%) had large sections natural shoreline. Two parks and Highways right-of–ways, and select private properties also maintained natural values important to fish and wildlife. The disturbed foreshore sections (36%) were primarily the result of residential land use (34%). The residential areas exhibited loss of riparian and emergent aquatic vegetation as numerous shoreline modifications (i.e., retaining walls, docks boat houses, substrate modification (sand) and boat launches).

Fish and wildlife field assessments were conducted during the FIM. Owing to the fall season temperatures, only two fish (both yellow perch (*Perca flavescens*)) were observed using above-water boat observations and an underwater video over an 11 hour period,. Wildlife observations also were limited due to the time of year. The literature review findings thus provided important contributions to understanding the ecological values of the shoreline. Overall, the shoreline (and adjacent upland areas) of Tie Lake was found to be biologically diverse, largely due to the wetland habitat. Only two native fish are known to the area (redside shiner (*Richardsonius balteatus*) and longnose sucker (*Catostomus catastomus*); however stocked sportfish are also an important (recreationall) contribution. Exotic species (largemouth bass (*Micropterus salmoides*), yellow perch and pumpkinseed sunfish (*Lepomis gibbosus*)) are likely negatively influencing native fish populations. Several sensitive mammal, amphibian, bird, reptiles,

[1] Natural condition refers to a state where human modification was not apparent.

gastropods and insects species potentially inhabit the area. The blue-listed western painted turtles (*Chrysemys picti bellii*) identified during the shoreline assessment were potentially utilizing unique environments specific for overwintering physiological needs. Further, the blue-listed ecological community, the common cattail marsh was observed to potentially occur around the lake. Further assessment of all sensitive habitats and species would be beneficial.

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. Parameter values were based on their positive or negative contributions to environmental health. Zones of Sensitivity for Tie Lake were determined to be: 1) areas with high juvenile rearing potential/wildlife biodiversity potential and 2) areas with overwintering turtles. The following Existing Ecological Shore Rankings were determined from the AHI: Very High - 38% of shoreline, High – 21%, Moderate – 12%, Low – 0%, Very Low - 29%. Through the AHI analysis, it was determined that with restoration (modifications removed), several segments would increase in their ecological rankings.

The Shoreline Management Guidelines were prepared by using templates from Windermere and Moyie 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 were coloured Red. These areas were designated for conservation use, with the guideline that no development occurs within them other than very low impact activities. Segments ranked as High were coloured Orange, indicating that they were sensitive to development and that an environmental assessment would be required for most activities. Moderately ranked segments were yellow, and Low and Very Low segments were 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 ecological 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 were proposed, including: conducting species and habitat inventories, addressing modifications, incorporating sensitive habitats into existing policies and bylaws, and further educating the community.

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1 Introduction

Tie Lake is located between Cranbrook and Fernie in the East Kootenay region of British Columbia. Tie Lake is accessed by travelling 4 km north from the Village of Jaffray, off of Highway 3 (Appendix A). The lake includes two recreation parks; Tie Lake Regional Day Use Park and the Tie Lake Forest Recreation area. It is both a valuable recreational and ecological resource providing opportunities for swimming, canoeing, boating, fishing and water skiing. Portions of the shoreline have been developed for residential and vacation homes.

As with many lakes across the province, Tie Lake has seen growth in terms of recreational popularity. In 2009, the lake was reported to be surrounded by approximately 150 residences (Carter 2009). This is a 50% increase from the 99 residences counted in 1981 (MacDonald 2011). The numbers of full time residences have stayed consistent over this period with 22 and 25 identified respectively in 1981 and 2009. The recent trend in lake shoreline development in the East Kootenay has been a transformation from cabins with a small footprint to dwellings that tend to cover a larger area of the land, include a greater number and/or larger shoreline structures (such as docks and retaining walls) and shoreline alterations (including beach grooming and riparian disturbance). These alterations and their potential negative impacts on the shoreline environment have become a concern for regulatory agencies and community groups.

The provincial Ministry of Forests, Lands and Natural Resource Operations (MFLNRO, formerly Ministry of Environment) commissioned Lotic Environmental Ltd (Lotic Environmental) and Anatum Ecological Services Ltd (Anatum) to complete this Sensitive Habitat Inventory and Mapping (SHIM) project for Tie Lake. SHIM involves the completion of three components:

1) **Foreshore Inventory and Mapping (FIM)** - a biophysical assessment of contiguous segments along the shoreline;
2) **Fish and Wildlife Assessment (F&W Assessment**) - a detailed review of fish and wildlife attributes specific to each segment and the completion of an Aquatic Habitat Index (or AHI) ranking the ecological value of each segment;
3) **Shoreline Management Guidelines for Fish and Wildlife Habitats (Shoreline Guidelines)** - one of four colour zones are attributed to each segment according to their AHI ranking and associated risk from development activities.

SHIM helps regulatory agencies, landowners, developers, and planners better understand the lake specific values. The report and mapped products provide guidance on best practices and restrictions of use where necessary. SHIM uses a science-based approach that was first initiated on Okanagan Lake where a FIM and F&W assessment were completed (Schleppe and Arsenault 2006). Shoreline Guidelines were then added when the process was undertaken for Windermere Lake (McPherson and Hlushak 2008). The standard SHIM process has since been applied to several other lakes in the province. Columbia and Wasa lakes (McPherson *et al.* 2010a and b), and Moyie and Monroe lakes (Schleppe 2009a and b) are examples of other lakes in the East Kootenay where similar assessments have been undertaken.

1.1 Shoreline Ecological Significance and Sensitivity

The shoreline is an important link between the aquatic and terrestrial environments and is extremely sensitive to disturbance. The shoreline is comprised of four zones, the littoral zone,

the shoreline, the riparian area and the upland zone, each with specific ecological values (Table 1):

Table 1. The shoreline zones (source Fisheries and Oceans Canada 2008)

Littoral Zone 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; -Important area for primary production (plant growth); -Stones, twigs and plants serve as valuable substrates for food production and habitat for animals; and -Wildlife such as ducks typically forage on plants and invertebrates here; and fish often tend to spawn, forage and seek cover (i.e., as juveniles) here.
Shoreline Where the land and the water meet
- Overhanging vegetation here shades and cools the water and provides important food sources for fish. -Stones, plants, shrubs, fallen limbs and tree trunks provide habitat, food and protection against erosion; and -Corridor for animals, insects and birds travelling back and forth between the lake and the upland areas
Riparian and Upland Zones Land closest to the foreshore and the upland is the higher, drier ground
-Vegetation 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; and -Provides important refuge for wildlife.

Foreshore vegetation, habitat structure and species use are commonly altered by anthropogenic disturbances. Disturbance examples include: 1) direct habitat loss, such as road and house construction; 2) transition of native plant communities to ornamentals resulting in loss of nesting and foraging habitats; 3) presence of humans resulting in avoidance by species and alteration of predator-prey relationships (predator species tend to avoid areas with high human densities); and, 4) direct mortality through species considered a nuisance (e.g., bats killed by property owners) and domestic animals (preying on birds and other small vertebrates).

Some studies have assessed the impacts on fish and wildlife resulting from increased development around lakes. Lindsay *et al.* 2002 showed that increased foreshore development has a significant influence on the presence of some breeding bird species, particularly in relation to 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.

Fish productivity has also been shown to be impacted by changes in the littoral zone habitat complexity. Coarse woody debris, aquatic macrophytes and substrates provide important fish habitat. 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 with increased development, the quantity of woody debris, emergent vegetation and floating vegetation decreased and that littoral sediment contained more fine particles, all conditions not considered favourable to fish and other aquatic organisms.

1.2 Shoreline Jurisdiction and Associated Acts, Regulations and Bylaws

The lake foreshore or 'shoreline' is defined as the land between the high and low water mark. In BC, this area is named "Aquatic Crown land" and includes the permanently wetted lake area. Aquatic Crown land falls under provincial jurisdiction, and the public retains the right to access it even if the upland is privately owned (BC Ministry of Agriculture and Lands 2009). Provincial authorization is required for any developments in this area, including those planned by the property owner of the adjacent or "upland" property (BC Ministry of Agriculture and Lands 2009). The Shoreline Guidelines help regulators apply a clear, consistent and coordinated management strategy to ensure the protection of the environmental values when considering development referrals on Aquatic Crown land.

Development along the shoreline and protection of the environment is also governed by several other Federal, Provincial and Regional Acts and Regulations (listed in Shoreline Management Guidelines (Appendix E). Of note is the Jaffray, Tie Lake, Rosen Lake Land Use and Floodplain Management Bylaw No 1414 (Regional District of East Kootenay (RDEK) 1999). This bylaw provides policies and regulations specific to the study area to guide development. Regulations include those pertaining to parcel area requirements, parking and loading, land use designations and floodplain management provisions. Specific items in the bylaw relating to protection of the shoreline, waterbody or other associated environmental values are as follows (RDEK 1999):

OBJECTIVES

(1) To respect and protect those attributes that contribute to the rural quality of life that makes the area attractive as a place to live and recreate.

(7) To protect surface and ground water quality.

(10) To protect fish and wildlife values.

POLICIES

Agriculture

(a) The Board supports a full range of agricultural activity in the Agricultural Land Reserve. Farmers are encouraged to locate intensive agricultural operations on parcels or parts of parcels where negative impacts on surrounding residents, properties and watercourses will be minimized.

Commercial

(e) The Regional District will not support an application for a private commercial marina on either lake. However, the Regional District will support an application by property owners presently having individual docks, to consolidate their moorage facilities in order to improve safety for recreational users of the lakes.

(f) Should residents and property owners wish to initiate discussion on boating restrictions following adoption of this plan, the Regional District will work with the community to examine whether some form of boating restrictions should be requested on Rosen Lake and Tie Lake.

GENERAL REGULATIONS
Floodplain Specifications

(a) Flood Construction Levels: The following elevations are specified as flood construction levels, except that where more than one flood construction level is applicable, the higher elevation shall be the flood construction level:

(i) 3.0 metres above the ordinary high water mark of Sand Creek;
(ii) 1.5 metres above the ordinary high water mark of any other watercourse;
(iii) 1.5 metres above the ordinary high water mark of any lake, marsh, or pond;

(b) Floodplain Setbacks: The following distances are specified as floodplain setbacks, except that where more than one floodplain setback is applicable, the greater distance shall be the floodplain setback:

(i) 15 metres from the ordinary high water mark of Sand and Little Sand Creeks;
(ii) 15 metres from the ordinary high water mark of any other watercourse;
(iii) 7.5 metres from the ordinary high water mark of a lake, marsh, or pond;
(iv) 7.5 metres from any standard dyke right-of-way, or structure for flood protection or seepage control.

Similarly to that found with other lakes in the province, the existing land use bylaws specify little in regards to protecting the environmental values of the shoreline. The SHIM process has been developed to assist in addressing this. The Shoreline Guidelines specifically will help agencies provide consistent policy information in a timely manner.

2 Objectives

The objectives of this study are to provide an overview of foreshore habitat condition, differentiate and rank contiguous shoreline segments based on their fish and wildlife habitat values, and prepare shoreline 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 shoreline.

3. Shoreline Management Guidelines for Fish and Wildlife Habitats

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

3 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. The F&W Assessment and Shoreline Guidelines adhered to methods used at other lakes in the province including, Okanagan Lake (Schleppe and Arsenault 2006), Windermere Lake (McPherson and Hlushak 2008), Moyie Lake (Schleppe 2009a), and Columbia Lake (McPherson et al 2010a).

3.1 Field Review

The FIM and F&W field assessments were conducted on November 7 & 8, 2011. The field assessment was completed by Sherri McPherson (Aquatic Biologist, BSc), Dale Paton (Wildlife Biologist, MSc Candidate), and Mike Robinson (Aquatic Biologist, MSc). All surveys were conducted from the shoreline, with crews in an aluminum boat operated by a small electric motor.

3.1.1 FIM

During the field review, the shoreline was delineated into contiguous segments based on biophysical features. Standard FIM data for each segment was collected to provide an understanding of environmental value and condition. Examples of parameters reviewed include: land use, shore type, substrates, riparian cover, aquatic vegetation, and shoreline modifications. Specific details on the determination of two key parameters, segment breaks and shore types are provided for clarity:

Segment Breaks:

Segments are stretches of shoreline with contiguous features. Segment breaks are determined using a combination of shore type, land use and vegetation (Schleppe and Mason 2009). For designation of segments along contiguous shore types or land use areas, Level of Impact (LoI) was also used to designate segments since it generally corresponded with habitat availability. LOI was determined by level of anthropogenic disturbance within the following categories: Low = <10%, Moderate = 10-40%, and High = >40%. Typically when a change was observed in the LOI category, and it occurred over a sustained length (minimum of 50 m) a new segment was employed. Conversely, if land management was similar for differently zoned properties or LOI was similar along different shore types (or land uses) and contiguous habitat features were observed, properties were combined together into one segment.

Vegetated Shore Type:

The Vegetated Shore designation is no longer accepted in the FIM Standards, as it was determined that a Shore Type is better described by its physical or geologic composition (with the exception of wetlands which are particularly unique). The Gravel Beach shore type (low or moderate slopes with substrates that are predominantly gravels and cobbles) was thus the most applicable shore zone to use around Tie Lake where there was no wetland. Gravel and cobble substrates were typically visible in the natural banks at the lake's edge, when there was no aquatic vegetation.

Wetland Shore Type versus Emergent Vegetation

Remnant emergent vegetation from the 2011 growing season, which was dominated by bulrush, was still clearly visible in the fall. Using the field data and photos, wetland shore type and emergent vegetation were documented in the field so they could be digitized as

polygons on the GIS map. The definitions for these features remained consistent with the FIM standards (Schleppe and Mason 2009) and past studies including Columbia Lake (McPherson *et al* 2010a).

Specifically, the **Wetland Shore Type** was determined by the presence of 'shore marsh wetland' as defined in the Wetlands of British Columbia (MacKenzie and Moran 2004). The shore marsh is a seasonally or permanently flooded, non-tidal, mineral wetland that is dominated by emergent grass like vegetation. In order to be classified as a wetland, the emergent vegetation was to also have a plant density of more than 10% (MacKenzie and Moran 2004). Additionally, we incorporated the general rule that the width of the emergent aquatic vegetation band was also to be greater than 25 m (from the shore's edge). The rationale for this is that although emergent vegetation was found along many stretches of the shore, narrower fringes were not determined to provide the high value wetland attributes for fish and wildlife and soil development potential as the sections with wider coverage.

When the density of emergent plants was less than 10% and the emergent bandwidth was less than 25 m, the area was not typed as a wetland shore type. Instead, the section was attributed a shore type relating to its parent material along the banks of the lake (e.g., gravel beach). In these areas, the segment received value for the extent of **Emergent Aquatic Vegetation**. Although not quite as highly valued as wetland shore types, areas with emergent aquatic vegetation are considered valuable along shorelines, since they provide habitat for fish and wildlife, protect the shore from erosion, and typically are found in areas with fewer shoreline modifications and less riparian disturbance.

Figure 1. Wetland shore type (left) versus emergent vegetation area (right).

GPS waypoints of segment breaks and emergent vegetation zones were collected. Photo documentation of the shoreline was also undertaken to aid in office analysis and reporting.

Fish Assessment

The fisheries assessment involved collecting standard data on habitat features and conditions, including air temperatures, water temperatures, substrate, aquatic vegetation (percentage and species), and large woody debris (LWD) availability. The fish assessment also involved using an underwater camera (SeaViewer underwater recording system) to videotape the aquatic

environment along the lake's edge for each segment and to enumerate and identify fish present. In addition to recording fish use alongside the general path of the boat, the video camera was also aimed under structures such as docks in order to review areas that fish may be seeking cover. The underwater video image was projected to a screen on the boat. The presence of fish was determined through observation of this screen as well as from direct visual observations from the boat. The clarity of the water allowed for 5 to 10 m distance from the boats edge to be assessed. Further, the boat had a small quiet electric motor and was only capable of low speeds; and was thus not a factor in limited fish numbers seen. The time of video capture and boat observations was recorded. A description of fish habitat potential for each segment was completed based on visual observations and professional judgement.

Wildlife Assessment
The field component of the wildlife assessment was completed from the boat as it travelled along the shore of Tie Lake. The assessment involved collecting standard data on wildlife features and conditions including riparian attribute data and presence of coarse woody debris (CWD), veteran trees and snags. Presence of high value areas such as wetlands, emergent vegetation zones, and mature forests were recorded as well as species presence including birds (using visual and audio accounts) and painted turtle. Potential zones of sensitivity were evaluated.

3.2 GIS Base Map

The shoreline of Tie Lake was defined by digitizing the boundary using orthophotos captured during (2004), which were supplied by FLNRO. The shoreline was delineated along the far side of wetlands, where the emergent aquatic vegetation stopped and the riparian vegetation started. Segment breaks were located by overlying GPS waypoints and other field markers onto the base map.

Legal boundary data (cadastral data) for properties around the lake were provided by the RDEK. This data layer was incorporated into the GIS map as a general reference only. The current legal data for Tie Lake has a lower than normal accuracy (+/-40 meters). However, a basic "shift" of the data was completed to improve the accuracy to the best degree possible to suit the purposes of this project. As a result, there are no warranties or representations concerning the validity or accuracy of the legal boundary 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.

3.3 FIM and F&W Office Analysis and Reporting

All FIM and F&W field data was entered into one database (SHIM database). A detailed review of orthophotos, digital field photos, and land use maps was undertaken to verify qualitative and quantitative findings for each segment. This office analysis was completed for all parameters, but was particularly important to conduct on the following:

- natural and disturbed (%)
- shore type (%)

- land use (%)
- overhanging vegetation (%)
- emergent vegetation (%)
- substrate modified (%)
- retaining wall (%)
- road (%)

A two-page summary form with representative photos was prepared for each segment. The form incorporated both FIM and F&W findings into one location for ease in review. FIM results were also presented both graphically and on the GIS map.

A literature review was conducted to obtain additional existing information on the environmental values of Tie Lake. A valuable component of the literature review was the search of the BC Conservation Data Centre (BC CDC 2011) records to identify sensitive plant and animal species potentially in the area. Using the field data and historical accounts, a fish and wildlife summary was prepared that discussed Tie Lake specific data and identified important habitats and interactions, particularly for sensitive species and critical life stages of native species. Habitat for sensitive species or critical life stages was included in the Aquatic Habitat Index as a Zone of Sensitivity (Section 3.4.2 - ZOS).

3.4 Aquatic Habitat Index (AHI)

The AHI estimates the biological value or environmental sensitivity of the shoreline. For consistency and comparison between lake systems, the AHI methods closely followed those used in the Moyie F&W study (Schleppe 2009a) and at Columbia Lake (McPherson *et al.* 2010a). 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 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 as fish and 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 docks 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. Appendix D (Table 1) summarizes the categories and parameters that were incorporated into the index and identifies the calculations and possible 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. The definitions of the biophysical and modification parameters are provided in the FIM Standards (Schleppe and Mason 2009).

3.4.1 Biophysical Parameters

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 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, determined by analyzing native species use during different life stages, were established in the earlier lake studies using assessment findings and literature reviews. The values remain consistent with those used at Moyie, Wasa and Columbia lakes where the wetland and stream mouth shore types have been incorporated. 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. 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. Substrate values have subsequently been accepted as standards for this and other lake assessments (e.g., Moyie, Wasa and Columbia lakes (Schleppe 2009a, McPherson *et al.* 2010a and McPherson *et al.* 2010b). Overall, coarse substrates such as cobble and gravel have a higher value than the finer substrates such as organics, muds and sands. Boulders have moderate value while bedrock is low. The percent coverage was determined by assessing a 5 - 7 m wide band in the littoral zone for the length of the segment.

Percentage Natural

Natural shorelines have a high fisheries, wildlife and ecological value because they provide intact littoral zone, shoreline and/or riparian habitats. This parameter recognizes that natural areas typically function better and are more similar to historical ecosystems than highly disturbed shorelines. The value of this parameter follows the standard used at other lake's including Moyie Lake (Schleppe 2009a), and Columbia Lake (McPherson *et al.* 2010a). Percent natural was based on a review of the shoreline area visually apparent from the shore (up to 50 m). Orthophotos analysis was also used to confirm findings.

Aquatic Vegetation

All vegetation below the high water level is considered productive (Schleppe 2009a). Aquatic plants provide fish and wildlife with food, spawning or nesting habitat, foraging substrates, and cover from sun and predators (Engel 1990). They also function to protect shorelines from wave-action and subsequent erosion. The combined cover (%) of emergent, submergent and floating vegetation contributed directly to the AHI. The percent coverage was determined by assessing a 5 - 7 m wide band in the littoral zone along the length of the segment.

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. Overhanging vegetation extent (% of linear shoreline) was calculated using the field observations and photos.

3.4.2 Zones of Sensitivity

Zones of sensitivity (ZOS) typically are habitats for sensitive species, species of regional significance or habitats supporting critical lifestages of native fish species. ZOS are determined through the field investigations and the literature review. At Tie Lake, two types of ZOS were identified, 1) areas with high juvenile fish rearing / biodiversity potential, and 2) winter painted turtle habitat. Additional supporting information is provided in Sections 4.4 Fish Results and 4.5 Wildlife Results.

1. **Juvenile Fish Rearing & Biodiversity Potential**:

   High value areas for native juvenile rearing fish were identified. Juvenile fish rearing potential was determined by the presence of cover along the shallow shoreline margins (Figure 2). Wetlands were evaluated to provide the highest cover elements as a result of the abundant emergent vegetation. Other features important to juvenile rearing include overhanging vegetation, large woody debris, and cobble or large gravels. Areas with docks and other man-made structures were not considered valuable habitat because of their preference by non-native adults, particularly largemouth bass (Bisset pers. comm. and Porto pers. comm.).

Figure 2. Valuable shoreline areas for juvenile fish rearing along Tie Lake include areas with cover elements such as emergent vegetation (left, segment 8), and overhanging vegetation (right, Segment 10).

   This ZOS also corresponds with areas providing high biodiversity potential. One of the goals of BC Ministry of Environment is to conserve biodiversity in the province (Stevens 1995). Wetlands are a relatively uncommon habitat feature in south east British Columbia and several species of plant and vertebrates found using them are sensitive species. Wetlands enhance biodiversity potential because of the numerous plants, vertebrates and invertebrates typically found in these habitats (Klinkenberg 2011; Stevens 1995). Lake wetlands are able to meet the requirements of several stages of the bird life cycle including summer breeding and feeding sites, feather molting time periods for ducks and geese, and migration stop over areas. Other valued areas for biodiversity were the areas with wide bands of undisturbed mature forest, which had associated coarse woody debris, veteran trees and snags.

Each segment was assessed as having High, Moderate or Low value for fish rearing/ biodiversity potential. The segments with High and Moderate potential were attributed 6 points and 3 points respectively to their AHI score. Given the high value of the areas, the weightings given to this ZOS were moderate; this was considered appropriate since the general biophysical attributes (e.g., high wetland shore type score, % overhang, %natural, vegetation scores) also attributed value to these features individually. This ZOS corresponds with the biologically productive areas ZOS at Wasa Lake (McPherson *et al.* 2010b) and Juvenile rearing area ZOS at Moyie Lake (Schleppe 2009a).

2. Winter Painted Turtle Habitat:

The western painted turtle (*Chrysemys picta bellii*) is the most northerly occurring turtle in North America and is limited to the southern area of British Columbia. This turtle is on the BC provincial blue list indicating they are vulnerable to habitat loss, and susceptible to human and natural disturbances (BC CDC 2012, Stevens 1995). It is also listed as of "Special Concern" by Committee on the Status of Endangered Wildlife in Canada (COSEWIC. 2006). Painted turtle habitat is limited to wetlands and ponds, which they use for hiding and foraging (Blood and Marcartney 1998). For basking they prefer floating logs or other sites surrounded by water where they are safe from predators. Where such sites are not available, they are known to bask in warm lakeshore mud. They require habitats adjacent to upland areas with soils suitable for nesting (Blood and Marcartney 1998). Their habitats are often prime areas for human development.

Painted turtles were observed on the muddy lake bottom of Tie Lake during our November assessment (Figure 3). Most of the observations were in shallow water close to the shoreline away from developed areas such as docks and other shoreline developments in segments 1, 2, and 13 (some shoreline areas including parts of segments 10, 11, and 15 could not be assessed due to ice coverage). These sightings are considered important. Studies found that painted turtles at the nearby Kikomun Creek Provincial Park wintered in shallow waters (10-100 cm deep) within 10 m of the shore, on top of mud (Blood and Marcartney 1998). Oxygen levels in these areas were higher than areas in other parts of the lake suggesting turtles may select higher oxygenated areas to avoid lactic acid poisoning due to anaerobic metabolism during winter. Based on the timing of our surveys, in late fall just before freeze-up, the areas identified during our survey could be specific over wintering areas for painted turtles. For these reasons a segment was considered a ZOS if greater than one painted turtle was observed during our assessment. Since further investigation would be necessary to confirm if turtles consistently use these areas, their presence during the November field assessment resulted in a negligible rating of 2 points in the AHI.

Figure 3. Muddy bottom habitat with SWD and LWD in undeveloped forested segment 1 where western painted turtles were concentrated in November 2011.

Further assessment would be required to determine the range of locations used during the turtle's active period from spring to fall (including basking, feeding and nesting areas). It is expected that undeveloped areas would provide valuable habitat for this species; consequently these areas would coincide with the High Biodiversity Potential ZOS above.

3.4.3 Riparian Parameters

Band 1 and Band 2

Riparian vegetation is distinct from upland vegetation due to the presence of water and is considered more productive. Shoreline vegetation is important to aquatic animals such as fish and turtles for food sources and cover (See Overhanging Vegetation above). Riparian vegetation is also an essential component for most terrestrial wildlife species dependant on shorelines. The intact wetland, shrub, mixed forest and coniferous forest habitats found at Tie Lake provide shelter, nesting areas and food for the many species potential to the area (see Section 4.5). Vegetated shorelines also help to reduce erosion by stabilizing banks and reducing the erosional energy of rainfall and wave action.

Following the FIM standards, field data and photo analysis were used to determine vegetation bandwidth and vegetative quality values for the riparian Bands 1 and 2. Band 1 is the first distinct vegetation zone along the shore, while band 2 is the zone found immediately behind it. The two bands together represent a maximum 50 m wide area along the segment. In accordance with parameter values used on other studies (e.g., Columbia and Moyie lakes, McPherson *et al.* 2010a and Schleppe 2009a, respectively), vegetation class and bandwidth were scored for the AHI. Following these examples, Band 1 vegetation, situated closest to the lake (thus contributing more to the lake productivity) was weighted higher than Band 2 vegetation.

3.4.4 Habitat Modification Parameters

Schleppe and Arsenault (2006) provided much of the background on influences of habitat modification parameters on the shoreline habitats and their original evaluations of shoreline modifications have been used consistently. Direct quotes of their findings have been shown in italics. The influence of each modification follows calculations used in past studies, and where

analyses differed between lakes, the potential influence on small lakes was considered and the most applicable value was attributed. All modifications have generally been given equal potential maximum scores in the index, which are dependent on density. This means that with high densities they all would have similarly negative impacts on habitats for fish and wildlife.

Retaining Walls

Retaining walls are generally constructed to armour or protect shorelines from erosion, and are also built for landscaping purposes (e.g., to flatten sections of properties that are on an incline). Retaining walls are considered a negative habitat features in terms of fish and wildlife habitat. This is because they eliminate complex habitat features such as emergent vegetation and LWD, natural substrates are covered, and riparian vegetation including overhanging shrubs are typically removed when retaining walls are put in. The loss of these natural features has been described to potentially reduce the diversity and abundance of nearshore fish assemblages that function as critical prey refuge areas (Kahler *et al.* 2000), and to reduce the diversity of benthic macroinvertebrate communities (Carrasquero 2001).

Quite often retaining wall construction leads to energy transfer via waves resulting in erosion somewhere else. A solution better suited to maintaining environmental values would be the retention of riparian vegetation. Retaining walls were evaluated in the AHI by using the percentage of shoreline segment length coverage value. They were evaluated similarly to Moyie and Columbia lakes (Schleppe 2009a, McPherson *et al.* 2010a).

Docks

Docks are reported to have both negative and positive impacts on fish habitat. The positive aspects are that they provide shaded areas that can attract fish and provide prey refuge, and pilings can provide good structure for periphyton growth (Carrasquero 2001).The negative attributes are that they provide hiding areas for ambush predators, reduce large woody debris inputs, and are often associated with other anthropogenic disturbances such as retaining walls (Kahler et al. 2000; Carrasquero 2001). Docks have also been found to increase fish density due to fish's general congregation around structure, but to decrease fish diversity in these same areas (Lange 1999). 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).

Overall, it is understood that docks do affect fish communities and the degree of effects are most likely related to the intensity of the development, and fish assemblages present. Different fish assemblages may respond differently to increased development intensity. 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 docks are included in the index, and that docks are treated as a negative parameter, with increasing dock density considered as having more negative effects than lower dock densities. Docks were evaluated similarly to Moyie and Columbia Lakes (Schleppe 2009a, McPherson *et al.* 2010a)

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. Groynes were evaluated similarly to other lakes assessed in the past (e.g., Columbia and Wasa lakes (McPherson *et al.* 2010a and McPherson *et al.* 2010b)).

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. Primitive boat launches, constructed of gravels, can also impact the shoreline through riparian and aquatic plant disturbance and compaction of the substrates with vehicular travel. 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.

Past studies (Okanagan and Moyie Lake) have assessed each lane of a boat launch lane in order to incorporate the size of the structure into the index. At Tie Lake, all boat launches were one lane and gravel based. Their scoring was consistent with Moyie Lake (Schleppe 2009a) in terms of value per lane, and Columbia Lake (McPherson *et al.* 2010a) in terms of maximum point value.

Substrate Modifications

Substrate modifications at Tie Lake includes beach grooming, which is the conversion of shoreline to sand beach through sand placement and placement of gravel/cobble substrates along the shoreline to protect from erosion. The key concern at Tie Lake is that these substrate modifications impact the shoreline diversity through a reduction of vegetation (aquatic and riparian). Sand also has lower habitat value than the naturally occurring gravel beach shore type and the mud substrates.

The loose placement of a narrow and low band of cobble/gravel along the shoreline is seen as less of an impact than building vertical retaining walls structures. This is reflected in the scoring multiplier for this modification. Beach grooming was also considered similarly at Wasa Lake (McPherson *et al.* 2010b). An estimate of linear shoreline (percent) with beach grooming was determined using field assessments and photo analysis.

Marinas

Marinas were not included in the AHI because they were absent in Tie Lake. Typically, this modification would be left in the criteria table, so its potential impact would be considered if proposed in the future. However, a marina is not expected at Tie Lake since the Land Use Bylaw for the area states that the Regional District will not support an application for a private commercial marina on the lake (RDEK 1999).

3.4.5 Index Ranking

The biophysical, ZOS, riparian and modification scores were summed for each segment. In this study, negative habitat parameters were constrained to have a potential negative effect of 18% for the segment. This is equivalent with other studies (e.g., Columbia Lake, Wasa Lake (McPherson *et al.* 2010a and McPherson *et al.* 2010b)) and allows for appropriate weighting of modifications. 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 correspond with the segment's **Current Ecological Value**.

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.

3.5 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. Tie Lake Guidelines were developed following the templates developed initially at Windermere Lake (East Kootenay Integrated Resource Management Partnership (EKILMP) *et al.* 2008) and refinements provided at Moyie Lake (Schleppe 2009).

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 denotes segments with a Very High Ecological Value;
2. Orange Shoreline denotes segments with a High Ecological Value;
3. Yellow Shoreline denotes segments with a Moderate Ecological Value; and
4. Grey Shoreline denotes 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.

4 Results

4.1 Hydrology

Tie Lake is a depression in the quaternary glaciofluvial sediments of the southern Rocky Mountain Trench; as such its hydrology is dependent on summer rainfall and water table fluctuations which reflect annual snowpack (McDonald pers. comm). The small "watershed" determines the flushing rate of the lake which affects the accumulation of nutrients such as phosphorus, critical to the lake's trophic status (McDonald pers. comm.). No permanent overland flows enter the lake (Carter 2010). Some small drainages from the hillsides flow into the lake as small creeks, some enter the lake as groundwater "springs"; the source is the same and all are important to the lake hydrology (McDonald pers. comm). Several areas where groundwater or seasonal flows are known to enter the lake have been mapped (Appendix A). Tie Lake has one outflow, Tie Lake Creek, located at the east end of the lake. The outflow is controlled with a weir to maintain water levels of the lake.

The perimeter of Tie Lake as determined through this project is 11.9 km. This is higher than that previously documented (e.g., FISS 2011 reported 10.9 km perimeter). The difference is related to delineation methods; in this study we delineated the shoreline along the edge of the wetlands farthest away from the lake. Additional general lake information is summarized in Table 2.

Table 2. Tie Lake waterbody summary (Sources: FISS 2011[1], Carter 2010[2], and MacDonald 2011[3])

Watershed Code[1]	Waterbody Identifier[1]	Elevation[1]	Area[2]	SHIM Perimeter	Maximum Depth[3]	Average Depth[2]
349-284500-14300-27400	00178BULL	850 m	126.3 ha	11.9 km	5.5	2.2

4.2 Water Quality

McDonald (2011) completed a water quality status report of Tie Lake which provides valuable information on the lake's water quality processes relative to fish habitat conditions. The information provided in McDonald's report is relevant as background for the SHIM and has thus been summarized for context below.

For its surface area Tie Lake is quite shallow. This results in a large surface area:volume ratio (SA:V) which, in conjunction with a low flushing rate has several influences on the lake. Because of the large SA:V ratio, the lake becomes very warm in the summer, reaching surface temperatures of 25°C or greater in the summer.

The large SA:V also likely contributes to winter fish kills, last reported to have occurred in the winter of 1979-80 (McDonald 1984). Winter fish kills are usually caused by oxygen depletion from bacterial growth on the lake bottom under ice cover when atmospheric diffusion is cut off. The large SA:V ratio also results in ice having a higher than normal effect on dissolved mineral concentrations in the water, when minerals are excluded from the ice. The development of high concentrations of unionized ammonia, toxic to fish, has been a resulting concern (McDonald 1984).

The shallow depth of Tie Lake also prevents the development of temperature – density stratification, having water clarity and fish habitat implications. No thermocline layer develops in

the summer, which is where the water temperature decreases rapidly with depth. As a result there is no hypolimnion of deeper and cooler unmixed water, which is preferred summer refuge habitat for fish (e.g,. trout). Also in the absence of a thermocline, mixing of the deep waters, which can become concentrated with nutrients, is ongoing. Because of this, if the nutrient supply is high, Tie Lake is prone to algae blooms (including large populations of cyanobacteria or blue-green algae). These blooms have been linked to fish kills in the lake, occurring when oxygen is depleted at night when algae switch from photosynthesis to respiration (McDonald 1984). Cattle grazing and septic runoff were the primary sources of nutrients (i.e., phosphorus) contributing to the blooms. Grazing schedules have been altered to address this.

4.3 Biophysical FIM Summary

The Tie Lake total shoreline length was determined to be 11,863 m. The shoreline was divided into 16 contiguous segments, ranging in length from 147 m to 1831 m. GIS maps showing segment locations and key segment information are provided in Appendix A. Segment summaries including representative photos, and physical and biological findings are provided in Appendix B.

4.3.1 Natural versus Disturbed

Overall, 63% (7,552 m) of the shoreline was determined to be in a natural condition, while the remaining 37% (4,301 m) was disturbed (Figure 4). Disturbances were associated with several activities including residential related modifications (e.g., docks, retaining walls), riparian removal, roads, grazing and park development. The natural areas were mostly identified along undeveloped Crown land sections of the shoreline; and to a lesser extent, residential areas with intact riparian vegetation.

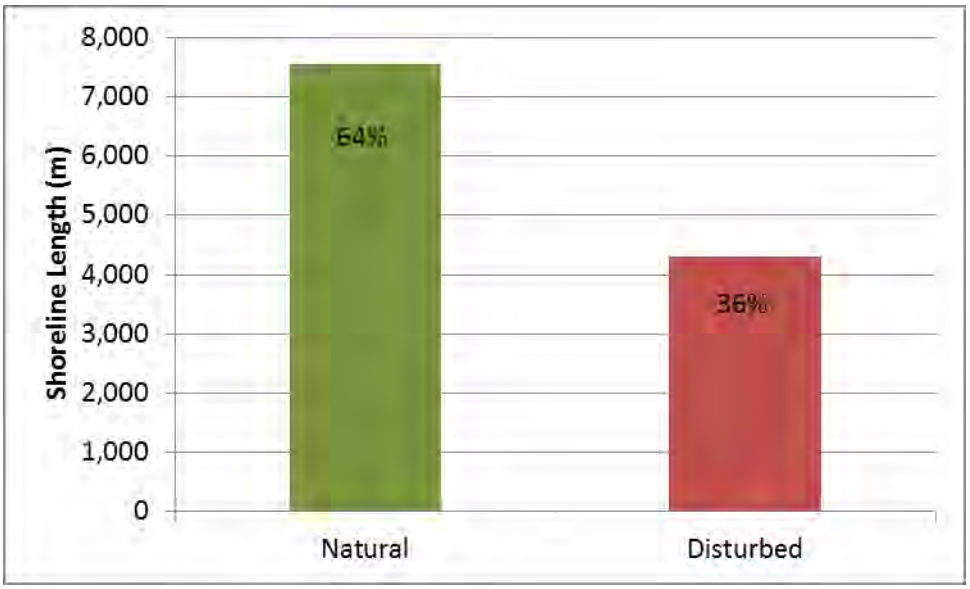

Figure 4. Extent of natural and disturbed shoreline along Tie Lake in 2011 (metres and percentages).

4.3.2 Land Use

Land use along the immediate shoreline of Tie Lake was predominantly Crown land (44%), and Single Family Residential (34%), with lesser extents of Highways property (11%), Parks (8%) and Other Lands (3%) (Figure 5). 'Other' refers to Private Land Zoned RR 60; the shoreline is part of larger property across the road used for grazing livestock. Land use is shown on the SHIM map as well as on the RDEK (2012) Land Use map (Appendix A).

Generally, levels of disturbance related to land use designation. Crown land areas were generally undisturbed (i.e., segments 1, 3, 8, 10, 11), other than cattle grazing, vegetation removal and erosion along Segment 13. Residential areas typically had high levels of disturbance (segments 5, 9, 12, 14, 16); however, there were some locations where efforts were employed to limit residential related shoreline disturbances (segments 4, 7 and 11). Parks had moderate levels of disturbance, owing to development for recreational use (such as beach development, boat launch and picnic sites). Highways property was a mix with some segments, such at 5 and parts of 15 being protected from development due to the designation. The roadways in other areas including Segment 2, and other parts of Segment 15; however, came close to the shore, having a negative impact on habitat.

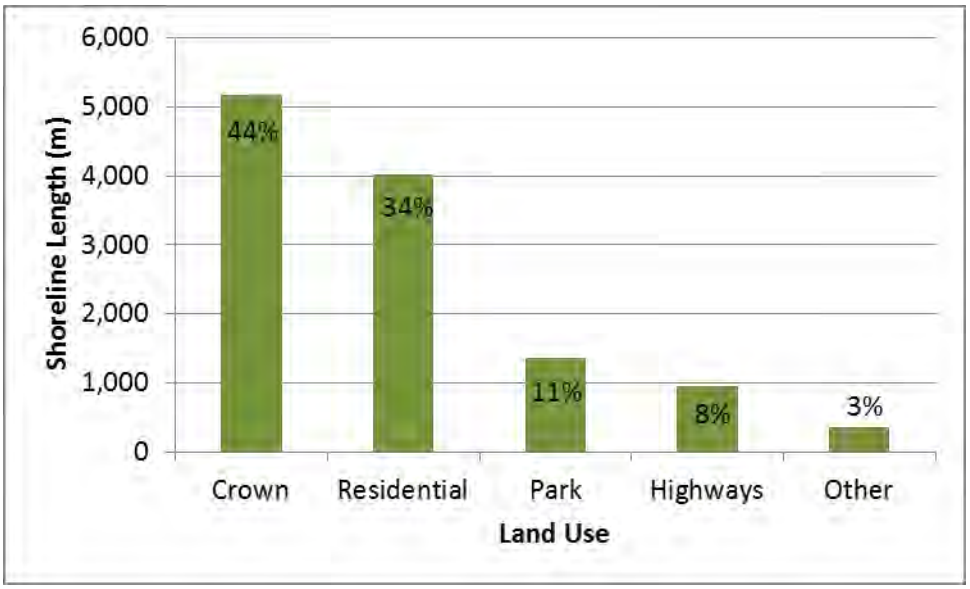

Figure 5. Land use designation along the shoreline of Tie Lake in 2011 (metres and percentage).

4.3.3 Shore Type

Gravel beach was the predominant shore type at Tie Lake, comprising 70% of the shore (Figure 6). Gravel Beach was typified by a narrow band of gravels and cobbles along the bank, which generally did not influence the lake bottom by providing course substrate habitat for fish (Figure 7). Where emergent vegetation impeded the view of the banks, and where it was not a wetland or stream mouth, it was presumed that the parent substrates of the banks had gravel components. Shoreline development was concentrated on the gravel beach shore areas, which were evaluated to be 34% disturbed. This estimate includes assessed sand beach areas which were a modification of natural gravel beaches through the import of sands.

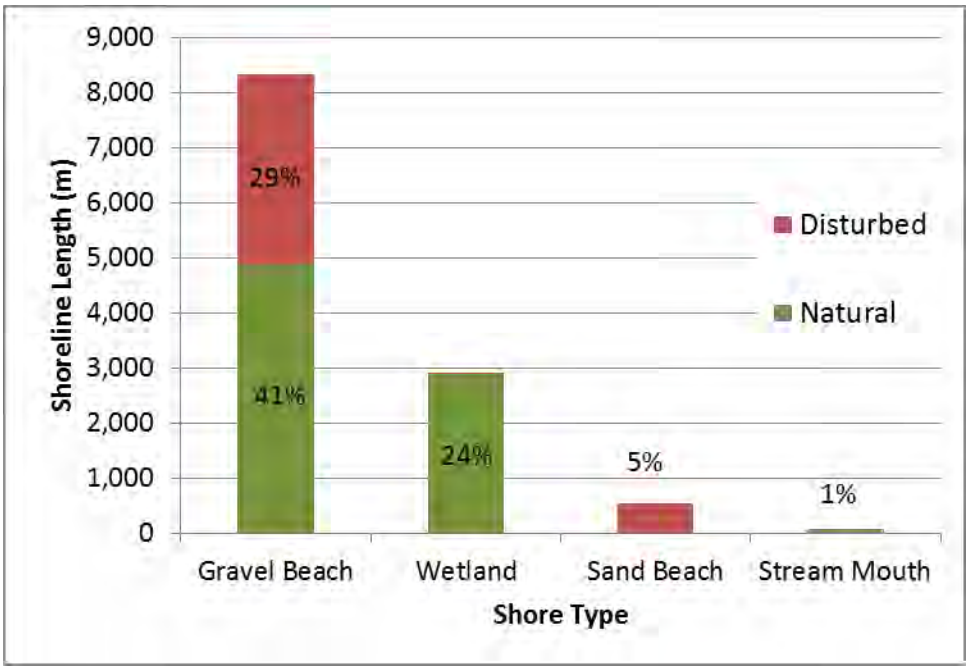

Figure 6. Shore Types at Tie Lake and extent of impact in 2011 (metres and percentage)

Figure 7. Gravel Beach shore type at Tie Lake in 2011 (segments 1 and 13 respectively)

The wetland shore type comprised 24% of Tie Lake. Twelve wetlands, covering a total area of 79,199 m^2 (or 79.2 hectares) were found in bays around the lake. The wetlands generally appeared to be in a natural condition, other than where roads were developed proximal to the shoreline.

Tie Lake has seven inlet streams and one outlet stream identified through the literature sources (McDonald 1983 and BC Fish and Wildlife 1959). These inlet streams were all quite small, running only seasonally and were thus labelled as ephemeral on the project map. Five of the inlet streams (located in segments 2 (2), 7, 8 and 11) flow through culverts under the road. The streams influence is evident as a dark blue line on the orthophoto map. We applied a 20 m shoreline contribution to each stream as a Shore Type which resulted in streams representing 1% of the shoreline. As a consequence of their size and intermittent flows, their influence to fish

and wildlife was accounted as minimal; however, they do appear to contribute to the wetland development where they enter in the bays (segments 8, and 13). The outlet (Segment 2) was also considered a small stream with negligible direct habitat benefits to fish as a result of the weir at the lake for managing lake levels.

4.3.4 Substrate Type

The lake substrates were primarily mud, other than small components of gravel and cobble associated with the banks (maximum contribution was only 7%, estimated in Segment 14). Mud is typically dark in colour and consists of a mixture of silts, clays and finely decayed organic material that is typically not discernible (Schleppe and Mason 2009). Although these fine substrates do not provide cover or spawning substrates for fish, they are valuable in terms of food production, since aquatic invertebrates and other organisms inhabit these substrates.

4.3.5 Riparian Vegetation

Figure 8 illustrates the results of the riparian assessment, combining data for Band 1 and Band 2. Together, these bands describe a representative 50 m wide section for each segment. First, the undisturbed areas along the shoreline (e.g., coniferous forest, mixed and natural wetland) typically had a 3-5 m shrub band. This shrub band was often not present in the disturbed segments (lawn and herb/grass). Shrub cover varied from segment to segment, providing sparse to abundant coverage. Shrub cover directly related to the amount of overhanging vegetation cover provided to the littoral zone, valuable to fish. Figure 9 depicts how the percent overhanging vegetation corresponds with the Level of Impact, which is discussed further in Section 4.3.8.

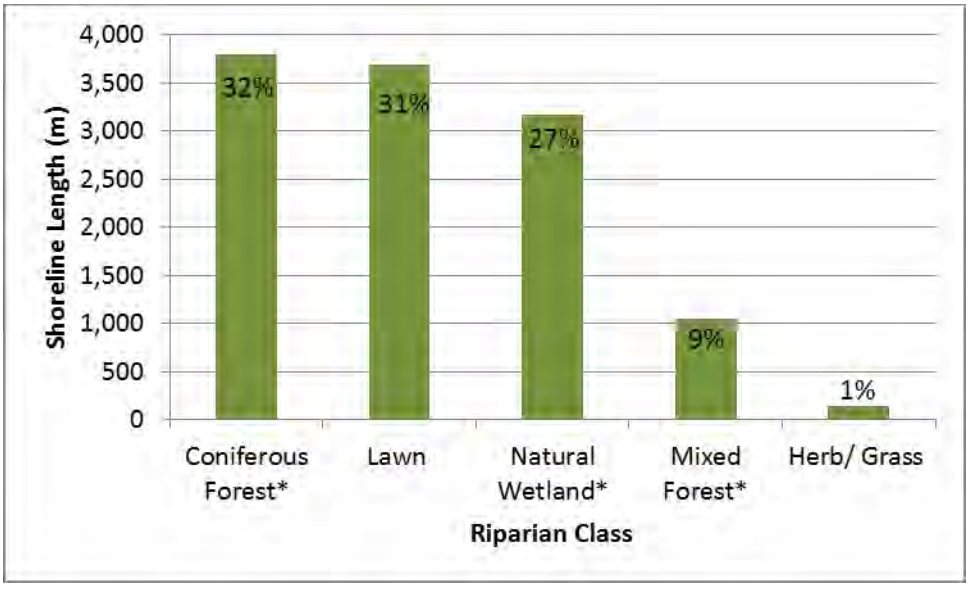

Figure 8. Riparian vegetation along the shoreline of Tie Lake in 2011 (metres and percentages). The asterix denotes the typical presence of a 3-5 m shrub band at shoreline.

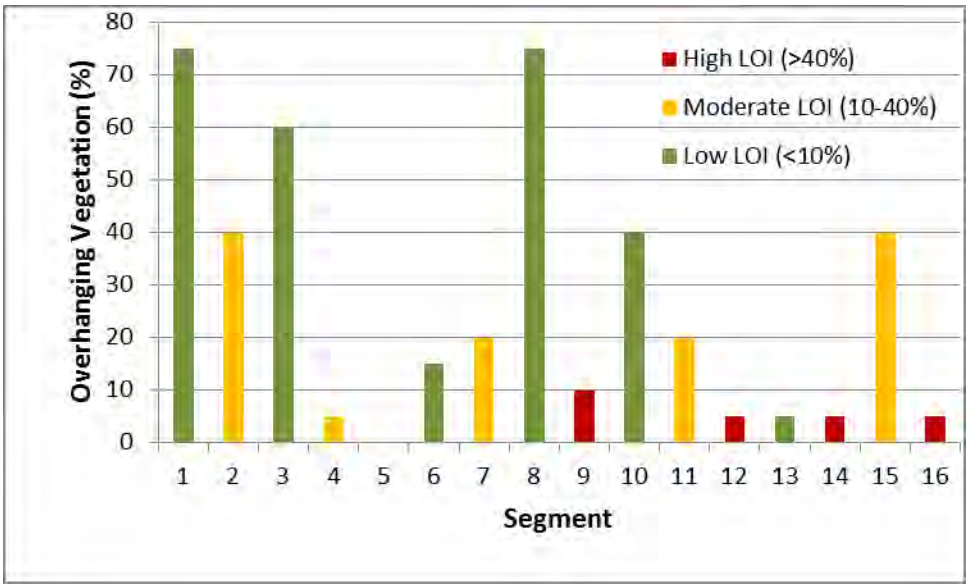

Figure 9. Overhanging vegetation in each segment of Tie Lake and corresponding Level of Impact rating for each segment, 2011.

Past the initial shrub band, shoreline riparian vegetation most prevalent was coniferous forest (32%), lawn (31%) or natural wetland (27%). Mixed forest (9%) and herb/grass areas (1%) were less abundant. The coniferous and mixed forest areas were assessed to be in a mature stage. The disturbed segments typically had lawn; however, some properties left native vegetation intact either as a minor over-story to the lawn or as a buffer between properties. This forest cover was the primary determiner of percentage natural in the disturbed segments.

Note that wetlands were described by their band widths of emergent aquatic vegetation first and then shrub cover. The wetland riparian area also included a mixed forest band that was described but not included in the AHI. The emergent zones in the wetlands, typically were greater than 50 (average maximum width for the 12 wetlands was 80 m).

The vegetation assessment provides an overview of common species present and was conducted from the lake aboard a boat and in November when the leaves were off the deciduous trees. As a result some species may have not been observed. The shrub species identified included: red-osier dogwood (*Cornus serice*a), willow (*Salix spp*), and green alder (*Alnus viridis*). The conifer species included Douglas fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and spruce (*Picea* spp.). The deciduous species were trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) which was also noted as a shrub.

Snags and veteran trees were dispersed throughout forested segments, with Segment 13 having the highest numbers of both (>25). This Crown land segment, however, was the longest of all segments (3,172 m).

4.3.6 Aquatic Vegetation

Tie Lake has a moderate to wide littoral zone (10 to >50 m) and is ideal habitat for aquatic plants that grow in the nutrient-rich, organic sediments (McDonald 2011). Aquatic vegetation was evidenced in each segment of Tie Lake. Emergent vegetation was the most prominent,

found along 48% of the shoreline (Figure 10). Emergent vegetation was mapped during the field assessment and is depicted as a sensitive habitat feature. Emergent vegetation was dominated by bulrush (*Scirpus* spp.) and cattails (*Typha latifolia*). Segment 1 is the only undisturbed segment with no emergent vegetation. Excluding segment 1, generally emergent vegetation extent decreased with increasing development.

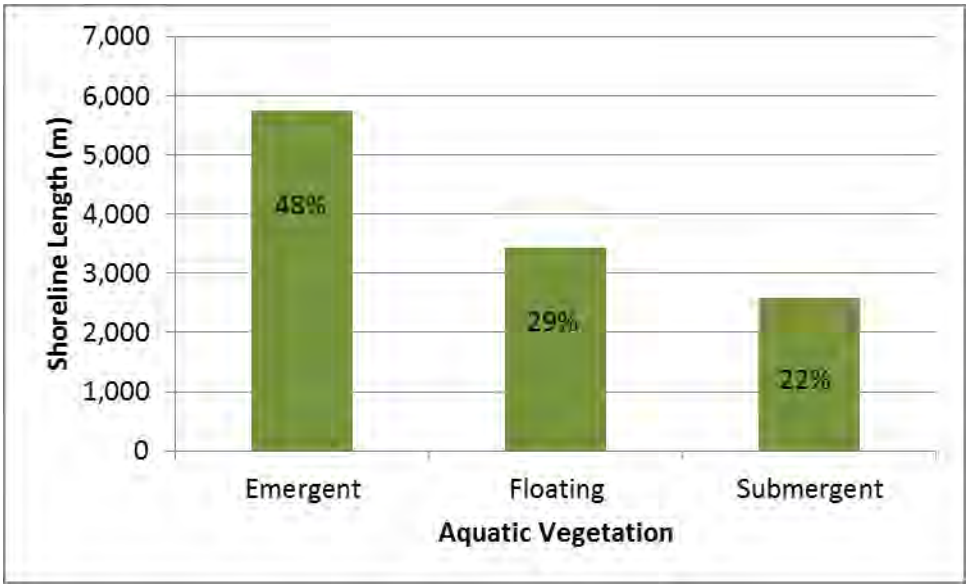

Figure 10. Shoreline extent (metres and percentage) with emergent, floating and submergent aquatic vegetation.

Estimates for floating and submergent species considered that some dieback of the plants had occurred as a result of late fall conditions (this was not necessary for the emergent vegetation as even the dead plants were very evident). For instance, sparse lily pad coverage of an area with decaying fronds and stems was estimated to have provided greater coverage during the growing season. Floating aquatic vegetation was found along 29% of the shoreline while submerged vegetation was found along 22%. Where there was floating vegetation there tended to be no submergent vegetation, due to shading. Floating species observed included floating pondweed (*Potamogeton natans*), and lily pads (*Nuphar* spp). Submergent species were coontail (*Ceratophyllum* spp) and *chara* spp (an algae).

Generally the shoreline had moderate amounts of LWD. LWD was most abundant along natural forested segments such as segments 1, 2, 10, 13 and 15 and was generally absent or low in developed and wetland segments.

4.3.7 Shoreline Modifications

Shoreline modifications included docks (138 total), retaining walls (61 total), boat launches (6 total), boat houses (4 total), substrate modification (11%), and roads (14%) (Table 3). Substrate modification included beach development and low lying cobble/gravel retaining walls. Roads considered were the main public access roads around the lake (i.e., Tie Lake Road and Tie Lake Shore Road), if they were within 50 m of the shore.

Table 3.Summary of shoreline modifications at Tie Lake

Modification	Total #	# per km	% of Shoreline	Total shoreline length (m)
Docks	138	11.59	n/a	n/a
Boat Houses	4	0.3	n/a	n/a
Boat Launch	6	0.5	n/a	n/a
Retaining Walls	61	5.12	15	1827
Substrate Modifications	n/a	n/a	11	1351
Road	n/a	n/a	14	1681

As a result of their negative influence on fish habitat, modifications below the high water mark were reviewed in more detail by segment. Modifications were associated with areas of dense residential land use (segments 5, 9, 12, 14, and 16). In these segments, dock densities ranged from 23 to 42 docks per km; retaining walls below the high water mark ranged from 50-55% of shoreline length; and substrate modifications ranged from 20-45% of the shoreline length (Figure 11). Particular modifications of concern for fish and wildlife habitat would be the areas with high dock densities, continuous and impermeable retaining walls below the high water mark, and boathouses built in the wetted perimeter (Figure 12).

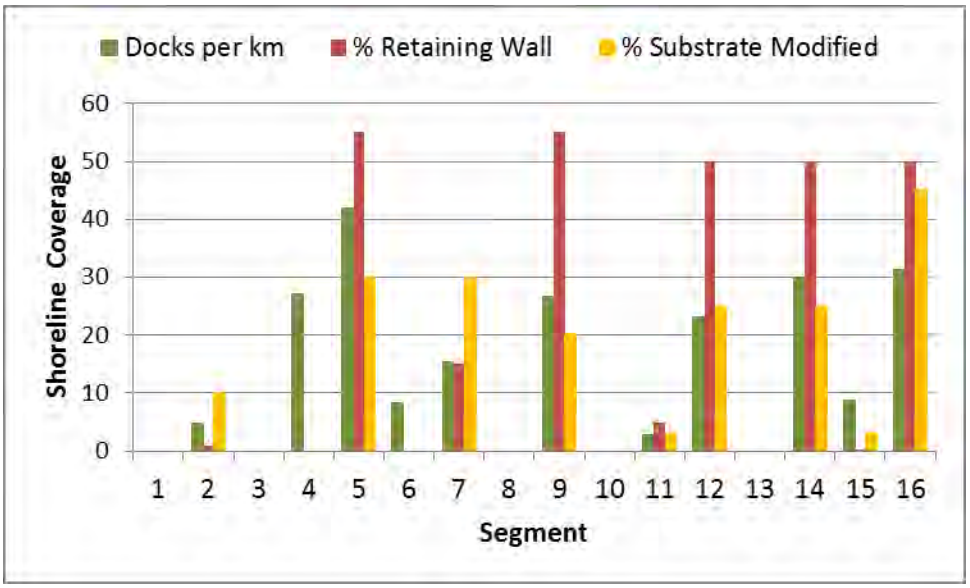

Figure 11. Docks (per km), retaining walls (%), and modified substrate (%) at shoreline segments at Tie Lake, 2011

Figure 12. Examples of high impact modifications along the shoreline

Several unauthorized docks (23 including boardwalk), retaining walls (2) and day use areas (approximately 16) have been built adjacent to Crown land and Highways shoreline properties in segments 2, 6 and 15 (Figure 13). Other modifications causing shoreline disturbance were human access down the banks along the forestry recreation site (Segment 2) and cattle watering/grazing along Segment 13. Both of these activities presented erosion requiring remediation (Figure 14). Efforts to decrease erosion were also noted along Segment 2 with boulders placed as a measure to deactivate boat launch sites. Lack of vegetation at these sites was apparent and revegetation efforts are recommended.

Figure 13. Unauthorized docks, boardwalks and picnic areas along Highways Land at Tie Lake.

Figure 14. Erosion issues – Segment 2 shows access along forest recreation site, Segment 13 shows cattle watering/grazing access. Segment 2b shows deactivation of historic boat launch using boulders.

4.3.8 Level of Impact

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. Tie Lake shoreline was determined to have 6% with no impacts, 34% with Low LOI, 28% with Moderate LOI, and 31% with High LOI. Figure 16 illustrates the various LOI present at Tie Lake.

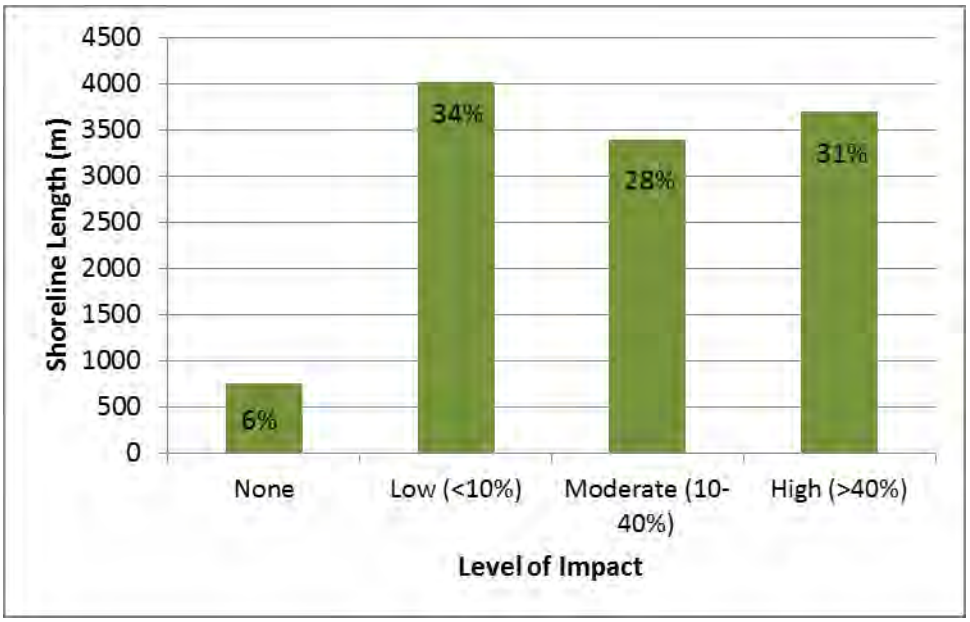

Figure 15. Level of Impact (metres and shoreline length) for the Tie Lake shoreline, 2011.

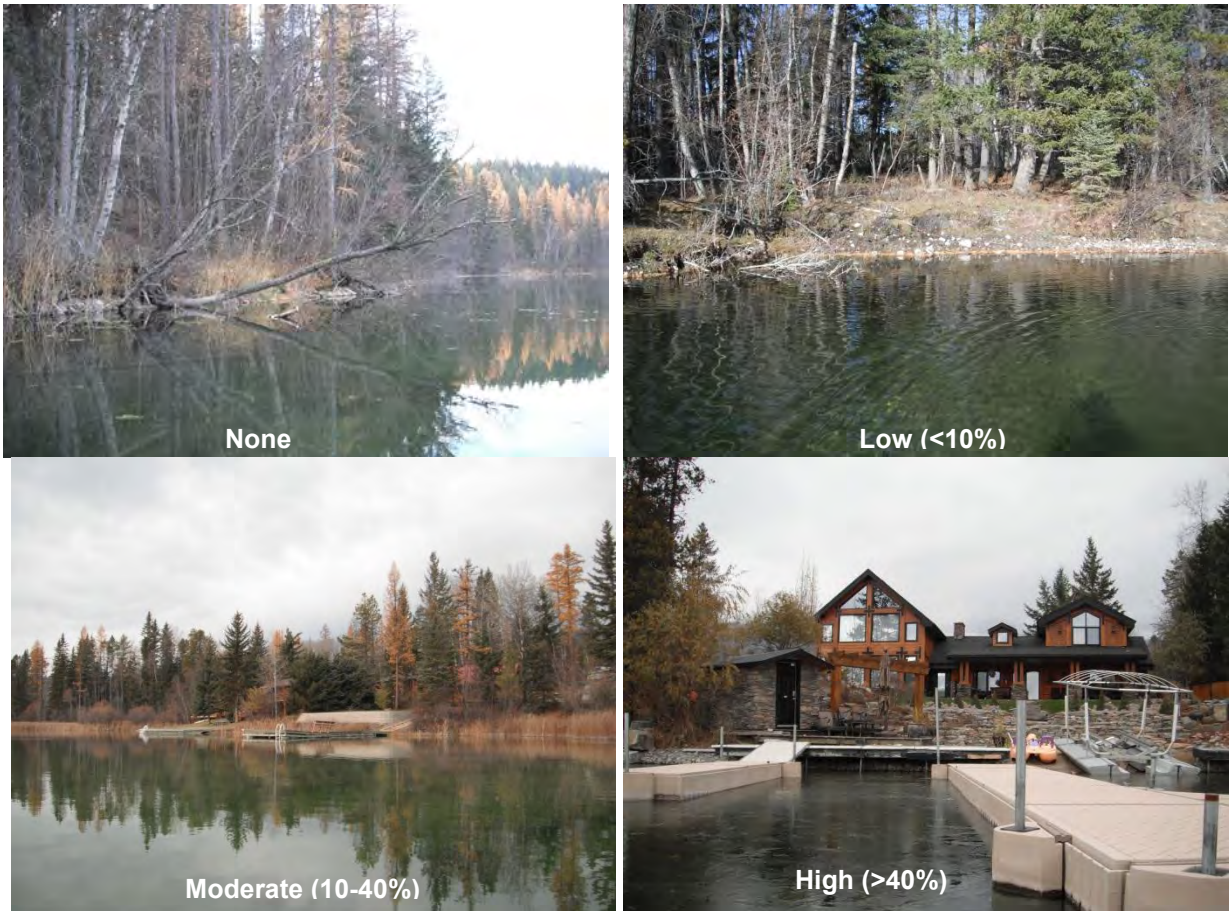

Figure 16. Examples of the different Levels of Impact assessed at Tie Lake, 2011

LOI largely corresponded to land use with the following overall observations:

- The Crown land shoreline generally had low LOI and included the forested segments 1, 2, 10 and 13, and many of the wetland segments (segments 3, 8, 11).
- Other than segments 4, 7 and 11, which had moderate LOI, the residential lands had high LOI associated with shoreline modifications and riparian disturbance.
- Parks included the Tie Lake Forest Recreation area in Segment 2 and the Tie Lake Regional Park in Segment 13. Both showed moderate LOI as a result of recreational related modifications including sand beach creation, picnic areas, and parking areas.
- Highways contributed to the LOI by fragmenting the riparian area and through unauthorized public uses (e.g., docks, picnic area).

4.4 Fish Results

Eight fish species are known to Tie Lake; two are native to the area, three are non-native/ introduced and three are stocked sport fish species (Table 4). The native species are longnose sucker (*Catostomus catastomus)* and redside shiner (*Richardsonius balteatus).* Native species diversity in the lake is likely limited by habitat. There is no connection to year-round tributary flow required for spawning by salmonid and char species. Summer temperatures routinely exceed 25^{o}C and there is no hypolimnion layer of cool, deep water for refuge (MacDonald 2011). For example, rainbow trout (*Oncorhynchus mykiss),* the species currently being stocked in the lake, usually are stream spawners (although are known to spawn in upwelling areas of lakes) prefer cool temperatures between 7 – 18 ^{o}C (Raleigh *et al* 1984). Westslope cutthroat trout (*O. clarkii lewisi),* also stocked historically, typically require a stream for spawning and are known to avoid waters that exceed 20^{o}C (Shepard *et al.* 1984). Periodic summer and winter fish kills due to oxygen depletion are also confounding influences on fish populations at Tie Lake (MacDonald 2011).

The introductions of non-native, warm-water species including largemouth bass (*Micropterus salmoides),* yellow perch *(Perca flavescens)* and pumpkinseed sunfish (*Lepomis gibbosus)* are additional factors likely influencing native fish populations (and other wildlife species) in the lake. These non-native species compete with the native fish for habitat and food resources. Largemouth bass are a particular concern since they are known for their voracious appetites and rapid growth, and have been described as 'wreaking havoc' with native fishes and their population growth once introduced to a system (McPhail 2007). Fish are their primary food source, but adult largemouth bass are omnivores known to consume frogs, baby ducks, macro-invertebrates, and crayfish (Bisset pers. comm.). Juvenile and adult largemouth bass are typically associated with structures both natural (e.g., floating lily pads and large woody debris) and manmade (particularly docks) (Bisset pers. comm.). At Wasa Lake, juveniles were concentrated in groomed areas around docks (McPherson et al. 2010b). At Windermere Lake adults were found utilizing modified structures such as boats, docks and retaining walls and juveniles were in warm vegetated bays (Porto pers. comm.). The provincial fisheries management strategy for Tie Lake is directed at addressing this. The Fisheries Regulation for Tie Lake allows for a high daily catch of bass (8 fish) and an unlimited daily perch quota (MFLNRO 2011). The long-term objective for Tie Lake is to control the non-native species enough that the lake can be confidently stocked with native trout to support a small lake "family experience" sport fishery (Burrows pers. comm.).

Table 4. Fish species known to Tie Lake (source: BC MoE 2011) and typical lake habitat use.

Common Name	Scientific Name	Spawning	Rearing
Native Species			
Longnose sucker	*Catostomus catostomus*	In streams over gravel substrates, and along lakeshores in shallow water (<20 cm) (McPhail 2007).	Young-of-year (YOY): close to shore near cover (vegetative or wood) and associated with soft substrates. Juveniles remain in shallow areas close to shore (McPhail 2007).
Redside shiner	*Richardsonius balteatus*	Any shoreline with cobble, gravel or vegetation present (Schleppe and Arsenault 2006)	Inhabit shallows and are often associated with aquatic vegetation (McPhail 2007) Large concentrations around dense aquatic macrophytes at Columbia Lake (McPherson *et al.* 2010a).
Introduced/Naturalized			
Largemouth bass	*Micropterus salmoides*	1 m or less and typically near wood cover (McPhail 2007)	At Wasa Lake, juveniles were concentrated in groomed areas around docks (McPherson et al. 2010b). At Windermere Lake, adults were found utilizing modified structures such as boats, docks and retaining walls and juveniles were in warm vegetated bays (Porto pers. comm.).
Pumpkinseed sunfish	*Lepomis gibbosus*	In sand or gravel substrates, associated with aquatic vegetation, <1m depth (McPhail 2007)	Littoral areas throughout juvenile and adult stages (McPhail 2007). Found both in vegetated shore (Windermere and Wasa lakes) and around docks in groomed area (Wasa Lake) (McPherson and Hlushak 2008, and McPherson et al 2010b)
Yellow perch	*Perca flavescens*	Inshore waters (McPhail 2007)	Juveniles found in the littoral zones, usually associated with vegetation. Adults in littoral areas and offshore (McPhail 2007)
Hatchery Stocked			
Eastern brook trout	*S. fontinales*		n/a – not stocked since 1993
Rainbow trout	*Oncorhynchus mykiss*	Typically spawn in streams, but a few introduced populations spawn on gravels in lakes (McPhail 2007)	Fry inhabit shallow water, typically 2-5 m offshore. Associated with cover (e.g., cobble, boulder or LWD) (McPhail 2007).
Westslope cutthroat trout	*O. clarkii lewisi*	Typically in stream, or lake outlet, and some may spawn on gravel beaches (Carl and Stelfox 1989)	Fry inhabit shallow littoral areas. Juveniles seek cover during the day (woody debris or large gravel and cobble) and gradually shift to open waters as they grow (Bonneau and Scarnecchia 1998).

Only two fish were observed during our field investigation on November 7 and 8, 2011, which was completed over an 11 hour period. Both observations were adult yellow perch; one was alive (Segment 3) and one dead (Segment 16). The underwater video identified no fish present under the docks and boathouse structures reviewed. The absence of fish is likely attributed to the late time of year that the survey was completed. Adult largemouth bass are known to move into deeper waters during the fall when temperatures decrease (McPhail 2007). Other species likely would be doing the same as the water temperatures had dropped to 6°C, the air temperature averaged 5°C, and ice was beginning to form along sections of the shore. The visibility through the water was good and the quiet, slow electric motor of the boat should not have affected observations.

The native fish species in Tie Lake can spawn along lake margins and are suited to the vegetated shoreline habitat available throughout their lives (Table 4). These species form the native fish assemblage of the lake, and although they are not sport fish, their habitat is valuable to maintain. In addition to their inherent contribution to biodiversity of the lake, the native species would provide an important food source for wildlife in the area, particularly birds. Rearing habitat for native species and stocked sport fish were considered valuable at Tie Lake, and they were thus evaluated as sensitive (ZOS) in the AHI (*See* Section 3.4.2). The juvenile rearing ZOS was defined similarly to Moyie and Wasa lakes (Schleppe 2009 and McPherson 2010b), as areas associated with wide littoral areas (>50 m), stream mouths/outlets, aquatic vegetation and/or wetlands. All streams flowing into Tie Lake are ephemeral, flowing only seasonally (Carter 2010). The streams and the springs identified by MacDonald (1983) have been mapped in this study, as they contribute to the aquatic community. Further assessments of the stream/spring habitats would provide additional understanding of their contribution.

4.5 Wildlife Results

Wildlife accounts and habitat assessment during the field review are summarized in the segment summaries (Appendix B). Aquatic resources are critical habitats in lentic ecosystems, particularly the wetlands found along their periphery. Although they may be variable in their value as wildlife habitat, this value is based on their location, ecological condition and size. A number of variables (e.g., presence of water and its depth, degree of structural diversity, cover within the wetland or adjacency to riparian habitats) increase the biological diversity and habitat value of a wetland (Gill 1996). A wetland with productive characteristics of vegetation consisting of a variety of species with the aquatic habitats that are shallow or ephemeral in nature can provide a high food base for many animals such as amphibians, fish, birds and bats. Wetlands and lakes are critical to these wetland dependent species and important to many upland species for food, water and cover (Stevens 1995). Tie Lake wetland environments have the potential to meet a wide range of habitat requirements important for numerous amphibians, waterbirds, waterfowl, and fish. Upland birds and mammals also benefit from the wetlands due to the adjacent riparian vegetation (trees and shrubs). Many water associated species specialize in using the wetland areas for breeding and raising of young. Wetlands are a relatively uncommon habitat feature in south east British Columbia and several species of plant and animals found using them are sensitive species (Appendix C). The lower valued sections of narrow emergent vegetation strips may fill another ecological function of helping to stabilize shorelines. We reviewed a number of sources of information to identify the potential numbers and species types using Tie Lake (Blood and Marcartney. 1998, B.C. Conservation Data Centre 2012, British Coumbia Frogwatch 2007, Klinkenberg, Brian. (Editor) 2011, E-Fauna BC, Matsuda et al. 2006, Reptiles of British Columbia. 2008). Definitions of provincial species ratings are based on a color scheme of risk or sensitivity. A red rating designates a threatened species, blue rating is a

species of special concern and yellow indicates the species is not at risk in British Columbia (B.C. Conservation Data Centre 2012).

Amphibian Habitat Potential

Tie Lake has the potential to support amphibians particularly in the areas of wetlands. Wetlands are the most common habitats for frogs, toads and salamanders provided the wetlands have good vegetation structure for egg mass attachment and sufficient shallow water for juvenile development. Common species such as western toad (*Anaxyrus boreas*), Pacific Chorus Frog (*Pseudacris regilla*), long-toed salamander (*Ambystoma macrodactylum*), and Columbia spotted frog (*Rana luteiventris*) could be found in or adjacent to Tie Lake. The presence of fish in the lake reduces the likelihood of high amphibian populations because fish will readily feed upon the amphibian juveniles. No amphibians were observed during our surveys. Nor were surveys conducted during the spring which is the best time to detect amphibians. The western toad is a blue-listed species in BC, and all the other amphibians potentially found at Tie Lake are yellow-listed.

Waterbird and Waterfowl Potential Habitat

A number of bird species such as loons, grebes, phalaropes, herons, shorebirds, terns, ducks and geese rely on wetland habitats. Wetlands with moderately fluctuating water levels can be the most productive waterbird habitat because modest changes in water levels increase vegetation and aquatic insect productivity, all good food sources. Lake wetlands are able to meet the requirements of several stages of the bird life cycle including summer breeding and feeding sites, feather molting time periods for ducks and geese, and migration stop over areas. Great blue herons (*Ardea herodias*), blackbirds, osprey, loons, and waterfowl such as mallard ducks (*Anas platyrhynchos*), Canada geese (*Branta Canadensis*), lesser scaups (*Aythya affinis*), ring-necked ducks (*Aythya collaris*), common goldeneye (*Bucephala clangula*), and buffleheads (*Bucephala albeola*) could use Tie Lake. Our surveys conducted during late fall observed common goldeneye, mallard ducks, lesser scaup and a common loon (*Gavia immer*) on the lake. Adjacent upland habitat observations during shoreline surveys consisted of black-capped chickadees (*Poecile atricapilla*), red-breasted nuthatch (*Sitta canadensis*), northern flicker (*Colaptes auratus*), and common ravens (*Corvus corax*). One of the goals of BC Ministry of Environment is to conserve biodiversity in the province (Stevens 1995). Conservation of sensitive and less common species is one means to do this. Birds designated as sensitive in BC and the species that could be potentially found at Tie Lake are identified (Appendix C). Not only is the lake expected to be valuable to breeding birds, it also is expected to be used by fall and spring migrating avifauna. A unique habitat feature of Tie Lake is the island in segment 10. This tree/shrub island combined with a wetland to the northwest represents an area of high potential habitat for a wide range of species due its variety of plant species and structural diversity consisting of low lying emergent vegetation, grasses, shrubbery, and mature conifers.

Painted Turtles Habitat Potential

The western painted turtle (*Chrysemys picta bellii*) is the most northerly occurring turtle in North America and is one of two populations in BC. Painted turtles prefer the edges and shallow areas of lakes and ponds with muddy bottoms with numerous aquatic plants that provide important life history requirements such as feeding, basking and hibernation areas. Upland turtle nesting areas without vegetation are used in June and July with young hatching in September. This

turtle is on the BC provincial blue list indicating they are vulnerable to habitat loss, and susceptible to human and natural disturbances (BC CDC 2012, Stevens 1995). It is also listed as of "Special Concern" by Committee on the Status of Endangered Wildlife in Canada (COSEWIC. 2006). The painted turtle is BC's only remaining native pond turtle. They are sensitive to pollution, waterway changes due to damming, agriculture and urbanization of waterfronts. Painted turtles of a variety of sizes (age classes) were observed in muddy bottom areas during surveys of Tie Lake. A total of 45 painted turtles were observed during a two day survey of the lake shore. A majority of the observations were in shallow water close to the shoreline away from developed areas such as docks and other shoreline developments in segments 1, 2, and 13. Biologists found that turtles at Kikomun Creek wintered in shallow waters (10-100 cm deep) within 10 m of the shore, on top of mud (Blood and Marcartney 1998). Oxygen levels in these areas were higher than areas in other parts of the lake suggesting turtles may select higher oxygenated areas to avoid lactic acid poisoning due to anaerobic metabolism during winter. Based on the timing of our surveys in late fall just before freeze-up, the areas identified during our survey could be over wintering areas for painted turtles. Further investigation would be necessary to confirm if turtles consistently use these areas. The island shoreline of segment 10 consisted of submerged and exposed large woody debris which could be used by turtles as summer habitat particularly for sunning or foraging areas.

Besides overwintering and summer feeding habitat, breeding areas are a limiting factor for painted turtle populations. In B.C. females lay clutches of eggs beginning in early June to early July. The turtle are very selective about where they build there dirt nest. The sites are usually unvegetated south facing sites with dry, light textured soils lacking roots or large stones. Nest sites are typically within 150 meters from water and may be in human disturbed environments such as road shoulders and dikes. The eggs hatch in late August or early September but the hatchlings do not leave the nest until the following year in May or June, when they journey to suitable ponds (Blood and Marcartney 1998, COSEWIC. 2006). Tie Lake painted turtle nesting locations have not been documented.

Bats

Of the 17 species of bats in British Columbia, 5 occur within southeastern British Columbia, and have the potential to use the Tie Lake area. These are the little brown bat *(Myotis lucifugus),* Big-brown bat (*Eptesicus fuscus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Hoary Bat (*Lasiurus cinereus), and* Silver-haired Bat (*Lasionycteris noctivagans)*.

Tie Lake could be a concentrated source of insects for bats distributed in the area. Bats also require roosting areas which varies depending on species. Some use trees, old buildings or caves and mine sites. Bats may use habitats within the Tie Lake area during migration (regional or long-distance), dispersal (one-way movement), roost shifts and short distance (<50km) habitat shifts (Fleming and Eby 2003). Migration can be regional, moving moderate (100-500 km) distances between summer and winter roosts (e.g. little brown bat), or long distance, traveling large distances between summer and winter roosts, which require significant physiological shifts (e.g. silver-haired bat, hoary bat) (Fleming and Eby 2003, BC CDC 2012). Some species are sedentary, breeding and hibernating in the same local areas, usually moving <50km between summer and winter roosts (e.g. big-brown bat, and Townsend's big-eared bat) (Fleming and Eby 2003, BC CDC 2012).

Of the nine potential species that could use the Tie Lake area, all but one species, the Townsend's big-eared bat, are on the Yellow List (BC CDC 2012). The Townsend's big-eared

bat is on the Blue List, and globally is G4 (apparently secure), provincially S3 (vulnerable) and is on the CDC tracking list (BC CDC 2012). This species has been found at elevations ranging from sea level to greater than 3160 m, and maternity and hibernation colonies are typically found in caves or mine tunnels, occurring in a broad range of habitats except grasslands, but generally preferring coniferous or deciduous habitats (BC CDC 2012). Provincially, all of the potential bat species at Tie Lake are listed as S4, S5 or S4S5. The most common bat likely to utilize the Tie Lake habitats is likely little brown bats.

4.6 Sensitive Plants

Tie Lake is situated in the Kootenay Dry Mild Interior Douglas Fir biogeoclimatic zone (BEC Zone) variant (IDF dm-2) (BC Forests and Range 2008). A search was conducted of sensitive plants in aquatic habitats (lacustrine, palustrine or riverine) in this BEC Zone (BC CDC 2012). A total of 34 plant species and 10 plant communities were listed (Appendix C). Completing surveys for these species and communities was outside of the scope of this project; however, the presence of one sensitive plant community was possible, the common cattail marsh (*Typha latifolia* Marsh). The common cattail marsh is a blue-listed ecological community, considered particularly sensitive to human activities or natural events (BC CDC 2012). Cattail marshes occur in protected embayments, where the surface substrates remain saturated for most of the growing season, and are dominated by cattail often with few other rooted plants (MacKenzie and Moran 2004). Our field inspection did not review whether the marshes observed to have cattail could have been classified as this sensitive community. A review during the growing period would allow for a confirmation.

4.7 Aquatic Habitat Index Results

Using the AHI analysis, the **Current Ecological Value** of the Tie Lake shoreline was determined (*See* Appendix D for calculations). The AHI determined that the shoreline of Tie Lake was represented by a range of ranked values including Very High (38%), High (21%), Very Low (29%), and Moderate (12%) (Table 5 & Figure 17). The extent of Very High and High areas was largely attributed to the Crown land (segments 1, 3, 8, 10, 13) as well as undeveloped Highways, Park and Rural Resource Private Land areas (segments 6 and 15). The prevalence of wetlands, coupled with the fact that there was little disturbance in these areas resulted in their high ranking for fish and wildlife. Segment 11 was the one example where a residential area was set amidst high value wetland habitat, and had maintained the environmental shoreline values. To test the analysis, the AHI was run on its own for the residential property resulting in the same high ranking.

Segments with residential development were typically ranked as Very Low as a consequence of multiple shoreline disturbances (segments 5, 9, 12, 14, 16). Moderate ranked segments were those that had a balance of development and maintenance of shoreline values (segments 2, 4, and 7). There were no segments ranked as low, indicating a broad gap between Moderate and Very Low, which can be attributed to inherent natural values as well as level of disturbance.

The **Ecological Potential** analysis determined that with restoration shoreline areas impacted with retaining walls, docks, boat launches and substrate modifications would see an improvement in their ranking. Four segments would increase in value from Very Low to Low,

one segment would increase from Moderate to High and two High segments would become Very High. This analysis did not consider riparian habitat improvements; additional benefits could be realized at all disturbed segments with riparian restoration.

Table 5. AHI results of current ecological value (with modifications) and ecological potential (without modifications).

Ecological Value	Current Shoreline			Potential Shoreline		
	Segments	%	m	Segments	%	m
Very High	3,6,8,10,13	38	4,462	3,6,8,10,11,13,15	56	6,648
High	1, 11, 15	21	2,505	1,2	12	1,375
Moderate	2, 4, 7	12	1,461	4,7	3	405
Low	-	0	0	9,12,14,16	25	2,935
Very Low	5,9,12,14,16	29	3,435	5	4	500

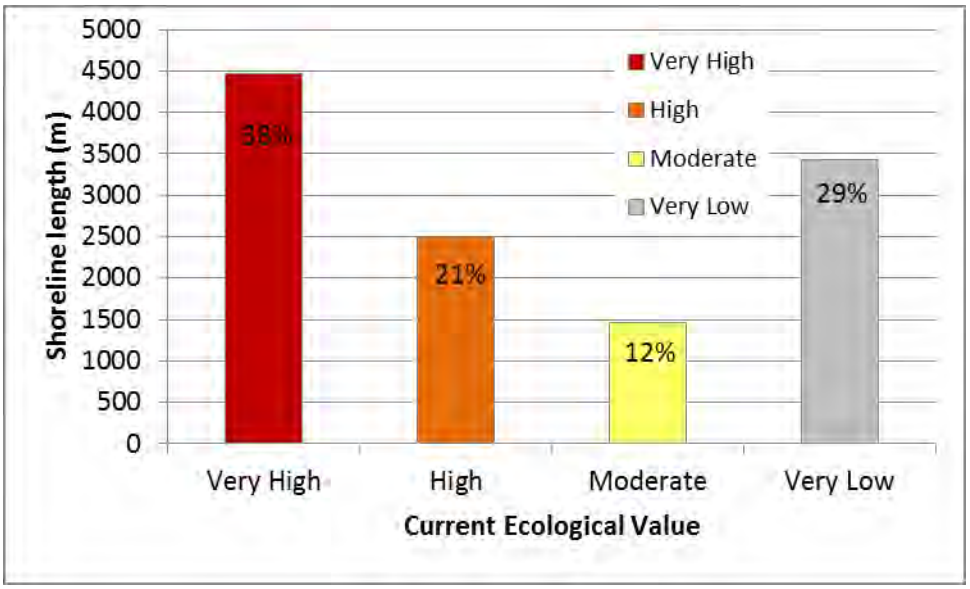

Figure 17. Current Ecological Value and associated percentage (%) of shoreline.

5 State of the Shoreline

Tie Lake was determined to have more than half (64%) of its shoreline in a natural state. Large and important contributions to this were the marsh wetlands, situated in 12 pockets around the lake. These wetlands were largely undeveloped, providing potentially valuable habitat to many fish, bird, mammal, amphibian, reptile, gastropod and insect species. Although sensitive species assessments were outside of the scope of this study, several blue-listed western painted turtle observations were made, and the potential presence of the blue-listed common cattail marsh was noted. The maintenance of natural areas was mainly attributed to Crown land zoning, although some park, highways and private uses also contributed to the natural shoreline. The foresight to allocate and maintain the Crown land around the lake is commendable, as it has done much to balance the effects of the residential areas on shoreline habitat.

The native fish species assemblages were comprised of non-sport fish species including redside shiners and longnose suckers. These species are valuable contributions to biodiversity of the lake. These species as well as the provincially stocked species (e.g., rainbow trout) are likely under pressure from the exotic species in the lake which include largemouth bass, yellow perch and pumpkinseed sunfish. Provincial management objectives for the lake are to reduce or eradicate these exotic species, to help improve habitat conditions for hatchery stocked fish (Burrows pers. comm.). Good juvenile rearing habitat, provided by areas with aquatic vegetation and overhanging riparian vegetation, was prevalent in the undeveloped shoreline areas. The man-made structures such as docks in the developed areas; however, provided habitat that is known to be preferential to the exotic species, to the detriment of native and stocked species (Piaskowski and Tabor 2001, Lange 1999).

The disturbed shoreline habitat (36%) was largely a result of residential development. Other than a modest number of good examples where environmental habitat values were maintained, residential land use was typically intensive, including a broad spectrum of shoreline modifications at any one property (e.g., docks, retaining walls and substrate modifications). These modifications corresponded with reductions in habitat valuable to fish and wildlife including riparian vegetation, overhanging vegetation, emergent aquatic vegetation, large woody debris in the lake for fish and coarse woody debris on land for the wildlife. Docks for example, are known to have potential impacts on native fish species assemblages, impact lakebed characteristics, limit vegetation through shading, and can introduce pollutants from associated motors (BC MoE 2006). In the intensively developed residential segments at Tie Lake, dock densities ranged from 23 to 42 docks per km. These densities are considered high. In comparison to similar studies on highly developed segments of other lakes: Windermere Lake had 12 docks/km (McPherson and Michel 2007), Columbia Lake had 5.3 docks/km (McPherson et al 2010a), and Wasa Lake had 13 to 30 docks/ km (McPherson et al 2010b). The trend appears to be for new development or upgrades to existing properties to incorporate greater levels of modification impact (e.g., impervious contiguous retaining walls, multiple docks, large beaches) than has been seen in the past.

Similarly to other lakes studied, such as Okanagan Lake (RDCO 2005) and Wasa Lake (McPherson *et al*. 2010b), shoreline modifications tended to be alike at neighbouring residential properties. A few good examples may initiate a trend of leaving the foreshore more natural, and of designing modifications in a more environmentally sensitive manner. Many of the values of

living on a lake depend on maintaining foreshore habitat including: fishing, bird watching, wildlife viewing and good quality water for recreation and drinking.

6 Shoreline Management Guidelines for Tie Lake

The Shoreline Management Guidelines for Tie Lake have been developed so that they may be utilized as a stand-alone document. The Guidelines have thus been incorporated into this SHIM report as Appendix E.

7 Recommendations

Overall to promote long-term health of the fish and wildlife at Tie Lake, in high value areas further habitat disturbance should be curtailed; while in other areas, 'soft' approaches to shoreline development should be considered. Maintaining a riparian leave strip along the shoreline is one mechanism to protect water quality, fish and wildlife habitat, maintain shore stability and reduce the visual impact of development. The Cariboo Regional District provides a relevant example through Riparian Buffer Zone Guidelines, which require a minimum 15 m buffer zone around all lakes and water courses in the district (Cariboo Regional District 2004). Restoration opportunities should be sought along disturbed shoreline areas. This could include, removing individual docks and cooperatively sharing such infrastructure (as supported by the RDEK (1999)), restoring riparian vegetation and removing sand and fill material (with the appropriate permits). As well, land owners should continue to be educated about foreshore development activities that cannot occur on Aquatic Crown land without prior approval.

A detailed list of recommendations is provided below. As a result of similar needs between lakes, many of the recommendations developed in the Moyie Lake FIM (Schleppe 2009) were utilized for this project (as indicated with italicized text).

Assessment and Inventory

1. **Conduct additional fish and wildlife inventories** to determine occurrences of sensitive species and habitats, including fish, reptile, amphibians, birds and mammals. For example, determine the range of locations used by the blue listed western painted turtle including nesting, basking, feeding and confirmation of wintering areas

2. Complete **stream assessments** to document the habitats available and benefits of the ephemeral streams and springs flowing into Tie Lake and the outlet stream, Tie Lake Creek

3. *Complete **Wetland Inventory and Mapping** (WIM)* and/or **vegetation surveys** for sensitive plant species and ecosystems in undisturbed foreshore areas. This would include confirming whether any of the wetlands are the blue-listed, cattail marsh ecological community.

4. **Complete a Wildlife Tree Assessment** and have all wildlife trees protected during development, where safely possible. Initiate an education program for local residents about the importance of wildlife trees.

5. ***Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM)*** *are useful mapping tools that help land managers identify sensitive terrestrial zones which can be integrated into other datasets.*

6. ***Survey, on a home by home basis, to help educate home owners.*** *A home owner report card could be prepared that would provide land owners with a review of the current condition of their property. This assessment would not single out individual owners, but rather help owners understand the important habitat values present on their properties and opportunities for improvements.* A similar activity was completed at Christina Lake (Mason pers. com.).

Planning and Management

7. **Address erosion issues on Crown land around the lake.** The Regional District should work with the MFLNRO to implement a management plan for the existing BC Forest Service campsite at Tie Lake (RDEK 1999). This plan should address maintenance and restoration of shoreline habitats. Also, cattle access to the shoreline of Segment 13 should be restricted to limit shoreline disturbance and associated erosion.

8. ***Environmentally Sensitive Areas should be identified and protected*** *as they are extremely important. Environmentally sensitive areas should be included in Official Community Plans, Bylaws, and policy documents. Sensitive areas should be added to the Development Permit Areas within any policy documents. The City of Kelowna has just recently completed a review of environmental development permit areas (EDP's) and has added over 400 properties to an EDP list. Numerous possibilities exist for areas identified as sensitive, including Section 219 No Build / No Disturb Covenants, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), or by other mechanisms (donation to trust, etc.).*

9. **Restrict high horsepower boats/jet skis in sensitive areas** (e.g., wetlands), particularly during critical periods for fish and wildlife.

10. ***Develop standard terms of reference for professional reports for environmental assessments of development applications.*** *This document will ensure consistency in environmental reporting. The Regional District of Central Okanagan (RDCO), City of Kelowna, and other Okanagan Valley municipalities have well developed terms of reference that could be used as templates. The Terms of Reference would outline professional requirements for assessments in the region and provide a list of considerations that environmental professionals must address as part of a development application. Site specific assessments are a critical component of a development permit process because every proposal is unique. The inventories and data within this SHIM document should be provided as part of the terms of reference.*

11. ***Habitat restoration*** *should be achieved wherever possible by identifying them during the development review processes.* Examples include removal of retaining walls, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, recontouring dredged areas, and removing sand placement, etc.

12. **Provide technical alternatives** to traditional foreshore modifications. This could include nodal development where docks are shared so that the density/length of shoreline disturbance is minimized.

13. ***A Land Act Section 16 Map Reserve*** *should be established on all areas identified as having very high value (Red Zones), where possible.* Red shoreline zones should be designated for conservation use, where no development can occur that has the potential to impact their sensitive communities.

14. ***Develop and use best practices for construction of bioengineered retaining walls.*** *Bioengineering has many different meanings. Concise guidelines and BMPs should be developed that are consistent with standard practices of bioengineering.*

15. **Develop and implement a coordinated enforcement protocol** with all levels of government to respond to foreshore habitat impacts of unauthorized and restricted activities. Address unauthorized docks constructed on foreshore areas with no upland ownership.

16. **A communication and outreach strategy** to inform stakeholders and the public of the findings of this study and improve stewardship & compliance. Notice of the availability of this report and associated products should be made available (e.g., on the Community Mapping Network or RDEK website). The outreach strategy could include an educational program for developers and existing lakeshore owners and users. This would 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 includes alternatives to traditional foreshore modifications; and, 4) understand the economic value inherent in protecting the ecological integrity of the lake. Another part of the outreach strategy, could include education panels being established at all boat launches.

17. ***Lakeshore erosion hazard mapping*** *should be conducted for private lands to identify areas at risk, which will stream line the review process and reverse the trend of unnecessary hard armoring and construction of retaining walls along the shoreline of the lake. Also, this methodology would be helpful to identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some adaptation of it should be used (Guthrie and Law, 2005). This mapping should be integrated with the SHIM data, and be completed for each segment. Flooding and terrain stability should also be considered for developing areas along the lakeshore. Until lakeshore erosion hazard mapping is completed, it is advisable to only consider shoreline protection works on sites with demonstrated shoreline erosion. To accomplish this, an engineer or biologist report should accompany any proposals for shoreline armoring to ensure that works are required, impacts are minimized and bioengineering techniques are used.*

18. ***Storm water management plans*** *should be included in all development applications that alter the natural drainage patterns. It appears that development along the lakeshore has been occurring without the benefit of a comprehensive storm water management plan. Poor storm water management can alter small streams by diversion, changes in water quality, and/or changes in discharge locations to the lake. This can result in erosion of foreshores and impacts to fish and wildlife habitats.*

19. *Governments should only approve developments with **net neutral or net positive effects** to biophysical resources, if feasible. Developments that have "significant" adverse effects to any biophysical resource (e.g., spawning areas) should not be approved on the basis that compensatory habitat works may offset such effects.*

20. ***Compensatory works** resulting from projects or portions of projects that could not be avoided must follow the DFO Decision Framework for the Determination and Authorization of a HADD of Fish Habitat and be consistent with the 'No Net Loss" guiding principle for the Management of Fish Habitat.*

21. ***Habitat mitigation and compensatory efforts** of biophysical resources should occur prior to, or as a condition of any approval of shoreline-altering projects. To ensure that works are completed, estimates to complete the works and bonding amounts should be collected. These bonds will ensure performance objectives for the proposed works are met and that efforts are constructed to an acceptable standard.*

22. ***Land use alteration proposals** should only be accepted if the compromises or trade-offs result in substantial, long-term net positive production benefits to biophysical resources.*

23. ***Low impact recreational pursuits (biking, non motorized boating, etc.), pedestrian traffic and interpretive opportunities should be encouraged**. These activities should be directed to less sensitive areas, and risks to biophysical resources should be considered. Only activities that will not diminish the productive capacity of biophysical resources should be considered.*

Future Data Management

24. ***Environmental information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information, orthophotos, and other electronic documents should be made readily available. One agency should take the lead role in data management and any significant studies that add to this data set should be incorporated and updated accordingly.*

25. **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 should be provided to the CMN database manager so that it may be incorporated into the digital atlas, located at www.cmnbc.ca.

26. *The following are recommendations for future use of the FIM dataset:*
    - ***A summary column(s) should be added to FIM GIS dataset that flags new GIS datasets as they become available.** Examples of this include new location maps for rare species, fish, wildlife data, etc. Where feasible, these new data sets should reference the shore segment number (see below).*
    - ***The Segment Number is the unique identifier.** Any new shoreline information that is provided should reference and be linked to the shore segment number.*

8 Conclusions

Conservation of the intact ecosystems in Tie Lake is critical in maintaining the environmental, social, 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 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. Federal and provincial legislation and local policies also protect the environment from irresponsible and unauthorized activities. Assessment and planning should ensure that individual lot-by-lot impacts (i.e., 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.

On behalf of Lotic Environmental and Anatum Ecological Consulting, we appreciated the opportunity to complete this valuable study, which contributes to sustainable development within the East Kootenay Region.

Sincerely,

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10 Appendices

Appendix A. Shoreline Maps

Segment Number: 9
Ecological Value: Very Low
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 8
Ecological Value: Very High
Shore Type: Wetland
Land Use: Crown
Level of Impact: None

Segment Number: 7
Ecological Value: Moderate
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 11
Ecological Value: High
Shore Type: Wetland
Land Use: Residential/ Crown
Level of Impact: Moderate (10-40%)

Segment Number: 6
Ecological Value: Very High
Shore Type: Wetland
Land Use: Highways
Level of Impact: Low (<10%)

Segment Number: 12
Ecological Value: Very Low
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 4
Ecological Value: Moderate
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: Moderate (10-40%)

Segment Number: 10
Ecological Value: Very High
Shore Type: Gravel beach
Land Use: Crown
Level of Impact: None

Segment Number: 3
Ecological Value: Very High
Shore Type: Wetland
Land Use: Crown
Level of Impact: Low (<10%)

Segment Number: 5
Ecological Value: Very Low
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 13
Ecological Value: Very High
Shore Type: Gravel beach / Wetland
Land Use: Crown
Level of Impact: Low (<10%)

Segment Number: 16
Ecological Value: Very Low
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 1
Ecological Value: High
Shore Type: Gravel beach
Land Use: Crown
Level of Impact: None

Segment Number: 14
Ecological Value: Low
Shore Type: Gravel beach
Land Use: Residential
Level of Impact: High (>40%)

Segment Number: 15
Ecological Value: High
Shore Type: Gravel beach / Wetland
Land Use: Park / Highways / Other
Level of Impact: Moderate (10-40%)

Segment Number: 2
Ecological Value: Moderate
Shore Type: Gravel beach
Land Use: Crown/Park
Level of Impact: Moderate (10-40%)

Tie Lake - Sensitive Habitat Inventory and Mapping

- Shoreline Segment Break
- Spring

Colour Zone - Ecological Value:

- Very High
- High
- Moderate
- Low / Very Low

Sensitive Habitat:

- Ephemeral Stream
- Emergent Vegetation
- Wetland
- Wintering Turtles

0 125 250 375 500

Meters
1:8,500
UTM Zone 11 NAD83

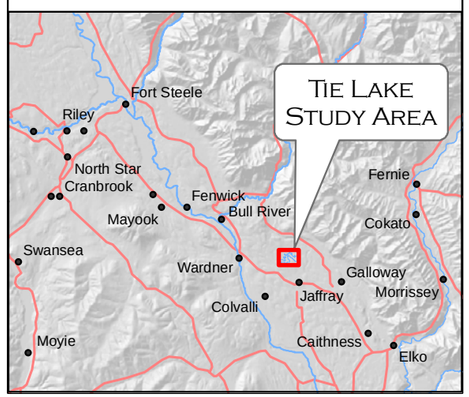
Data Sources:
1) One meter ortho photo from 2004 provided by FLNRO.
2) Legal boundary data (cadastral data) provided by RDEK. Current legal data for Tie Lake has lower than normal accuracy (+/- 40 meters). A "shift" of the data was completed to improve the accuracy to the best degree possible.
3) Shoreline segments and all sensitive habitats were digitized from ortho photo in conjunction with field verification.
4) Ephemeral streams and spring locations estimated from McDonald 1982 and Fish and Wildlife Branch 1959.

Client:
Ministry of Forests, Lands and Natural Resource Operations

Created by:
Lotic Environmental

Created on:
January 19, 2012

Overview Map



Map II. Tie Lake Land Use. Green = Crown land, yellow= Private land and Grey = Highways (Source: RDEK 2012)

Appendix B. Segment Summaries



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
1	319	gravel beach	none	moderate (5-20%)	Crown	None	No	100	0

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
100	0	0	0	0	0	For all segments, gravel beach could also be typed as vegetated shore based on old FIM standards

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	100	0	0	Cown land zoned as Public Institutional (P1) on RDEK land use map.

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
96	2	2	0	n/a	smooth	Natural gravel & cobble band along high water mark

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
shrubs	tall shrubs	abundant (>50%)	3	75	Abundant dogwood, willow and some paper birch along shore

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
1	Coniferous	young forest	abundant	47	Closed forest; douglas fir and western larch

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
5	5	1	0	sparse	S= chara spp.; F=floating pondweed	moderate (10-50 m)	5 to 25

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	0	0	n/a	0	0	0	0

Shoreline Modifications

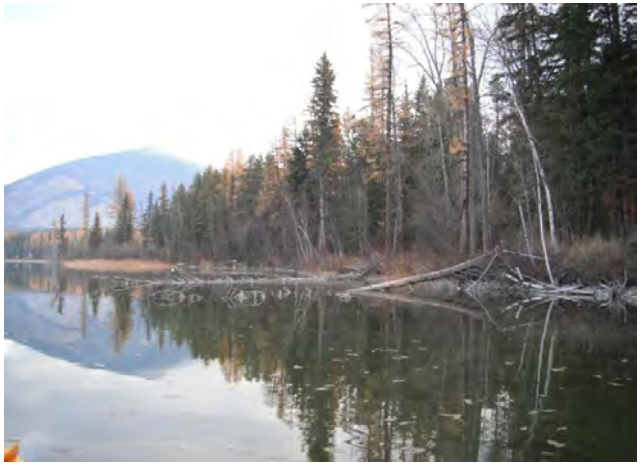
# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	No	0	None

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	no	Moderate	Yes	Total of 27 painted turtles observed. Turtles were associated with SWD (abundant throughout segment) and were a variety of age classes.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
31	0	6	none	low	Moderate	The time of year for assessment was not conducive to fish observation along shore as the existing species likely moved to deeper water to overwinter (pertains to all segments). Presence of overhanging vegetation, SWD and LWD would provide moderate cover for rearing fish. Low presence of aquatic vegetation for cover.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
2	1,056	gravel beach	road	low (<5%)	Crown	Moderate (10-40%)	No	60	40

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
81	6	11	2	0	0	Flows out of lake are regulated. Two inlet ephemeral streams at north end of segment. Stream entrance is fenced off and is within wetland depicted at south end of segment. Sand beach is the result of substrate modification at the south end of segment.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	42	43	15	0	Crown Land and Highways land. Crown Land includes Tie Lake Forest Recreation Site (which has an associated parking area, boat launch, 16 camp sites and a beach).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
96	2	2	0	n/a	smooth	Natural gravel & cobble band along high water mark

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
shrubs	tall shrubs	moderate (10-50%)	3	40	Dogwood, willow,alder moderate amount

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
2	Mixed forest	mature	moderate	47	Mature closed forest bisected by road for half of the segment.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
70	50	30	41	moderate	S= coontail, chara spp.; F= floating pondweed, lily pad	moderate (10-50 m)	5 to 25

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
1	1	wood	continuous	1	5	5	wood	0	0	57	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	1	Yes	10	Sand and/or gravel substrate additions at parking area and at south end of segment. Public road along 600 m of shore with minimal setback (approx. 20 m) from shore. Rec site road found within 20 m of remainder of segment. Evidence of boat launch deactivation (photo 828). Lake access from several points in the recreational site resulted in erosion and riparian vegetation damage. Five unauthorized docks at north end of segment.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
<5	<5	Moderate	Yes	Turtles (6) where no disturbance (before docks, near north end of segment); turtles seem to be associated with LWD and SWD. Also identified: pine grosbeak (5) and common raven (1) . 3 western larch veterns and 1 Douglas fir snag .

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
78	4	6	none	low	Moderate	Isolated locations associated with the road gravel contributions appear suitable for sunfish and bass spawning. Stream mouth is regulated and thus provides limited value for adfluvial species (species inhabitting lake and spawning in tributaries). Presence of LWD, wetland and aquatic vegetation provide juvenile rearing habitat.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
3	608	wetland	road	low (<5%)	Crown	Low (<10%)	No	97	3

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
33	0	67	0	0	0	none

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	100	0	0	0

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
natural wetland	grass/herb	abundant (>50%)	>45	60	Predominantly bulrush dominated marsh wetland, backed by shrub (~5 m band shrubs comprised of alder and dogwood) and then closed mixed forest. The forest extends for (~25m; douglas fir, western larch and trembling aspen). No wetland along 1/3 of segment.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
3	Shrub	Tall Shrub	abundant	5	

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
100	25	75	100	abundant	S= chara spp.; F= floating pondweed; E= bulrush	wide (>50 m)	<5

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	0	0	n/a	0	0	30	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	No	0	Road is found along 185 m of segment set back approx. 20 m from shore.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
5 to 25	no	High	No	Good bird breeding habitat, excellent structural diversity, expect high diversity of bird species based on habitat. Black-capped chickadee (1). No SWD for turtles

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
29	4	6	1 adult yellow perch	low	High	Good summer rearing habitat with high emergent vegetation cover associated with wetland.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
4	147	gravel beach	riparian removal	low (<5%)	Single family residential	Moderate (10-40%)	No	60	40

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
100	0	0	0	0	0	none

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Two large properties where immediate shoreline had limited modifications; houses set back from shore. Zoned single family residential RS-1(A)

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
99	1	0	0	n/a	smooth	Some gravel associated with boat launch

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
grass/herb	grass/herb	sparse (<10%)	50	5	Cleared historically with grasses now predominating. Open regen spruce amongst grass / herb area, providing moderate shoreline cover.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
4	n/a	n/a	n/a	0	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
97	10	0	97	abundant	S= chara spp.; E= bulrush	moderate (10-50 m)	<5

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	4	27	wood	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	1	No	0	House/cabins set back, immediate shoreline left largely intact (e.g., emergent vegetation and substrate) with few modifications.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
<5	no	Moderate	No	Black-capped chickadee (1), red-breasted nuthatch (2). Habitat values are moderate because of limited shoreline distrubance with negihbouring high value wetland and intact mature forest . Good example of develoment with consideration for the environment.

Fish Assessment

Period of fish review (minutes)	Air Temp (°C)	Water Temp (°C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
16	4	6	none	low	Moderate	Aquatic vegetation, particularly emergent vegetation provides cover for juvenile rearing.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
5	500	gravel beach	residential	low (<5%)	Single family residential	High (>40%)	No	10	90

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
80	0	0	20	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned single family residential (RS-1(A)).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
96	2	2	0	n/a	smooth	Gravel & cobble band along high water mark - both natural and imported

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
lawn	n/a	n/a	50	0	Many properties have lawn dominated understory, with some mature mixed forest left intact providing overhead cover (open Douglas fir, western larch, trembling aspen, and paper birch). The intact vegeation contribute directly to the percent natural attributed to this segment.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
5	n/a	n/a	n/a	0	#REF!

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
15	10	5	3	sparse	S= chara spp.; F= lily pads, floating pondweed; E= bulrush;	moderate (10-50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
15	11	cement, rock, gabion, wood	discontinuos	55	21	42	wood, fiberglass, polymer	0	0	2	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	3	Yes	30	Modifications were highly concentrated along the shoreline of this segment. The immediate shoreline of approx. 20% of the lots have been altered so extensively that little in the way of natural features exist. Retaining walls to the lakes edge are examples . Substrate modifications include sand placement (20% total length) and loose low profile placement of large gravels/cobbles (10% total). One access road leads to gravel based boat launch at shoreline.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
5 to 25	no	Low	No	Red-breasted nuthatch (1), common golden-eye (5), lesser scaup (4), red squirrel.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
100	4	6	none	low	Low	Sparse riparian and aquatic vegetation for cover. Coarse gravel/cobble placement as a substrate modification would have less impact on fish habitat than sand placement or retaining wall; however riparian and overhang is still compromised.

General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
6	243	wetland	road	low (<5%)	Highways	Low (<10%)	No	92	8

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
0	0	100	0	0	0	Natural wetland

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	0	100	0	0

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
natural wetland	grass/herb	abundant (>50%)	>45	15	Bulrush dominated marsh wetland, backed by sparse band of shrubs(~5 m band) and followed by mixed forest (~20 Douglas fir, trembling aspen, lodgepole pine).

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
6	Shrubs	Tall Shrub	sparse	5	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
100	0	75	100	abundant	S= coontail; F= floating pondweed,lily pads; E= bulrush, cattail	wide (>50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	2	8	wood	0	0	62	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	No	0	53 m long boardwalk input as second dock - erected to gain access from road to unauthorized dock at end of wetland. Road is setback approx. 18 m from shoreline along 150 m of the segment.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
<5	no	High	No	0

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
16	5	6	none	low	High	Wetland habitat and associated aquatic vegetation would provide good cover for fish during the summer.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
7	258	gravel beach	residential	low (<5%)	Single family residential	High (>40%)	No	25	75

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
47	0	33	20	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned single family residential (RS-1(A)).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
shrubs	tall shrubs	moderate (10-50%)	5	20	Willow, dogwood, alder. Emergent vegetation intact along many properties.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
7	Lawn	n/a	n/a	45	Mixed forest of Douglas fir, trembling aspen, lodgepole pine provide moderate cover to segment and were located along the margins of the property or as overhead component ot the lawn. The intact vegetation contributed to the percent natural of this segment.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
80	10	20	78	abundant	S = chara spp., coontail; F= lily pad, floating pondweed; E= bulrush, cattail	wide (>50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
1	1	concrete	discontinuos	15	4	16	wood, polymer	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	Yes	30	Fewer modifications per property evident compared to many other residential segments. Substrate modification was sand placement. Abundant emergent vegetation along shoreline; properties that have left emergent and riparian veg. intact provide good example of maintaining habitat. Some mergent removal area. Dredging also potentially occured along west end of segment, at start of Segment 8 wetland.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	no	High	No	Biodiversity potential ranked are moderate because of limited shoreline distrubance with high value wetland along both ends of segment. Provides examples of develoment with consideration for the environment.

Fish Assessment

Period of fish review (minutes)	Air Temp (°C)	Water Temp (°C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
24	5	6	none	low	High	Cover provided by aquatic vegetation to provide juvenile rearing; surrounded by high value wetland segments.

General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
8	235	wetland	none	low (<5%)	Crown	None	No	100	0

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
0	0	100	0	0	0	none

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	100	0	0	0

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
natural wetland	grass/herb	abundant (>50%)	>45	75	Bulrush dominated marsh wetland with some cattail. Abundant dogwood and willow at the back margins of the wetland. This area is backed by mature mixed forest.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
8	Shrubs	Tall Shrub	sparse	5	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
100	10	15	100	abundant	S= coontail; F= floating pondweed,lily pads; E= bulrush, cattail	wide (>50 m)	<5

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	0	0	n/a	0	0	36	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	0	0	Minor road influence as it was setback 40 m from shore for a 86 m length of shoreline.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	no	High	No	0

Fish Assessment

Period of fish review (minutes)	Air Temp (°C)	Water Temp (°C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
20	5	6	none	low	High	Wetland has small channels that would allow fish access for rearing



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
9	338	gravel beach	residential	low (<5%)	Single family residential	High (>40%)	No	10	90

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
80	0	0	20	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned RS-1(A). Developed land between two wetlands.

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
lawn	n/a	n/a	50	10	Very little shrub band left intact. Patches of mixed forest generally located back from shoreline or along edges of properties.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
9	n/a	n/a	n/a	0	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
35	1	30	33	scattered	S= coontail, chara spp.; F= floating pondweed, lily pads; E= bulrush, cattail	wide (>50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
6	5	wood, gabion, rock	discontinuous	55	9	27	wood, polymer	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	Yes	20	The contribution to the % natural area is that mature trees have been retained.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	no	Low	No	Northern flickers (2)

Fish Assessment

Period of fish review (minutes)	Air Temp (^oC)	Water Temp (^oC)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
48	5	6	none	low	Low	Non-native species (e.g., largemouth bass) would use lily pads and docks.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
10	204	gravel beach	none	low (<5%)	Crown	None	No	100	0

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
64	0	36	0	0	0	Small island surrounded by wetland and emergent vegetation.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	100	0	0	0

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
96	2	2	0	n/a	smooth	Natural gravel & cobble band along high water mark

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
natural wetland	grass/herb	abundant (>50%)	>45	40	Wetland extends off the north side of the island (>50 m band); the south side of the island is coniferous forest (30 m bandwidth with an initial 5 m shrub band).

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
10	Shrubs	Tall Shrub	moderate	5	Moderate shrub component of dogwood, birch and willow. Douglas fir and western larch comprise the mature coniferous components of the island.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
100	20	15	100	abundant	S= chara spp.; F= floating pondweed, lily pads; E= bulrush, cattail	wide (>50 m)	5 to 25

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	0	0	n/a	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	0	0	none

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
<5	5 to 25	High	No	No turtles seen; however, could not be assessed round east portion of wetland/island due to ice. Segment provides wood and root mats for resting habitat. High wildlife values for birds.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
21	5	6	none	low	High	Wetland, associated aquatic vegetation and LWD valuable for rearing.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
11	355	wetland	residential	low (<5%)	Crown	Moderate (10-40%)	No	75	25

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
35	0	58	7	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
50	0	50	0	0	Crown Land wetland and one residential lot

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	0	0	0	n/a	n/a	none

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
natural wetland	grass/herb	abundant (>50%)	>45	20	Wetland surrounded by birch, spruce, Douglas fir and western larch

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
11	Shrubs	Tall Shrub	sparse	5	Shrub component not as prelavent as in other island segments.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
90	30	30	87	abundant	S= chara spp.; F= floating pondweed, lily pads; E= bulrush	wide (>50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
2	1	rock	discontinuous	5	1	3	wood	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
1	0	Yes	3	Substrate modified with sand placement on residential property. Boathouse above HWM thus not accounted for in AHI.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	no	High	No	Black-capped chickadee (4). Biodiversity potential ranked are high because of wetland. Residential property provides example of maintaining shoreline features (e.g., riparian and emergent along sides of property) , in consideration of high neighbouring environmental values.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
37	5	6	none	low	High	Wetland and associated aquatic vegetation valuable for rearing.

General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
12	519	gravel beach	residential	low (<5%)	Single family residential	High (>40%)	No	12	93

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
93	0	0	7	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned single family residential (RS-1(A)).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
96	2	2	0	n/a	smooth	Gravel & cobble band along high water mark - both natural and imported

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
lawn	n/a	n/a	50	5	Low abundance of shrubs. Patches of mixed forest generally located back from shoreline or along edges of properties.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
12	n/a	n/a	n/a	0	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
30	10	15	12	scattered	S= coontail; F= floating pondweed, lily pads; E= bulrush	moderate (10-50 m)	0

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
11	8	rock, treated wood, concrete (lock blocks)	discontinuous	50	12	23	wood	0	0	0	1

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	Yes	25	Substrate modifications included both sand placement and loose low profile placement of large gravel/cobbles.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
<5	0	Low	No	One turtle seen at western end of segment, near start of Segment 13, in natural area.

Fish Assessment

Period of fish review (minutes)	Air Temp (^oC)	Water Temp (^oC)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
30	5	6	none	low	Low	Sparse riparian vegetation and scatted aquatic vegetation remained. Coarse gravel/cobble placement as a substrate modification would have less impact on fish habitat than sand placement or retaining wall.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
13	3172	gravel beach	cattle grazing	low (<5%)	Crown	Low (<10%)	Yes	93	7

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
74	2	24	0	0	0	Two streams shown on bathymetric map. Presumed ephemeral and small since they were not evident on the orthophoto (no open channel at stream outlet to the lake).

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	0	100	0	0	Zoned Rural Resource (RR-60)

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	2	2	0	n/a	smooth	Natural gravel & cobble band along high water mark

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
shrub & wetland	tall shrubs & grass/herb	shrubs -sparse (<10%); grass/herb (abundant>50 %)	weighted average 15	5	This segment is primarily comprised of a mature forest with some shrub (birch) along the shore margins. There were also significant areas of wetland class vegetation (25%) within three cattail marshes in bays of this segment. Vegetation Band 1 bandwidth thus represents an average contribution of the shrub and wetlands over the segment. Cattle have grazed down much of the shrub vegetation along the forested sections of shoreline.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
13	coniferous	mature	abundant	35	Lack of understory as a result of grazing. Spruce, larch, lodgepole pine, Douglas Fir. Coarse woody debris evident throughout forest.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
70	20	20	55	abundant	S= coontail, chara spp.; F (assoc. with wetlands)= floating pondweed, lily pads; E= bulrush	moderate (10-50 m)	>25

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
0	0	n/a	n/a	0	0	0	n/a	0	0	9	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	0	0	Shoreline vegetation trimmed down, bank erosion, and understory removal as a result of cattle grazing. Roadway along 230 m of segment setback approx. 30 m from shore.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
>25	>25	High	Yes	Ten turtles observed at start of segment. Nesting platform in wetland (photo 985). Duck nest box.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
59	5	6	none	low	High	LWD is mostly submerged, and not a lot of cover present. Overhanging vegetation is minimal due to cattle activity. Wetlands and associated channels through the emergent vegetation would provide good rearing for fish.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
14	900	gravel beach	residential	steep (20-60%)	Single family residential	High (>40%)	No	15	85

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
90	0	0	10	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned single family residential (RS-1(A)).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
80	10	10	0	n/a	smooth	Gravel & cobble band - both natural and imported

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
lawn	n/a	n/a	50	5	There was a diversity of vegetation strategies amongst lots. Some properties retained a beneficial shrub band along the shoreline where modfications were not present. Mature mixed forest components were also found along the periphery of porperties or as an overstory to the lawn. The retention of native vegetation contributed directly to the percent natural.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
14	n/a	n/a	n/a	0	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
50	50	10	3	moderate	S= coontail, chara spp.; F= lily pads	moderate (10-50 m)	<5

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
19	14	rock, concrete, wood	discontinuous	50	27	30	wood, polymer	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
2	0	Yes	25	Where modifications were not present, natural vegetation components were retained. Substrate modification was both sand placement (10% total) and low profile placement of loose large gravels/cobbles (15%). Floating boathouse with two bays, thus counted as two.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
5 to 25	0	Low	No	One turtle observed at start of segment. Coarse woody debris was not evident.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
49	7	6	none	low	Low	Videotaped for fish under docks. None seen; would expect high concentrations of non-native species such as largemouth bass in the summer. More naturally available course substrates in this segment provide increased rearing potential over other developed segments; but increased depths associated with stteper slopes may limit juvenile use.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
15	1831	gravel beach	road and unauthorized works	low (<5%)	Park	Moderate (10-40%)	No	85	15

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
57	0	40	3	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
0	50	0	30	20	Other' refers to Private Land Zoned RR 60, with shoreline being part of larger property across the road used for grazing beef. The western wetland is Highways property and the eastern wetland is privately owned. The park is Tie Lake Regional Park.

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	2	2	0	n/a	smooth	Natural gravel & cobble band along high water mark

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
shrub/natural wetland	tall shrubs/herb grass	shrubs - moderate (10-50%); grass herb -	weighted average 15	40	There were nearly equivalent lengths of wetland class shore type as there were of shrubs along the first band. The bandwidth thus represents an average of contribution of the two over the Band 1. Three cattail marshes.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
15	coniferous	mature	abundant	35	The coniferous band is bisected by a road (set back 25 m from shoreline) for approximately 20% of this segment.

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
80	20	40	77	abundant	S= chara spp.; F= floating pondweed, lily pads; E= bulrush, cattail	wide (>50 m)	>25

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
1	1	wood	discontinuous	0	16	9	wood	0	0	20	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
0	0	Yes	3	Substrate modification was sand placement at park. Park also has some vegetation removal. Other shore modifications including docks, retaining wall and rustic picnic sites, were unauthorized. Road occured along 375 m of segment setback approx. 30 m from shore.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
5 to 25	<5	High	No	Three natural marsh wetlands surrounded by low impact activity. Cattails present in middle wetland. Could not access 1/2 of shoreline due to ice. The other 1/2 had no turtles evident. Inactive beaver lodge in wetland (photo 1049). Very little wildlife activity owing to time of year. Abundant coarse woody debris on forest floor (>25 pieces)

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
52	4	6	none	low	High	Rearing potential is high as a result of wetlands, emergent vegetation, overhanging vegetation and LWD.



General Segment Classification

Segment	Segment Length (m)	Predominant Shore Type	Shore Type Modifier	Slope	Predominant Land Use	Level of Impact	Livestock Access	% Natural	% Disturbed
16	1178	gravel beach	residential	low (<5%)	Single family residential	High (>40%)	No	12	85

Shore Type (%)

Gravel Beach	Stream Mouth	Wetland	Sand Beach	Cliff/Bluff	Low Rocky Shore	Shore Type Comments
90	0	0	10	0	0	Sand beach is the result of substrate modification.

Land Use (%)

Residential	Park	Crown	Highways	Other	Land Use Comments
100	0	0	0	0	Zoned single family residential (RS-1(A)).

Substrates (%)

Mud	Gravel	Cobble	Boulder or Bedrock	Embedded-ness	Shape	Substrate Comments
100	2	4	0	n/a	smooth	Gravel & cobble band along high water mark - both natural and imported

Vegetation Band 1

Class	Stage	Shore Cover	Bandwidth (m)	% Overhang	Band 1 Comments
lawn	n/a	n/a	50	5	Birch shrub cover at isolated sections of the segment. Mature mixed forest also retained along sides of lots; retention of native vegetation contributed directly to the percent natural.

Vegetation Band 2

Segment	Class	Stage	Cover	Bandwidth (m)	Band 2 Comments
16	n/a	n/a	n/a	0	0

Aquatic Vegetation **Littoral Zone**

% Aquatic Vegetation	% Submergent	% Floating	% Emergent Vegetation	Type	Species (S=submergent, F=floating, E=emergent)	Littoral Zone	Large Woody Debris
60	10	50	0	abundant	S= chara spp, coontail.; F= floating pondweed, lily pads; E= bulrush, cattail	moderate (10-50 m)	<5

Shoreline Modifications

Total # Retaining Walls	# Retaining Walls below HWM	Retaining Wall Material	Retaining Wall Type	% Retaining Wall (below HWM)	# Docks	Docks per km	Dock Material	# Groynes	# Marinas	% Road (within 50 m)	Marine Railway
21	19	wood, gabion/rock, cement	discontinuous	50	37	31	wood, polymer	0	0	0	0

Shoreline Modifications

# Boat House	# Boat Launch	Substrate Modification	% Substrate Modified	Modification Comments
1	1	Yes	45	Substrate modification was sand placement (10% total) and low profile placement of loose large/gravels/cobbles (35%). One boathouse built over the water.

Wildlife

Veteran Trees	Snags	Biodiversity Potential	>1 Winter Turtle Observation	Wildlife Observations
no	0	Low	No	Nuthatch. Coarse woody debris was not evident.

Fish Assessment

Period of fish review (minutes)	Air Temp (^{o}C)	Water Temp (^{o}C)	Fish Observed	Spawning Habitat	Juvenile Fish Rearing Potential	Fish Habitat Comments
39	4	6	1 dead adult yellow perch	low	Low	Minimal natural LWD or overhanging vegetation. Low value juvenile fish habitat; would be improved if more natural cover. Higher value for adults. The floating vegetation would be good for adult summer rearing. The docks would be used for cover by non-native species (e.g., largemouth bass).

Appendix C. Sensitive Species Listing

Rank codes for sensitive species

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;

NR = not ranked**; B**= breeding; **N** = non breeding; **Z=** moving, diffuse populations.

A numeric range rank (e.g., S3S4) indicates the range of uncertainty in the status of a species. Source: NatureServe (2008)

COSEWIC (Committee on the Status of Endangered Wildlife in Canada):

E= Endangered**; SC** = Special Concern**; NAR** = Not at Risk

SARA (*Canadian Species at Risk Act*):

Schedule 1 = Species recognized under the Act

Schedules 2 and 3 = COSEWIC Species under review

British Columbia Conservation Data Centre (provincial element ranking organization):

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".

Identified Wildlife (under the British Columbia *Forest and Range Practices Act*)

Wildlife which require special management attention to address the impacts of forest and range activities on Crown land.

Appendix C. Sensitive Wildlife Species Potential to the Shoreline of Tie Lake. Source: BC CDC 2012

Scientific Name	Common Name	Global Status	Prov Status	COSEWIC	BC List	Identified Wildlife	SARA	National GS
Amphibians								
Ambystoma macrodactylum	Long-toed Salamander	G5	S4S5	NAR (Apr 2006)	Yellow			4 - Secure (2005)
Anaxyrus boreas	Western Toad	G4	S3S4	SC (Nov 2002)	Blue		1-SC (Jan 2005)	3 - Sensitive (2005)
Rana luteiventris	Columbia Spotted Frog	G4	S4	NAR (May 2000)	Yellow			4 - Secure (2005)
Birds								
Aegolius funereus	Boreal Owl	G5	S4	NAR (May 1995)	Yellow			4 - Secure (2005)
Ammodramus leconteii	Le Conte's Sparrow	G4	S3S4B		Blue			4 - Secure (2005)
Asio flammeus	Short-eared Owl	G5	S3B,S2N	SC (Mar 2008)	Blue	Y (May 2004)	3 (Mar 2005)	3 - Sensitive (2005)
Botaurus lentiginosus	American Bittern	G4	S3B		Blue			4 - Secure (2005)
Buteo swainsoni	Swainson's Hawk	G5	S2B		Red			4 - Secure (2005)
Chlidonias niger	Black Tern	G4	S4B	NAR (May 1996)	Yellow			4 - Secure (2005)
Chordeiles minor	Common Nighthawk	G5	S4B	T (Apr 2007)	Yellow		1-T (Feb 2010)	4 - Secure (2005)
Circus cyaneus	Northern Harrier	G5	S4B	NAR (May 1993)	Yellow			4 - Secure (2005)
Contopus cooperi	Olive-sided Flycatcher	G4	S3S4B	T (Nov 2007)	Blue		1-T (Feb 2010)	4 - Secure (2005)
Cypseloides niger	Black Swift	G4	S4B	C (Jul 2011)	Yellow			4 - Secure (2005)
Dolichonyx oryzivorus	Bobolink	G5	S3B	T (Apr 2010)	Blue			4 - Secure (2005)
Falco mexicanus	Prairie Falcon	G5	S1S2B	NAR (May 1996)	Red	Y (Jun 2006)		3 - Sensitive (2005)
Falco peregrinus	Peregrine Falcon	G4	S3B	SC (Apr 2007)	No Status			4 - Secure (2005)

Scientific Name	Common Name	Global Status	Prov Status	COSEWIC	BC List	Identified Wildlife	SARA	National GS
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	G4T4	S2?B	SC (Apr 2007)	Red		1-T (May 2003)	
Grus canadensis	Sandhill Crane	G5	S4B	NAR (May 1979)	Yellow	Y (Jun 2006)		4 - Secure (2005)
Haliaeetus leucocephalus	Bald Eagle	G5	S5B,S5N	NAR (May 1984)	Yellow			4 - Secure (2005)
Hirundo rustica	Barn Swallow	G5	S3S4B	T (May 2011)	Blue			4 - Secure (2005)
Megascops kennicottii	Western Screech-Owl	G5	S4		No Status			1 3 - Sensitive (2005)
Megascops kennicottii macfarlanei	Western Screech-Owl, *macfarlanei* subspecies	G5T4	S2	E (May 2002)	Red	Y (May 2004)	1-E (Jan 2005)	
Melanerpes lewis	Lewis's Woodpecker	G4	S2B	T (Apr 2010)	Red	Y (May 2004)	1-SC (Jun 2003)	3 - Sensitive (2005)
Numenius americanus	Long-billed Curlew	G5	S3B	SC (May 2011)	Blue	Y (May 2004)	1-SC (Jan 2005)	3 - Sensitive (2005)
Otus flammeolus	Flammulated Owl	G4	S3S4B	SC (Apr 2010)	Blue	Y (May 2004)	1-SC (Jun 2003)	3 - Sensitive (2005)
Recurvirostra americana	American Avocet	G5	S2B		Red			4 - Secure (2005)
Sphyrapicus thyroideus	Williamson's Sapsucker	G5	S3B	E (May 2005)	No Status		1-E (Aug 2006)	1 - At Risk (2005)
Spizella breweri breweri	Brewer's Sparrow, *breweri* subspecies	G5T4	S2B		Red	Y (Jun 2006)		
Gastropods								
Cryptomastix mullani	Coeur d'Alene Oregonian	G4	S3S5		Blue			
Magnipelta mycophaga	Magnum Mantleslug	G3	S2S3		Blue			
Vallonia cyclophorella	Silky Vallonia	G5	S3		Blue			
Insects								

Scientific Name	Common Name	Global Status	Prov Status	COSEWIC	BC List	Identified Wildlife	SARA	National GS
Argia vivida	Vivid Dancer	G5	S2	C (Jul 2011)	Red			3 - Sensitive (2005)
Danaus plexippus	Monarch	G5	S3B	SC (Apr 2010)	Blue		1-SC (Jun 2003)	6 - Not Assessed (2000)
Epargyreus clarus	Silver-spotted Skipper	G5	S3		Blue			6 - Not Assessed (2000)
Epargyreus clarus clarus	Silver-spotted Skipper, *clarus* subspecies	G5T5	S3		Blue			
Hesperia nevada	Nevada Skipper	G5	S3S4		Blue			6 - Not Assessed (2000)
Libellula pulchella	Twelve-spotted Skimmer	G5	S3		Blue			4 - Secure (2005)
Lycaena dione	Dione Copper	G5	S2	C (Jul 2011)	Red			6 - Not Assessed (2000)
Polites themistocles themistocles	Tawny-edged Skipper, *themistocles* subspecies	G5TNR	S3		Blue			
Pyrgus communis	Checkered Skipper	G5	S3		Blue			6 - Not Assessed (2000)
Speyeria aphrodite whitehousei	Aphrodite Fritillary, *whitehousei* subspecies	G5T4	S2S3		Blue			
Mammals								
Corynorhinus townsendii	Townsend's Big-eared Bat	G4	S3		Blue			2 - May be at risk (2005)
Martes pennanti	Fisher	G5	S2S3		Blue	Y (Jun 2006)		4 - Secure (2005)
Taxidea taxus	American Badger	G5	S1	E (May 2000)	Red	Y (May 2004)	1-E (Jun 2003)	3 - Sensitive (2005)
Reptiles								
Chrysemys picta pop. 2	Western Painted Turtle - Intermountain - Rocky Mountain Population	G5T2T3	S2S3	SC (Apr 2006)	Blue		1-SC (Dec 2007)	

Table II. Sensitive Plant Species of the IDFdm biogeoclimatic zone, Rocky Mountain Forest District (wetland, river, and lake habitats). Source BC CDC 2012

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	SARA	National GS
Anemone canadensis	Canada anemone	G5	S2S3		Blue		4 - Secure (2010)
Arnica chamissonis ssp. *incana*	meadow arnica	G5T3T5	S2S3		Blue		
Carex crawei	Crawe's sedge	G5	S2S3		Blue		4 - Secure (2010)
Carex rostrata	swollen beaked sedge	G5	S2S3		Blue		4 - Secure (2010)
Carex sychnocephala	many-headed sedge	G4	S3		Blue		4 - Secure (2010)
Castilleja minor ssp. *minor*	annual paintbrush	G5T5	S1		Red		
Cryptantha ambigua	obscure cryptantha	G4	S3		Blue		3 - Sensitive (2010)
Eleocharis rostellata	beaked spike-rush	G5	S2S3		Blue		3 - Sensitive (2010)
Epipactis gigantea	giant helleborine	G4	S2S3	SC (May 1998)	Blue	3 (Mar 2005)	3 - Sensitive (2010)
Glycyrrhiza lepidota	wild licorice	G5	S3		Blue		4 - Secure (2010)
Helianthus nuttallii ssp. *rydbergii*	Nuttall's sunflower	G5T5	S1		Red		
Heterocodon rariflorum	heterocodon	G5	S3		Blue		3 - Sensitive (2010)
Hypericum scouleri ssp. *nortoniae*	western St. John's-wort	G5T3T5	S2S3		Blue		
Impatiens ecalcarata	spurless touch-me-not	G3G4	S2S3		Blue		3 - Sensitive (2010)
Leptosiphon septentrionalis	northern linanthus	G5	S3		Blue		3 - Sensitive (2010)
Lewisia triphylla	three-leaved lewisia	G4?	S2S3		Blue		3 - Sensitive (2010)

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	SARA	National GS
Lomatium sandbergii	Sandberg's desert-parsley	G4	S2S3		Blue		4 - Secure (2010)
Megalodonta beckii	water marigold	G4G5	S3		Blue		4 - Secure (2010)
Mimulus breviflorus	short-flowered monkey-flower	G4	S1		Red		2 - May be at risk (2010)
Muhlenbergia andina	foxtail muhly	G4	S1		Red		2 - May be at risk (2010)
Muhlenbergia glomerata	marsh muhly	G5	S3		Blue		4 - Secure (2010)
Plantago eriopoda	alkali plantain	G5	S3		Blue		4 - Secure (2010)
Potamogeton strictifolius	stiff-leaved pondweed	G5	S2S3		Blue		4 - Secure (2010)
Pterygoneurum kozlovii	alkaline wing-nerved moss	G2G3	S2	T (Nov 2004)	Red	1-T (Aug 2006)	
Salix boothii	Booth's willow	G5	S2S3		Blue		4 - Secure (2010)
Schizachyrium scoparium	little bluestem	G5	S1		Red		4 - Secure (2010)
Scirpus pallidus	pale bulrush	G5	S1		Red		4 - Secure (2010)
Sphenopholis intermedia	slender wedgegrass	G5	S3		Blue		4 - Secure (2010)
Sphenopholis obtusata	prairie wedgegrass	G5	S1		Red		4 - Secure (2010)
Sporobolus compositus var. *compositus*	rough dropseed	G5T5	S3		Blue		
Stellaria obtusa	blunt-sepaled starwort	G5	S2S3		Blue		3 - Sensitive (2010)
Stuckenia vaginata	sheathing pondweed	G5	S2S3		Blue		4 - Secure (2010)
Thalictrum dasycarpum	purple meadowrue	G5	S2S3		Blue		4 - Secure (2010)
Veronica catenata	pink water speedwell	G5	S1		Red		

Table III. Sensitive Plant Communities of the IDFdm biogeoclimatic zone, Rocky Mountain Forest District. Source BC CDC 2012

Scientific Name	English Name	Global Status	Prov Status	BC List	Identified Wildlife	Ecosystem Group
Betula nana / Carex aquatilis	scrub birch / water sedge	G4	S3	Blue		Wetland, Shrub
Betula nana / Equisetum spp.	scrub birch / horsetails	GNR	S3	Blue		Shrub, Riparian
Carex lasiocarpa / Drepanocladus aduncus	slender sedge / common hook-moss	G3	S3	Blue		Wetland, Herbaceous
Deschampsia cespitosa Community	tufted hairgrass Community	G4	S3	Blue		Herbaceous, Grassland, Wetland
Distichlis spicata var. stricta Herbaceous Vegetation	alkali saltgrass Herbaceous Vegetation	GNR	S2	Red	Y	Herbaceous, Grassland, Wetland
Equisetum fluviatile - Carex utriculata	swamp horsetail - beaked sedge	G4	S3	Blue		Wetland, Herbaceous
Juncus balticus - Carex praegracilis	Baltic rush - field sedge	G3G4	S3	Blue		Wetland, Herbaceous
Picea engelmannii x *glauca / Equisetum* spp.	hybrid white spruce / horsetails	GNR	S5	Yellow		Forest, Riparian
Puccinellia nuttalliana - Hordeum jubatum	Nuttall's alkaligrass - foxtail barley	G3?	S2	Red		Herbaceous, Wetland, Grassland
Typha latifolia Marsh	common cattail marsh	G5	S3	Blue		Wetland, Herbaceous

Appendix D. Aquatic Habitat Index Tables

Table I. Aquatic Habitat Index (AHI) criteria and scoring

Category	Criteria	Maximum Score	Calculation	Parameter Value	*Percent of the Total*	*Percent of the Category*
Biophysical	Shore Type	20	% of Segment x Shore Type Value	Stream Mouth = Wetland (20); Gravel Beach = Rocky Shore (15); Sand Beach = Cliff /Bluff (10)	*20.0*	*33.9*
	Substrate	10	% Substrate x Substrate Value	Cobble (10); Gravel (8); Boulder = Silt = Mud = Marl (6); Sands (4); Bedrock (2)	*10.0*	*16.9*
	Percentage Natural	15	% Natural x Maximum Score (15)		*15.0*	*25.4*
	Aquatic Vegetation	8	% Aquatic Vegetation x Maximum Score (8)		*8.0*	*13.6*
	Overhanging Vegetation	6	% Overhanging Vegetation x Maximum Score (6)		*6.0*	*10.2*
Riparian	Riparian Band 1	10	Vegetation Bandwidth x Vegetation Class x Maximum Band 1 Score (10)	**Vegetation Bandwidth** 0 to 5 m (0.2); 6 to 10 m (0.4); 11 to 15 m (0.6); 16 to 20 m (0.8); > 21 m (1)	*10.0*	*62.5*
	Riparian Band 2	6	Vegetation Bandwidth Value x Vegetation Class Value x Maximum Band 2 Score (6)	**Vegetation Class** 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)	*6.0*	*37.5*
Zones of Sensitivity	Juvenile Fish Rearing/ Biodiversity Potential	5	Parameter Score	High (5); Moderate (3)	*5.0*	*71.4*
	>1 Winter Painted Turtle	2	Parameter Score	Presence (2); Absence (0)	*2.0*	*28.6*
Modifications	Retaining Wall	-4	% Retaining Wall x -5		*-4.0*	*22.2*
	Docks	-4	# Docks (and boathouses w/i HWM) x -0.1		*-4.0*	*22.2*
	Substrate Modification	-4	% Substrate Modified x -3		*-4.0*	*22.2*
	Groynes	-3	# Groynes x -0.5		*-3.0*	*16.7*
	Boat Launch	-3	# Launches x -1 per launch		*-3.0*	*16.7*

Table II. Aquatic Habitat Index Values

	Biophysical					Riparian		Zones of Sensitivity		Modifications				
Segment #	Shore Type	Substrate	% Natural	Aquatic Vegetation	Overhanging Vegetation	Band 1	Band 2	Juvenile Rearing / Biodiversity Potential	Winter Turtle Observation	Retaining Walls	Docks	Substrate	Groynes	Boat Launch
1	15.0	6.1	15.0	0.4	4.5	2.0	4.8	3.0	2.0	0.0	0.0	0.0	0.0	0.0
2	15.7	6.1	9.0	5.6	2.4	2.0	4.8	3.0	2.0	-0.1	-0.5	-0.3	0.0	-1.0
3	18.3	6.0	14.6	8.0	3.6	10.0	1.2	6.0	0.0	0.0	0.0	0.0	0.0	0.0
4	15.0	6.0	9.0	7.8	0.3	6.0	0.0	3.0	0.0	0.0	-0.4	0.0	0.0	-1.0
5	14.0	6.1	1.5	1.2	0.0	3.0	0.0	0.0	0.0	-2.8	-2.1	-0.9	0.0	-3.0
6	20.0	6.0	13.8	8.0	0.9	10.0	1.2	6.0	0.0	0.0	-0.2	0.0	0.0	0.0
7	15.6	6.0	3.8	6.4	1.2	2.0	1.8	6.0	0.0	-0.8	-0.4	-0.9	0.0	0.0
8	20.0	6.0	15.0	8.0	4.5	10.0	1.2	6.0	0.0	0.0	0.0	0.0	0.0	0.0
9	14.0	6.0	1.5	2.8	0.6	3.0	0.0	0.0	0.0	-2.8	-0.9	-0.6	0.0	0.0
10	16.7	6.1	15.0	8.0	2.4	10.0	1.2	6.0	0.0	0.0	0.0	0.0	0.0	0.0
11	17.6	6.0	11.3	7.2	1.2	10.0	1.2	6.0	0.0	-0.3	-0.1	-0.1	0.0	0.0
12	14.7	6.1	1.8	2.4	0.3	3.0	0.0	0.0	0.0	-2.5	-1.2	-0.8	0.0	0.0
13	16.3	6.4	14.0	5.6	0.3	6.0	4.8	6.0	2.0	0.0	0.0	0.0	0.0	0.0
14	14.5	6.6	2.3	4.0	0.3	3.0	0.0	0.0	0.0	-2.5	-2.9	-0.8	0.0	0.0
15	16.9	6.4	12.8	6.4	2.4	6.0	4.8	6.0	0.0	0.0	-1.6	-0.1	0.0	0.0
16	14.5	6.6	1.8	4.8	0.3	3.0	0.0	0.0	0.0	-2.5	-3.8	-1.4	0.0	-1.0

Table III. Aquatic Habitat Index Summary

Segment #	Biophysical Total	Riparian Total	Zones of Sensitivity	Modifications Total	Current Value	Current Ecological Rank	Current Color Zone	Potential Value	Potential Ecological Rank
1	41.02	6.80	5.00	0.00	52.82	High	Orange	52.82	High
2	38.82	6.80	5.00	-1.85	48.77	Moderate	Yellow	50.62	High
3	50.46	11.20	6.00	0.00	67.66	Very High	Red	67.66	Very High
4	38.08	6.00	3.00	-1.40	45.68	Moderate	Yellow	47.08	Moderate
5	22.82	3.00	0.00	-8.75	17.07	Very Low	Grey	25.82	Very Low
6	48.70	11.20	6.00	-0.20	65.70	Very High	Red	65.90	Very High
7	32.97	3.80	6.00	-2.05	40.72	Moderate	Yellow	42.77	Moderate
8	53.50	11.20	6.00	0.00	70.70	Very High	Red	70.70	Very High
9	24.90	3.00	0.00	-4.25	23.65	Very Low	Grey	27.90	Low
10	48.24	11.20	6.00	0.00	65.44	Very High	Red	65.44	Very High
11	43.21	11.20	6.00	-0.44	59.97	High	Orange	60.41	Very High
12	25.27	3.00	0.00	-4.45	23.82	Very Low	Grey	28.27	Low
13	42.50	10.80	8.00	0.00	61.30	Very High	Red	61.30	Very High
14	27.65	3.00	0.00	-6.15	24.50	Very Low	Grey	30.65	Low
15	44.76	10.80	6.00	-1.69	59.87	High	Orange	61.56	Very High
16	27.96	3.00	0.00	-8.65	22.31	Very Low	Grey	30.96	Low

Table IV. Color Zone Determination

Maximum	Minimum	Difference	Rank Breaks				
70.70	17.07	53.63	10.73	**Very Low**	17.07	to	27.80
				Low	27.81	to	38.53
				Moderate	38.54	to	49.27
				High	49.28	to	60.00
				Very High	60.01	to	70.74

Appendix E. Tie Lake Shoreline Management Guidelines for Fish and Wildlife Habitats

LOTIC ENVIRONMENTAL

Tie Lake
Shoreline Management Guidelines for Fish and Wildlife Habitats

Final Report
June 2012

Prepared for
Ministry of Forests, Lands and Natural Resource Operations
#401 – 333 Victoria St
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Suggested Citation

McPherson[1] S.M., D.G. Paton[2] and M.D. Robinson[1]. 2012. Tie Lake Shoreline Management Guidelines of Fish and Wildlife Habitats. Consultant report prepared for Ministry of Forests Lands and Natural Resource Operations, Nelson BC. Prepared by Lotic Environmental Ltd[1], Anatum Ecological Consulting Ltd[2].

Acknowledgments

We would like to thank Ministry of Forests Lands and Natural Resource Operations staff Paul Rasmussen (Director Resource Management) and Mike Knapik (acting Habitat Section Head) for their valued contributions in management of this project and review of the draft report.

We wish to give a special thanks to Al Soobotin, former Habitat Section Head, who will be missed.

Finally, we would like to acknowledge Guy Duke of L.A. Mapping Inc. for his professional expertise in completing the GIS mapping components of this project.

Key Reference

Key references used in developing this document were the Windermere Lake Shoreline Management Guidelines for Fish and Wildlife Habitats (EKILMP *et al.* 2009)[1] which was developed using and the 2008 Ministry of Environment document - *High Value Habitat Maps and Associated Protocol for Works along the Foreshore of Large Lakes within the Okanagan (MOE Region 8).* The Moyie Lake Shoreline Management Guidelines (Schleppe 2009)[2], followed with some improvements which were also incorporated into this document. This wording of this document remains largely unchanged from project to project, and the recognition should go to the original authors.

Disclaimer

The results contained in this report are primarily based upon data collected during a one-day field survey. The data were augmented with orthophoto interpretation, and existing scientific literature. In some cases, results were determined through qualitative assessment involving professional opinion. Use or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Lotic Environmental Ltd or Anatum Ecological Consulting Ltd, 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.

[1] East Kootenay Integrated Lake Management Partnership (EKILMP), McPherson S.[1] and Hlushak D.[1]. 2009. Windermere Lake Shoreline Management Guidelines for Fish and Wildlife Habitats. Combined agency and consultant (Interior Reforestation Co. Ltd. report)

[2] Schleppe, J. 2009. Moyie Lake Foreshore Inventory and Mapping. Ecoscape Environmental Consultants Ltd. Project File: 09-371. Prepared for: East Kootenay Integrated Lake Management Partnership.

Preface

This report provides Management Guidelines for the Shoreline of Tie Lake. It should be used as an initial step when reviewing, planning for, or prescribing alterations along the shoreline. The Guidelines have been developed using the technical results of the Sensitive Habitat Inventory and Mapping report (SHIM) commissioned by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO; McPherson *et. al.* 2012)[3]. This report showed that the Tie Lake shoreline has a diversity of important fish and wildlife habitats and species. The Guidelines are focused around the protection, conservation and restoration of important fish and wildlife values. The Guidelines will help focus where new development could be located on the lake while sustaining priceless natural public assets and maintaining the economic viability of the area.

The spectacular setting, which includes the fish and wildlife values of Tie Lake, draw many people to the area. Although high values remain, current development pressures are considerable at southern interior lakes, and without appropriate guidance, the natural values of the area could quickly be eroded. MFLNRO wishes to maintain the high environmental values of the lakeshore.

Guidance in this document is provided through shoreline mapping which outlines different color zones around the lake based on a Habitat Index Analysis. This approach provides a science-based assessment of areas of highest natural value requiring the highest level of on-going protection. There are four colour zones from red, which calls for the highest level of shoreline protection and are identified as conservation areas, to grey zones, where there is already significant impact from development and potential for redevelopment and restoration. The risks of selected development activities have been determined for each colour zone, identifying activities which require additional review or consideration. A flow chart has been developed based on activity risk, which outlines the review process at a broad scale.

This report only provides direction relating to fish and wildlife habitat values, and as such, does not consider other development factors (such as erosion hazards, drinking water quality or navigation considerations). Although some mention is made to potential permits required, the guidelines do not fully outline the regulatory agency permit planning process.

[3] McPherson S., D. Paton, and M. Robinson. 2012. Tie Lake Sensitive Habitat Inventory and Mapping. Consultant report Ministry of Forests Lands and Natural Resource Operations. Prepared by Lotic Environmental Ltd., Cranbrook, BC.

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1 Introduction

This document provides the Shoreline Management Guidelines (henceforth 'the Guidelines') for Tie Lake that were developed based on fish and wildlife values. The Guidelines are intended to conserve fish and wildlife habitat. The Guidelines were originally been developed by the East Kootenay Integrated Lake Management Partnership (EKILMP). The partnership is comprised of federal, provincial and local governments, First Nations and non-profit organizations.

EKILMP was formed in 2006 for the purpose of creating lake management guidelines that balance development with environmental needs for the key lakes in the East Kootenay. To date, similar guidelines have been developed for Windermere Lake, Wasa, Moyie, Munroe Lakes, Jim Smith, and St. Mary lakes. The Guidelines include shoreline designation maps, risk rating for potential proposed activities and a flow chart that indicates selected preliminary approval procedures when making development applications. These are provided as tools to assist landowners and developers who want to propose shoreline development. Once these guidelines have been reviewed, landowners and developers should submit applications to the appropriate offices listed below.

FrontCounter BC

The one-window approach for permit applications offering over 80 different authorizations required by natural resource clients. All applications for government-related permits should be submitted through FrontCounter BC. Application forms are available online. Inquiries can be directed to:

1902 Theatre Road
Cranbrook, BC, V1C 7G1
Phone: (250) 426-1766 Fax: (250) 426-1767

Service BC

Provides information and some additional permitting applications and information. The one particular application that Service BC provides pertinent to shoreline development is the Navigable Waters Act applications. Local contact information is:

100 Cranbrook Street North
Cranbrook, BC, V1C 3P9
Phone: 250-426-1211 Fax: 250-426-1253

Regional District of East Kootenay

19-24th Avenue South
Cranbrook, BC, V1C 3H8
Phone: 250-489-2791 Fax: 250-489-3498

2 Definitions

Development

For the purposes of the Guidelines, unless otherwise stated, "development" is defined as follows (adopted from the Lake Windermere Official Community Plan (OCP)):

(a) Adding or removing fill;
(b) Construction or maintenance of retaining walls, bank protection installations, docks, marinas, boathouses, groynes or breakwaters, or other structures within the foreshore;
(c) Any activity that may alter, disrupt or destroy fish habitat;
(d) Removing foreshore or riparian vegetation; or
(e) Other significant works, including activities listed in the Activity Risk Rating Table (See Table 1).

Qualified Professional

An applied scientist or technologist, acting alone or together with another qualified environmental professional, if:

(a) the individual is registered and in good standing in British Columbia with an appropriate professional organization constituted under an Act, acting under that association's code of ethics and subject to disciplinary action by that association;
(b) the individual's area of expertise is recognized in the assessment methods as one that is acceptable for the purpose of providing all or part of an assessment report in respect of that development proposal, or;
(c) the individual is acting within that individual's area of expertise.

Aquatic Habitat Index (AHI) Rankings

The Aquatic Habitat Index (AHI) estimates the environmental sensitivity or current ecological value of the shoreline. The AHI analysis was completed during the fish and wildlife assessment using fieldwork, literature review and professional consultation. The index incorporates physical and biological data into a model which analyses and ranks each segment. 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. The index included four categories of parameters: 1) Biophysical, 2) Zones of Sensitivity, 3) Riparian and 4) Modifications., several habitats were identified as being highly important to fish and wildlife, and sensitive to development. The outcome of the AHI is a segment ranking of Very High, High, Moderate, Low or Very Low.

3 Shoreline Management Guidelines

A colour scheme has been developed which delineates the shoreline based on habitat values determined through the AHI analysis in the Sensitive Habitat Inventory and Mapping (SHIM) report. The scheme has coloured shoreline areas as red, orange, yellow or grey zones. These zones are defined in the following Section (Step 1) and have been mapped (See Appendix A of SHIM report). 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. This approach has been adopted from the lake management protocols being developed by the Ministry of Environment in the Okanagan Region (BC MoE 2008)[1].

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
Development Planning in Fish and Wildlife Shoreline Colour Zones

Step 1: Determine the colour zone that your application is situated in using the maps in Appendix A of SHIM Report. 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.

[1] BC Ministry of Environment. 2008. High Value Habitat Maps and Associated Protocol for Works along the Foreshore of Large Lakes within the Okanagan (MOE Region 8). Draft Version (03/04/2008).

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 of SHIM report.

The AHI Values (or Current Ecological Value) as defined in the SHIM 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 AHI Analysis. These areas are essential for fish and/or wildlife populations, and include intact wetlands and forest areas. MFLNRO 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 38% of the total shoreline length of Tie 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 21% of the total shoreline length of Tie 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. Although these areas have been impacted to some degree, they still are largely intact. At Tie Lake, these areas all have valuable wetland habitats, important for the biodiversity including native fish and wildlife species. These values should be considered if any 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 (*See* Appendix D). High risk activities without a BMP or ROS will require a report from a Qualified Professional (QP).

Yellow zones account for 12% of the total shoreline length of Tie Lake.

Grey Shoreline

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

Background:
These are shorelines identified in the AHI analysis as having lower ecological value. However, they still may contain valuable habitats requiring some protection, such as aquatic or riparian vegetation. Their importance as corridors to neighbouring high value areas should also be considered during development.

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 41% of the total shoreline length of Tie 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 1). 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 Fisheries and Oceans Canada 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 should be avoided if at all possible.

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 Destruction 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 (*See* Appendix D), where available. 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. Additional potential legal requirement listings are provided in Appendix C. If these Guidelines are followed, the intent is that the subsequent permitting process(es) should be more streamlined for the applicant.

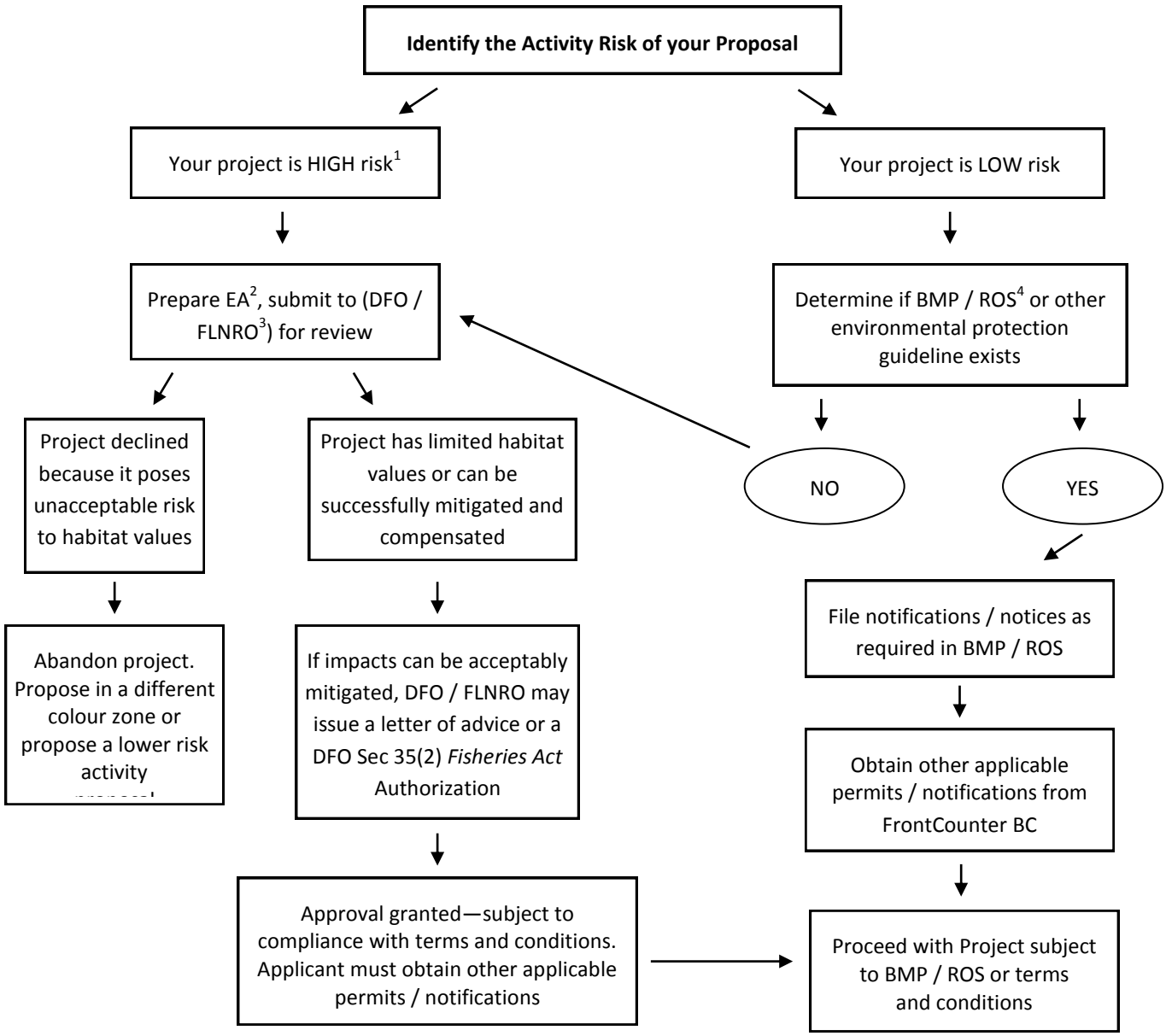
Contact FrontCounter BC to determine which permits, approvals or authorizations you need, in addition to fish and wildlife habitat authorizations.

Table 1. 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.

Decision-making process for High and Low Risk Activities - 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; FLNRO- Ministry of Forests Lands and Natural Resource Operations

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

4 Other Considerations

4.1 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 Fish & Wildlife Habitat Assessment Report is a tool available to help with this task; however, further studies may be necessary, due to limitations of currently available information. The Fisheries and Oceans Canada 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, Fisheries and Oceans Canada 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, Fisheries and Oceans Canada 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.

4.2 Restoration Techniques

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.

Appendix A. Shoreline Designation Maps

(*See* Appendix A of SHIM report)

Appendix B. Glossary of Terms

BMP	Best Management Practices
DFO	Fisheries and Oceans Canada
DOI	District of Invermere
EA	Environmental Assessment
EKILMP	East Kootenay Integrated Lake Management Partnership
FCBC	FrontCounter BC
HADD	Harmful Alteration Disruption or Destruction of fish habitat
HWM	High Water Mark
MFLNRO	Ministry of Forests Lands and Natural Resource Operations (formerly Ministry of Environment)
OCP	Official Community Plan
QP	Qualified Professional
RDEK	Regional District of East Kootenay
ROS	Regional Operating Statement
ZOS	Zones of Sensitivity

Appendix C. 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.

Jaffray, Tie Lake, Rosen Lake Land Use and Floodplain Management Bylaw No. 1414, 1999

This bylaw provides policies and regulations to guide development. Regulations include those pertaining to parcel area requirements, parking and loading, land use designations and floodplain management provisions.

Appendix D. 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 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