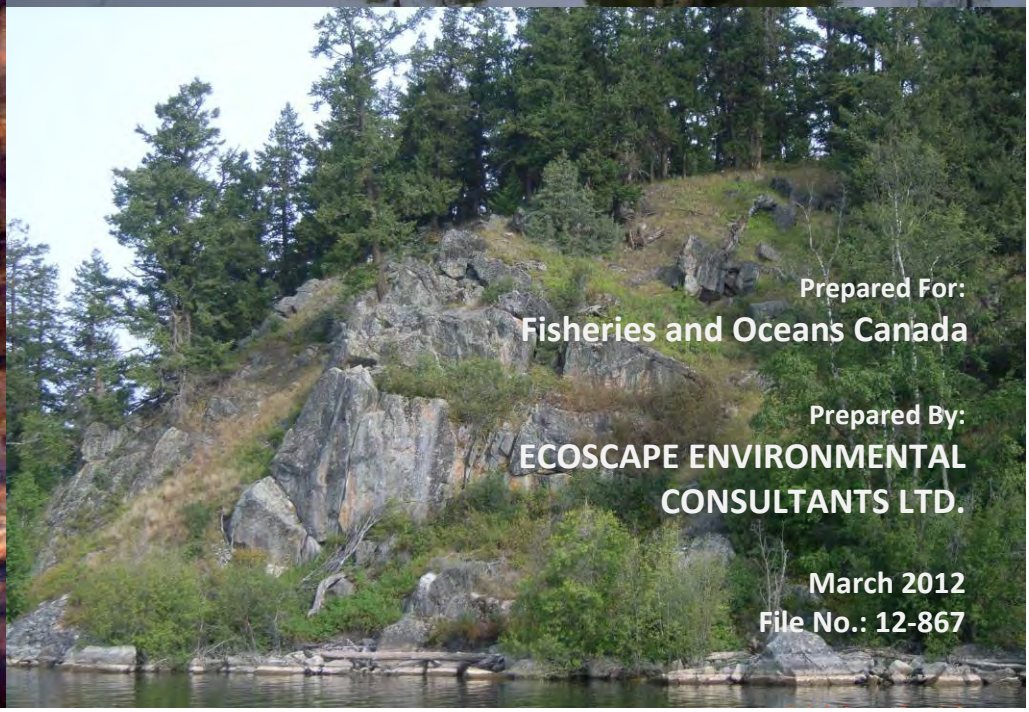
Foreshore Inventory and Mapping

FRASER LAKE



Prepared For:
Fisheries and Oceans Canada

Prepared By:
ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.

March 2012
File No.: 12-867

FORESHORE INVENTORY AND MAPPING

Fraser Lake

Prepared For:

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March 2012

File No. 12-867

EXECUTIVE SUMMARY

Fraser Lake occurs within Electoral Area "D" of the Regional District of Bulkley-Nechako (RDBN). The Village of Fraser Lake occurs along the southern shoreline towards the west end of the lake. Both the Nadleh Whut'en and Stellat'en First Nations occur along the Fraser Lake foreshore, with main communities situated around the Nautley River and Stellako River, respectively. The lake shoreline occurs within the Sub-Boreal Spruce biogeoclimatic zone. Fraser Lake has a surface area around 5.4 hectares, mean depth of 13.4 m, maximum depth of 30.5 m and volume of approximately 725,287,400 m^3 (RBDN 2009, Jacklin 2004).

Fraser Lake provides habitat for a diversity of fish and wildlife species, which makes it attractive for fishing and outdoor recreational pursuits, as well as a priority for resource managers. The fish species of particular management concern within Fraser Lake is the Nechako white sturgeon; both juveniles and adults of this species utilize the lake for overwintering and rearing/feeding. Fraser Lake in its entirety has subsequently been identified as providing critical habitat to the Nechako white sturgeon (Pers. Comm. Mark Potyrala (DFO) 2012). As development pressures are increasing within the region, resource managers recognize the need to maintain and protect water quality and identify and protect environmentally sensitive areas along the lakeshore (RDBN 2009).

Currently, lake management projects in the province of BC adhere to the following three-step process:

1. Foreshore Inventory and Mapping (FIM) – FIM is a broad scale inventory process that attempts to define and describe the shoreline of our large and small lake systems.

2. Aquatic Habitat Index or Ecological Sensitivity Index (AHI) – The AHI utilizes data collected during the FIM, field reviews, and other data sources (e.g., Land and Data Warehouse, previously published works, etc.) to develop and rank the sensitivity of the shoreline using an index.

3. Development of Shoreline Management Guidance Documents - Guidance documents are the final step in the process. By implementing this work into a guidance document, in conjunction with existing lake and watershed information, it will facilitate informed decision making and prioritization of management issues and key areas of concern.

This report presents Step 1 for Fraser Lake. FIM results for this project provides valuable information regarding features, habitats, and other information for the shoreline of Fraser Lake. A summary of the data collected indicates the following:

- The total length of shoreline along Fraser Lake is 70.9 km. Of this length, disturbed shoreline accounts for 19.5 km, while the remaining 51.4 km, or 72%, were described as natural.

- Rural properties were the primary land use around the shoreline, representing 33% of the shore length. Approximately 85% of the shore length of rural land parcels remain in a relatively natural state. However, these large, privately-owned parcels represent areas of potential future build-out from development pressures including subdivision and subsequent anthropogenic impacts. Natural crown lands were the next most common land use, accounting for over 23% of the shore length. Natural areas remained in primarily a natural state, with only 2.4% of the shore length disturbed.

- The most predominant shore types observed around Fraser Lake were rocky shores and wetland shore types. Each represented approximately 30% of the total shore length. Rocky shore areas were 73% natural, while wetland areas remained over 80%natural.

- There is approximately 25.2 km of shoreline that has aquatic vegetation, which represents approximately 36% of the total shoreline length. Most of the vegetation observed was emergent (e.g., sedges, bulrushes), which occurred along 35% of the shoreline or 24.5 km.

- Docks were the most commonly observed type of shoreline modification and occurred within both rural and single family residential areas. There were a total of 115 docks counted during the assessment, which equates to an overall density of 1.6 docks per km in Fraser Lake.

- Approximately 11 km or 15% of the shoreline was described as having no impact, while 24.6 km, or 35% of the shore length exhibited less than 10% impact. Approximately 34% (24.1 km) of Fraser Lake exhibited a high level of impact where greater than 40% of the shoreline was disturbed. Moderate impacts (10-40%) were documented along 11.3 km of shore length, or 16%.

The inventories and analysis completed as part of this study should complement existing efforts to effectively manage and protect important aquatic resources along Fraser Lake. Information collected with the FIM should be integrated with existing initiatives, such as the RDBN Shoreland Development Strategy and RDBN and Village of Fraser Lake Official Community Plan documents. Recommendations have been presented that are intended to aid foreshore protection, guide future data management, and identify future biophysical inventory works.

The findings of the FIM indicate that the foreshore areas of Fraser Lake have been impacted by our current land use practices. The current trend of reliance on best management practices and voluntary compliance with the regulations and guidance documents are not resulting in the required protection of important fish and wildlife habitats along the shoreline. Active construction that was not in compliance with best management practices was observed during the surveys. It was readily apparent that neighbors tended to mimic each other's activities. Finally, there was a significant number of shoreline modifications that encroached onto crown land (i.e., below the high water level) and several instances of land owners without foreshore constructing or modifying sections of foreshore to their liking. Given this, all agencies and

stakeholders need to work with the public on better communication and education to ensure that everyone is aware of the habitats present and their values. Recommendations for public awareness and education are presented to facilitate public involvement and compliance in the protection of foreshore areas. The combination of education and cooperative enforcement will help reduce the continued losses of habitat along the shoreline and help improve attitudes regarding foreshore protection.

ACKNOWLEDGEMENTS

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DISCLAIMER

The results contained in this report are based upon data collected during surveys occurring over a one week period. Biological systems respond differently both in space and time and exhibit extreme variability. For this reason, conservative assumptions have been used and these assumptions are based upon field results, previously published material on the subject, and air photo interpretation. Due to the inherent problems of brief inventories (e.g., property access, GPS/GIS accuracies, air-photo interpretation concerns, etc.), professionals should complete their own detailed assessments of shore zone areas to understand, evaluate, classify, and reach their own conclusions regarding them. Data in this assessment was not analyzed statistically, and no inferences about statistical significance should be made if the word significant is used. Use of or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Ecoscape Environmental Consultants Ltd., Fisheries and Oceans Canada, project partners, nor the authors of this report, are liable for accidental mistakes, omissions, or errors made in preparation of this report, as best attempts were made to verify the accuracy and completeness of data collected and presented.

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1.0 INTRODUCTION

Fraser Lake[1] occurs within the Sub-Boreal Spruce biogeoclimatic zone within the Regional District of Bulkley-Nechako (RDBN). Fraser Lake provides habitat to a diversity of fish and wildlife species, which makes it attractive for fishing and outdoor recreational pursuits, as well as a priority for resource managers. The fish species of particular management concern is the Nechako white sturgeon (*Acipenser transmontanus*), which utilizes Fraser Lake for rearing and overwintering. This species is recognized as endangered under the federal Species at Risk Act (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (BC CDC 2012). This sturgeon population is also provincially ranked as critically imperiled and red listed[2] (BC CDC 2012). Subsequently, Fraser Lake in its entirety has been identified as providing critical habitat to the Nechako white sturgeon (Pers. Comm. Mark Potyrala (DFO), 2012). Additionally, sport fish such as chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka*), kokanee (*O. nerka*), rainbow trout (*O. mykiss*), burbot (*Lota lota*), Dolly Varden (*Salvelinus malma*), lake trout (*Salvelinus namaycush*), mountain whitefish (*Prosopium williamsoni*) and lake whitefish (*Coregonus clupeaformis*) occur within Fraser Lake and its tributaries (MoFLNRO 2012a/b; Pers. Comm. Mark Potyrala (DFO), 2012).

Development activities within the Fraser Lake watershed include forestry, agriculture, urban and rural residential/recreational areas associated with the Village of Fraser Lake, Nautley, Stellaquo, and Seaspunkut First Nation reserves, and RDBN, mining, linear development associated with the railway and Highway 16 along the southern shoreline of Fraser Lake, and recreational development associated with the lake (Mac Donald et al 1995, RDBN 2009). As development pressures are increasing within the region, the RDBN recognizes the need to maintain and protect water quality and identify and protect environmentally sensitive areas along the lakeshore (RDBN 2009). It has been noted that failing onsite sewage disposal systems associated with waterfront recreational properties may be the highest contributor of non-point source pollution within the region (RBDN 2009). This issue will only be exacerbated as properties are redeveloped for year-round use, which will likely result in increases of other anthropogenic impacts along the foreshore. Fraser Lake has been classified as a development lake, although it is noted as having moderate development potential which is at or nearing its capacity (RDBN 2009). The maximum allowed subdivision, as determined within the shoreland strategy, is 30%, while the existing subdivision surrounding Fraser Lake is at 32% (RDBN 2009). While the RDBN Shoreland Development Strategy identifies many guidelines for responsible and

[1] Watershed Code: 180-374000

[2] **Red**: Includes any indigenous species or subspecies that have- or are candidates for- Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation (BC CDC 2012).

sustainable shoreland development, the spatially accurate baseline foreshore inventory will compliment and support this initiative.

In response to the need for improved understanding of foreshore conditions, an assessment and inventory was conducted along the shoreline of Fraser Lake. Detailed shoreline inventories increase the knowledge base regarding the environmental resources present, allowing stakeholders to better understand how future development proposals may affect these habitat features and their current level of impairment. The intended result of the FIM process is to facilitate informed land use planning decisions that balance stakeholder interests with important natural resource values. This report has been prepared to characterize the shoreline, identify historical modifications and impacts, and evaluate the overall environmental condition of the foreshore. Current management practices being implemented throughout British Columbia are utilizing a three step process to help integrate environmental data with land use planning information to provide a baseline of waterbody condition and to facilitate review and decision making processes. The three steps are comprised of the following:

1. Foreshore Inventory and Mapping (FIM) – FIM is a broad scale inventory process that attempts to define and describe the shoreline of our large and small lake systems. The inventory provides baseline information regarding the current condition, such as land use, shore types, substrates, natural features of the shoreline, and its level of development (e.g., number of docks, groynes, etc.). This information is combined with other mapping information such as fisheries inventories, recent orthophotos, and other natural resource data. Sufficient data is collected that will allow managers and the public to monitor shoreline changes over time and to measure whether proposed land use decisions are meeting their intended objectives. This baseline inventory provides sufficient information to facilitate identification of sensitive shoreline segments as part of step 2 below.

2. Aquatic Habitat Index or Ecological Sensitivity Index (AHI) – The AHI utilizes data collected during the FIM, field reviews, and other data sources (e.g., Land and Data Warehouse, previously published works, etc.) to determine the relative habitat value and sensitivity of discrete segments along the shoreline using an index. An index is defined as a numerical or categorical scale used to compare variables with one another or with some reference point. The index is used to compare the sensitivity or habitat value of each shoreline segment relative to other segments along the lake shoreline (i.e., the index compares the ecological or aquatic sensitivity of different shoreline segments within the lake system relative to each other rather than to other lakes). The AHI uses many different factors such as biophysical criteria (e.g., shore type, substrate information), fisheries information (e.g., juvenile rearing suitability, migration, and staging areas), shoreline vegetation (e.g., width and type of shoreline

vegetation), terrestrial information (e.g., conservation areas), and modifications (e.g., docks, retaining walls) to provide a qualitative estimate of the relative habitat value of each shoreline segment using a 5-Class system (i.e., Very High to Very Low). An aquatic restoration potential analysis (AHI_POT) is also completed which involves removing instream features from the AHI results. This analysis provides a summary of potential locations where habitat improvements are possible along the shoreline. This analysis *does not consider improvements to riparian vegetation*.

3. Development of Shoreline Management Guidance Documents - Guidance documents are the final step in the process. Guidance documents are intended to help land managers at all levels of government quickly assess applications and is intended to be the first step for review, planning, and prescribing shoreline alterations (i.e., land development) by applicants and review agencies. By implementing this work into a guidance document, in conjunction with existing lake and watershed information, it will facilitate informed decision making and prioritization of management issues and key areas of concern.

The importance of fisheries and wildlife resources along Fraser Lake and the sensitive ecosystems associated with the lake and foreshore provide a clear rationale for completion of a detailed shoreline inventory and mapping project. This report presents Step 1 for Fraser Lake.

2.0 PROJECT OVERVIEW

The FIM project for Fraser Lake provides an opportunity for the project partners to support an initiative that will act as a tool for future policy development and allow for improved management of these resources. The information generated from this project and future steps, including the development of shoreline management guidelines, should help to integrate results of this work into the existing policy framework and help facilitate informed review of land use applications. The intent of this project is to provide a baseline overview of the shoreline condition of Fraser Lake. The methodology employed for this assessment is discussed in detail below and is a provincial standard that is being used to map shorelines of priority lakes within the BC Interior. The FIM results will allow stakeholders to understand the current condition of the shoreline, set objectives for improved shoreline management in Official Community Plans (OCP) or other policy documents, and to measure and monitor changes in the shoreline over time.

2.1 Project Partners

The current FIM protocol has been developed over the last several years and has been used as a standard method for shoreline inventory. Various local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol, and detailed methods are provided in Appendix A. The Fraser Lake Step 1 FIM project was supported by the following agencies and organizations:

1. Fisheries and Oceans Canada
2. Regional District of Bulkley Nechako
3. Ministry of Forests, Lands and Natural Resource Operations
4. Community Mapping Network

2.2 Objectives

The following are the objectives of this project:

1. Assist DFO with overall objectives of restoring and protecting fish habitat, promoting public education and awareness programs, and developing partnerships with external parties.

2. Compile existing mapped resource information for Fraser Lake;

3. Foster collaboration between the local government, DFO, First Nations, Ministry of Forests, Lands, and Natural Resource Operations, and local residents;

4. Provide an overview of foreshore habitat condition on the lake;

5. Inventory foreshore morphology, land use, riparian condition, and anthropogenic alterations;

6. Obtain spatially accurate digital video of the shoreline of the lake;

7. Prepare the video and GIS geo-database for loading onto the Community Mapping Network (www.cmnbc.ca);

8. Collect information that will aid in prioritizing critical areas for conservation and or protection and lakeshore development;

9. Support the RDBN *Shoreline Development Strategy* of protecting water quality and the natural environment. Results are intended to assist with Official Community Plan (OCP) development, ongoing environmental public awareness

and education, implementation of development controls, support for lake management plans, acquisition of detailed environmentally sensitive areas mapping, and ensuring that zoning of shoreline properties is appropriate.

10. Make the information available to planners, politicians, and other key referral agencies that review applications for land development approval; and,

11. Integrate information with upland development planning, to ensure protection of sensitive foreshore areas, connectivity with sensitive terrestrial ecosystems, and watershed based land use planning.

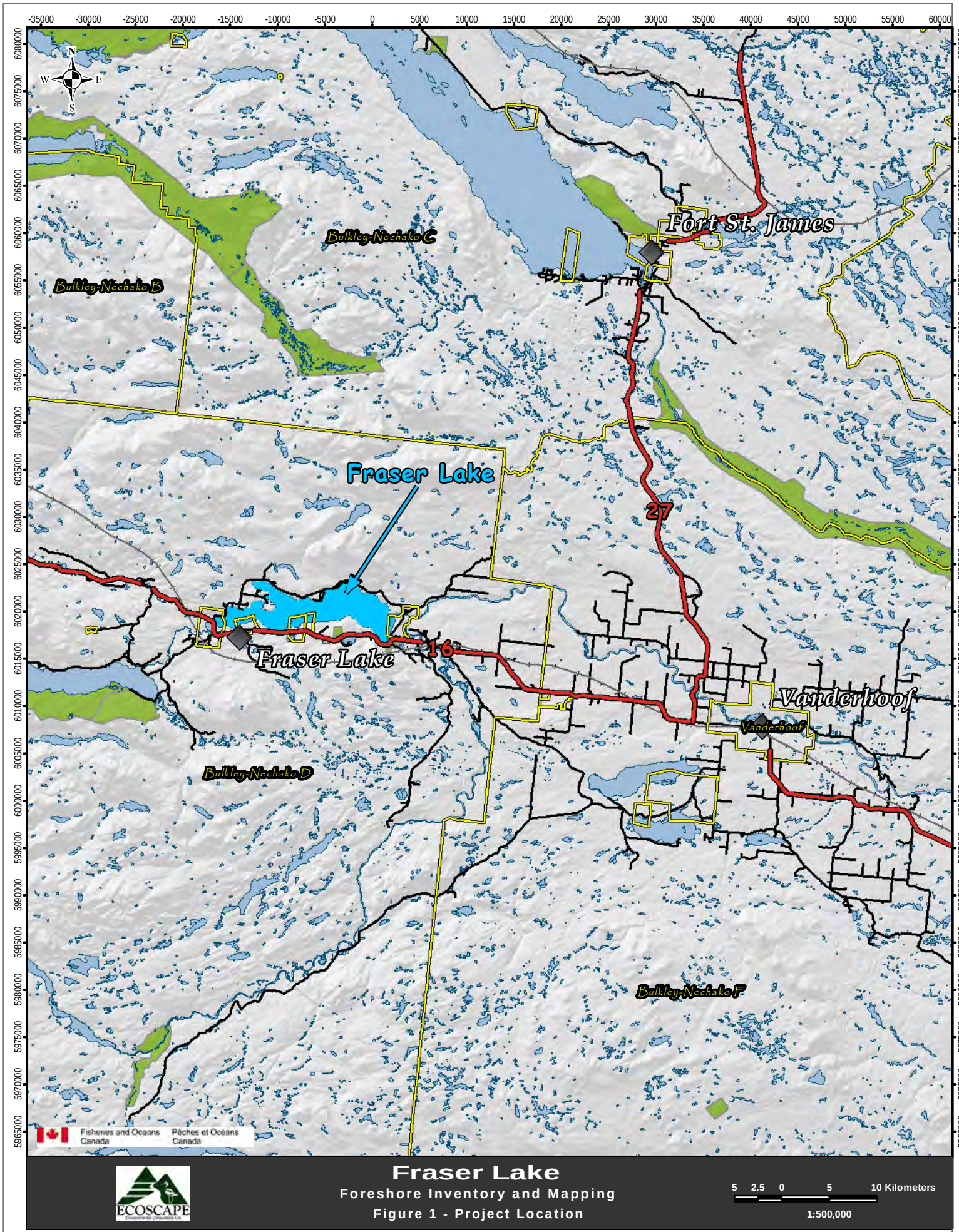
The FIM will begin to address many of these objectives. Completion of Steps 2 and 3, AHI and Shoreline Management Guidelines, respectively, are required to address the more detailed planning aspects to meet long term objectives.

2.3 Study Location

Fraser Lake is located in the RDBN Electoral Area "D", with the Village of Fraser Lake occurring along the southern shoreline towards the west end of the lake. The Nadleh Whut'en and Stellat'en First Nations also occur along the Fraser Lake foreshore, with main communities located towards the Nautley River and Stellako River, respectively. The lake shoreline occurs within the Sub-Boreal Spruce biogeoclimatic zone. Fraser Lake has a surface area around 5.4 hectares, mean depth of 13.4 m, maximum depth of 30.5 m, and volume of approximately 725,287,400 m^3 (RBDN 2009, Jacklin 2004). The Stellako River[3] is the primary inlet stream to Fraser Lake with a stream magnitude of 955, stream order of 6, and length of 13.5 km (BC MoFLNRO 2012a). It flows into Fraser Lake at the west end, downstream of its convergence with the Endako River[4]. Main tributaries flowing into Fraser Lake include Stern Creek[5], Perry Creek[6], Robertson Creek[7], and Ormond Creek[8] (BC MoFLNRO 2012a). The Fraser Lake outlet is at the east end of the lake as it drains to the Nautley River[9], which flows for only 900 m before entering the Nechako River[10].

The general location of the study area is found in Figure 1.

3 Stellako River Watershed Code: 180-374000-95200
4 Endako Creek Watershed Code: 180-374000-95200-01900
5 Stern Creek Watershed Code: 180-374000-67100
6 Perry Creek Watershed Code: 180-374000-92200
7 Robertson Creek Watershed Code: 180-374000-71300
8 Ormond Creek Watershed Code: 180-374000-51000
9 Nautley River Watershed Code: 180-374000
10 Nechako River Watershed Code: 180


Fort St. James
Bulkley-Nechako C
Bulkley-Nechako B
Fraser Lake
27
16
Fraser Lake
Vanderhoof
Vanderhoof
Bulkley-Nechako D
Bulkley-Nechako F
Fisheries and Oceans Canada
Pêches et Océans Canada
ECOSCAPE
Fraser Lake
Foreshore Inventory and Mapping
Figure 1 - Project Location
5 2.5 0 5 10 Kilometers
1:500,000

2.4 Important Fisheries and Wildlife Resource Information

The fish species of particular management concern within Fraser Lake is the Nechako white sturgeon; both juveniles and adults of this species utilize the lake for overwintering and rearing/feeding. The Nechako population is one of at least five distinct stocks of sturgeon that occur within the Fraser River watershed (NWSRI 2004). The Nechako population of white sturgeon is listed as endangered under the federal Species at Risk Act (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (BC CDC 2012). This sturgeon population is also provincially ranked as critically imperiled and red listed[11] (BC CDC 2012). Subsequently, Fraser Lake in its entirety has been identified as providing critical habitat for the Nechako white sturgeon (Pers. Comm. Mark Potyrala (DFO), 2012). A review completed by Norcan on historical information including sightings and catch records identified the presence of white sturgeon within Fraser Lake beginning in the early 1800s, with noted observations around the islands at the outlet to the Nautley River, the confluence of the Stellako River, and along the south shore at Lejac (Cadden 2000).

Additionally, sport fish such as chinook salmon, sockeye salmon, kokanee, rainbow trout, burbot, Dolly Varden, lake trout, mountain whitefish, and lake whitefish occur within Fraser Lake and its tributaries (RDBN 2009; MoFLNRO 2012a/b; Pers. Comm. Mark Potyrala (DFO), 2012). Fraser Lake was noted to have the fifth highest mean escapement of sockeye within sockeye salmon nursery lakes in the Fraser River Basin and the second highest spawner density behind Chilko Lake (Hobbs et al 2008). Both sockeye and chinook rear in Fraser Lake, with sockeye juveniles remaining within the lake environment for a year prior to outmigration downstream (Pers. Comm. Mark Potyrala (DFO), 2012). Fraser Lake also provides an important migration corridor for sockeye rearing in Francois Lake and anadromous fish species spawning upstream of Fraser Lake, such as sockeye and chinook which spawn in Fraser Lake and Francois Lake tributaries (Pers. Comm. Mark Potyrala (DFO), 2012). Spawning sockeye and Chinook are known to migrate through Fraser Lake from July to September. Anadromous salmon are considered extremely important ecologically due to the complex relationships they have with other species and with aquatic, riparian, and terrestrial ecosystems (Watkinson 2000). Spawning salmon provide an important food source for bears, eagles, osprey, and other scavenging wildlife, and the carcass remains provide valuable marine-derived nutrients to riparian and terrestrial plant communities (Mathewson et al. 2003).

Non-game fish species documented to utilize Fraser Lake include lake chub (*Couesius plumbeus*), largescale sucker (*Catostomus macrocheilus*), leopard dace (*Rhynichthys*

[11] **Red:** Includes any indigenous species or subspecies that have- or are candidates for- Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation (BC CDC 2012).

falcatus), longnose dace (*R. cataractae*), longnose sucker (*C. catostomus*), Northern pikeminnow (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), prickly sculpin (*Cottus asper*) and redside shiner (*Richardsonius balteatus*) (MoFLNRO 2012a/b; Pers. Comm. Mark Potyrala (DFO) 2012).

Chinook, sockeye, kokanee, rainbow trout, and Dolly Varden all spawn within Ormond Creek, located along the northern shoreline. These species also spawn in the Stellako River, located along the south west end of the lake (BC MoFLNRO 2012a). Salmon are highly sensitive to environmental conditions such as water quality, sedimentation, and riparian condition, which means that these species can be seen as indicators of watershed health and integrity. Rainbow trout have also been documented within Stern Creek, which enters Fraser Lake in Simon Bay at the northwest end of the lake (SKR Consultants Ltd 2007). Although not noted within the provincial fisheries database information, rainbow trout are also likely to utilize Perry Creek because of a surface water connection to Fraser Lake and presence of rainbow trout upstream within Deserter Lake (MoFLNRO 2012a/b). Robertson Creek is also noted to provide fisheries habitat for rainbow trout, longnose sucker, redside shiner and lake chub (MoFLNRO 2012a). While there has been no documented sockeye shore spawning within Fraser Lake, they may spawn at the lake outlet to the Nautley River (Pers. Comm. Mark Potyrala (DFO) 2012). An anecdotal reference to white fish shore spawning along the southern shore of Fraser Lake near Lejac was located during preparation of this report (http://www.kidfish.bc.ca/first_nations/life.htm), although little documented information appears to be available in regards to Fraser Lake shore spawning.

Fraser Lake and portions of the Stellako and Nautley Rivers have collectively been identified as a continentally significant Important Bird Area (IBA) for migratory waterfowl, with its wetlands and extensive foraging areas (Booth 2001). Sites with the IBA designation provide essential habitat and may contain threatened or endemic species, representative species of a biome, or high concentrations of birds (Booth 2001). Consistent with the Village of Fraser Lake promoting itself as the "white swan capital of the world"[12], Fraser Lake is recognized as a globally significant site for migratory and over-wintering Trumpeter Swans (*Cygnus buccinators)* (Booth 2001). Fraser Lake is also considered to be a nationally significant site for fall-migrating American Wigeon (*Anas americana*).

Segment 53 of the Fraser Lake FIM occurs within the Ellis Island Ecological Reserve, which contains one of only two Ring-billed Gull (*Larus delawarensis*) colonies occurring within British Columbia (BC Parks 2012). The nesting colony also includes Herring gull (*L. argentatus*) and the blue-listed[13] California Gull (*L. californicus*), in addition to multiple

[12] (http://www.fraserlake.ca/)

[13] **Blue:** Includes any indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly

other native avian species (BC Parks 2012). The blue-listed Caspian Tern (*Hydroprogne caspia*) has also been identified to nest on Ellis Island (BC Parks 2012).

During the FIM field survey, several incidental observations of wildlife were noted within the FIM database by segment. Several segments were observed to have raptor nests, including Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*). These largely occurred in mature black cottonwoods along relatively intact riparian areas. Freshwater bivalves were documented by field staff during the FIM field inventory in Segment 47, although species was not noted.

The above information only briefly touches on the fish and wildlife habitat values of Fraser Lake. Fish, wildlife, recreation, and water quality considerations make it essential to identify, manage, and protect the shoreline area. The data collected during this assessment provides a baseline upon which goals and objectives can be created and monitored, in order to effectively manage this valuable resource.

3.0 FORESHORE INVENTORY AND MAPPING METHODOLOGY

The FIM detailed methodology is found in Appendix A. This inventory is based upon mapping standards developed for Sensitive Habitat Inventory and Mapping (SHIM) (Mason and Knight, 2001) and Coastal Shoreline Inventory and Mapping (CSIM) (Mason and Booth, 2004). The development of mapping initiatives such as SHIM, FIM, and CSIM is an integral part of ecologically sensitive community planning. The following sections summarize specific information for the Fraser Lake FIM.

3.1 Field Surveys

Field surveys for this project occurred on August 16, 17, 18, and 19, 2011. A four to five person crew completed the field inventory. Field surveyors were each assigned data to collect during the surveys. Field assessors used 2 ft by 3 ft, scaled colour air photos with cadastre and topographic information to assist with field data collection. Spatial data was collected using a handheld Trimble Nomad GPS unit equipped with FIM data dictionary SHIM Lake v. 2.6. The GPS was used in conjunction with a ProXH receiver. Digital photographs and GPS digital video were collected. The specifics of the GPS digital video are discussed in the FIM methodology.

The principle objectives of these video and photographic surveys were to:

- Provide a baseline of photographic documentation of the entire shoreline.

sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened (BC CDC 2012).

- Record data relating to the presence and abundance of shoreline modifications, such as retaining walls and boat launches.

Weather is considered an important factor during the field survey, particularly during the photo and video data collection. High quality photo documentation is critical since the photos are instrumental during subsequent data analysis. The weather conditions that occurred during the field surveys were considered appropriate to collect accurate data. Any data fields that were estimated are clearly identified as such in the GIS datasets.

3.2 Methodology

Detailed methodology used for the Fraser Lake FIM project is provided in Appendix A and were generally adhered to throughout the assessment. Data collected by the field crews was provided to Ecoscape for post-processing, data analysis, mapping, and reporting. Ecoscape has attempted to ensure the data is as accurate as possible. However, due to the large size of the dataset, small errors may be encountered. These errors, if found, should be identified and actions initiated to resolve the error.

The following additional information was collected during field surveys:

1. The spatial extent of emergent grasses on flood benches and areas of emergent, submergent, and floating aquatic vegetation were mapped and photographed, to determine the approximate area where aquatic vegetation occurs. Aquatic vegetation includes any plants growing below the high water level of the lake, as these areas provide important fish habitat. Areas of extensive overhanging vegetation (from the high water level) were also mapped. It should be noted that on larger littoral areas, vegetation mapping may not have captured all occurrences.

2. Small stream confluences, seepage areas, and other features were recorded.

3. Features of interest including raptor nests and beaver lodges were also identified on the field maps for further digitization.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for the entire shoreline, with focus on foreshore areas. For the purposes of this assessment, aquatic vegetation includes any plant life occurring below the high water level of the lake (including flood benches). Although some of the plants are not truly aquatic, all are hydrophilic (water loving) and contribute to fish habitat. Vegetation mapping was completed by digitizing vegetation polygons from field observations recorded on air photos. Vegetation communities were classified using the Wetlands of British Columbia – A guide to identification (Mackenzie and Moran, 2004) and were categorized as:

Marsh (Wm)

A marsh is a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes, with early-season high water tables dropping throughout the growing season. Exposure of the substrates in late season or during dry years is common. The substrate is usually mineral, but may have a well-decomposed organic veneer derived primarily from marsh emergent vegetation. Nutrient availability is high (eutrophic to hyper-eutrophic) due to circum-neutral pH, water movement, and aeration of the substrate.

Low Bench Flood Ecosystems (Fl)

Low bench flood ecosystems occur on sites that are flooded for moderate periods (i.e., <40 days) of the growing season. These conditions limit the canopy to tall shrubs, such as willow and alder. Annual erosion and deposition of sediment generally limit understory and humus layer development.

Mid Bench Flood Ecosystems (Fm)

Middle bench ecosystems occur on sites briefly flooded (10-25 days) during spring freshet, allowing tree growth, but limiting tree species to only flood-tolerant broadleaf species such as black cottonwood and alder.

Swamp

A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs on sites with a flowing or fluctuating, semi-permanent, near-surface water table. Swamps tend to occur on slope breaks, peatland margins, inactive floodplain back-channels, back-levee depressions, lake margins, and gullies. Tall-shrub swamps typically form dense thickets, while forested swamps have large trees occurring on elevated microsites with an understory cover of tall deciduous shrubs.

Aquatic Vegetation

Sites not described by the nomenclature developed by Mackenzie and Moran (2004) were stratified into the following categories:

1. Emergent Vegetation (EV) generally refers to grasses, *Equisetum* spp. (i.e., horsetails), sedges, bulrushes, cattails, or other plants tolerant of flooding. Coverages within polygons needed to be consistent and well established to be classified as EV. These areas are generally not dominated by true aquatic macrophytes and tend to occur in steeper sloping areas.

2. Sparse Emergent Vegetation (SEV) refers to the same vegetation types as emergent vegetation, but in these areas coverage is typically not very dense or is very patchy. The patchiness is typically due to association with rocky beaches or intensive beach grooming.

3. Overhanging Vegetation (OV) consists of broadleaf vegetation that is growing over the surface of the lake, shading the nearshore littoral zone. Overhanging vegetation sometimes occurs with Emergent Vegetation (EVOV) and with Sparse Emergent Vegetation (SEVOV).

4. Submergent Vegetation (SUB) areas generally consist of aquatic vegetation that is typically rooted and does not break the water surface for most of the growing season, such as elodea (*Elodea canadensis).*

5. Floating Vegetation (FLO) generally consists of species such as native *Potamogeton* spp., pond lilies, and other types of vegetation that have floating parts.

3.2.2 GIS and FIM Database Management

Data management for this project followed methods provided in Appendix A and generally involved the following steps:

1. Data and photos were backed up to a computer/laptop on a daily basis.

2. A GPS camera that time/date stamps photos and creates GIS shapefiles, and GPS-enabled video were used to record data for review and interpretation.

3. Air photo interpretation was completed using high resolution air photos.

4. During data analysis, numerous quality assurance/quality control measures were completed to ensure that all data was reviewed, corrected, analyzed, and accounted for.

5. Air photo interpretation and TRIM shoreline files were used to accurately determine the high water level of the lake. It is believed that for the length of the shoreline, the high water level used is within 5 m of the mean annual high water level for at least 50% of the lake. The HWL assessment for Fraser Lake could be improved with higher resolution air photos when they become available. A site specific survey must be conducted to accurately determine the high water level for any site specific considerations, and the line presented in this assessment should not be considered a surveyed HWL.

The following data fields were added to the FIM data dictionary

1. An Electoral Area field was added to define the electoral area within a Regional District that shoreline segments were part of.

2. A Community Field was added to the database, but has not been utilized.

4.0 DATA ANALYSIS

The following section provides an overview of data analysis procedures for the Fraser Lake FIM.

4.1 General

General data analysis and review was completed using the Fraser Lake FIM database. Data collected was reviewed and analysis focused on discrete segments of shoreline. Analyses for this project were completed as follows:

1. The shoreline length for each discrete shore segment was determined using GIS and added to the FIM database.

2. For each category, the analysis used the percentage natural or disturbed field to determine the approximate shoreline segment length that was either natural or disturbed. This was done on a segment by segment basis. In some cases, the percentage natural or disturbed was reported because it made comparison easier than comparing shoreline lengths.

4.2 Biophysical Characteristics and Modifications Analysis

Biophysical characteristics of the shoreline segments were analyzed. For definitions of the categories discussed below, please refer to Appendix A. The following summarizes the analyses that were completed:

1. Percent distribution of natural and disturbed shoreline;
2. Total shoreline length that remained natural or disturbed for each slope category that occurs along the shoreline;
3. Total shoreline length that remains natural or has been disturbed for each land use identified along the shoreline;
4. Total shoreline length that remained natural or has been disturbed for each shore type that occurs along the shoreline;
5. Total length of shoreline that contained aquatic vegetation, emergent vegetation, floating vegetation, or submergent vegetation;
6. Total number of modification features recorded along the shoreline. This data represents point counts taken during the survey and is reported for groynes, docks, retaining walls, marinas, marine rails, and boat launches; and,
7. Total shoreline length of different shoreline modifiers (roadways, substrate modification, and retaining walls) was determined.

5.0 RESULTS

The following section provides an overview of the results of the Fraser Lake FIM. Data is presented graphically and summarized in the text for ease of interpretation. Data tables for each analysis are provided in Appendix B.

5.1 Biophysical Characteristics of Fraser Lake

The Fraser Lake FIM was completed along 70,927.7 m (70.9 km) of shoreline. The total length of disturbed shoreline was 19,513 m (19.5 km), which represents 28% of the shoreline (Figure 2). The total length of natural shoreline was 51,415 m (51.4 km), which represents 72% of the shoreline (Figure 2).

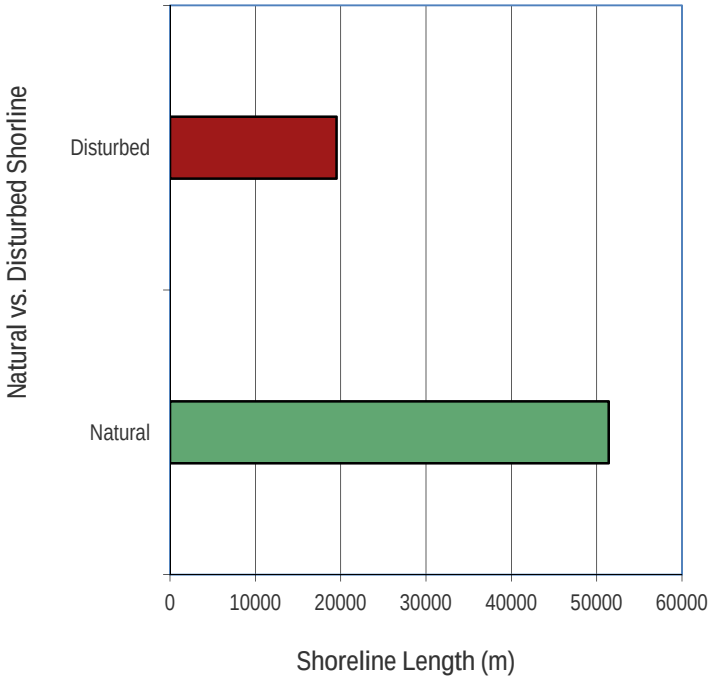


Figure 2 The total shoreline length that is either natural or disturbed along Fraser Lake.

The slope analysis is a summary of slope categories (% slope) that occur in upland areas above the high water level of the lake. Areas of a lower gradient tend to have the highest level of disturbance, typically because they are most suitable for development.

Photo 1: Looking towards a low gradient (0-5%) slope with single family development along the Fraser lake shoreline.

Approximately 39,015 m (39 km) of low gradient slopes were observed along the Fraser Lake shoreline, accounting for 55% of the total shore length (Figure 3). Low gradient areas were described as being 22% disturbed. Moderate (5-20%) and steep (20-60%) gradient areas along Fraser Lake were described as being 39 and 5% disturbed, respectively.

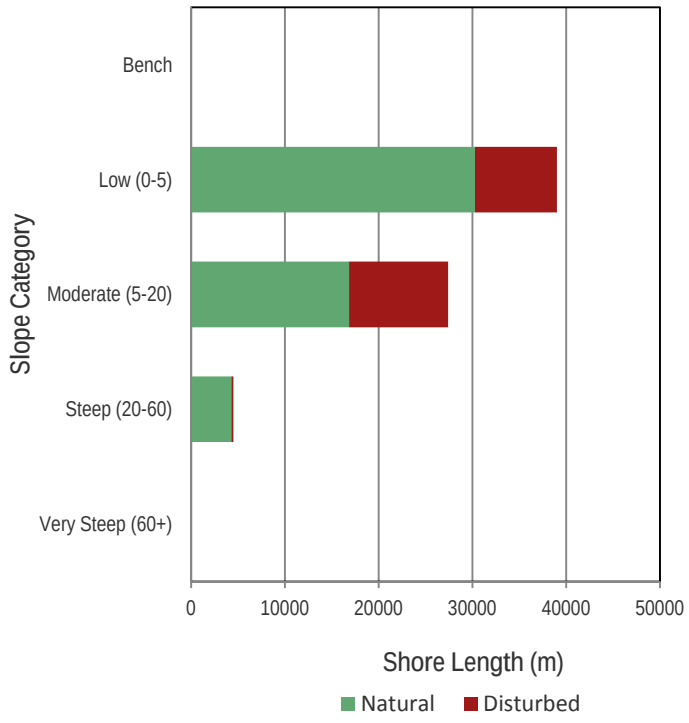


Figure 3 The natural and disturbed shoreline lengths along different slope gradients around Fraser Lake.

The most predominant land use type around Fraser Lake was described as rural, accounting for nearly 33% of the shore length, or 23.3 km (Figure 4). Rural areas were described as remaining 85% natural and 15% disturbed. However, these large, privately-owned parcels represent areas of potential future build-out, as development pressures increase, including subdivision and subsequent anthropogenic impacts.

Natural areas were the next most predominant shore type, accounting for 23% or 16.4 km of the total shore length. Approximately 98% of the natural areas were described as natural. Natural areas are limited to crown lands. Approximately 22% or 15.4 km of the Fraser Lake shore length was described as transportation, due to the close proximity of the railway. Shore length with a transportation land use was estimated to be approximately 57% natural and 43% disturbed. Single family land use included residential and recreational property developments along the foreshore and accounted for approximately 15% or 10.3 km of the Fraser Lake shoreline. Single family areas of shoreline were described as 63% disturbed. Anthropogenic impacts, including substrate modification, retaining walls, moorages, removal of riparian vegetation, and development within the Fraser Lake riparian area, were most evident along single family areas.

Parks accounted for 2.7% of the total shore length and were 74% natural, while urban parks occurred over 0.8% of the shoreline and were described as 2% natural. Recreation associated with a formal campground accounted for only 0.2% of the shoreline, although it is acknowledged that many of the rural and single family parcels around the lake are utilized for recreational purposes. Agricultural land use was documented along 2.6 % or 1.9 km of the Fraser Lake shoreline. Agricultural lands were described as 65% disturbed.

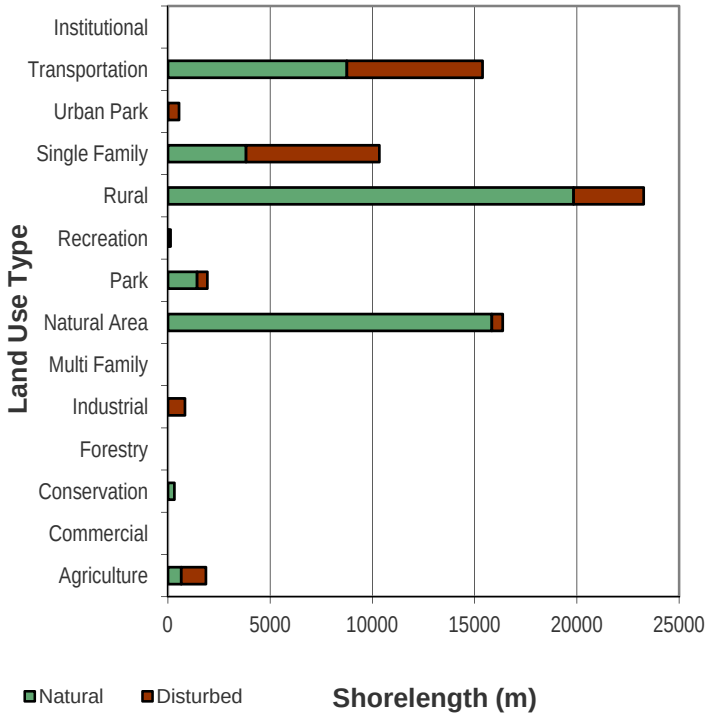


Figure 4 presents the natural and disturbed shoreline length by the different types of land use occurring around Fraser Lake.

The most predominant shore types observed around Fraser Lake were rocky shore, with 21.4 km, and wetland, accounting for 21.3 km, or 30% of the shoreline (Figure 5). Approximately 73% of rocky areas of the shoreline were noted to be natural, while 80% of wetlands were observed to remain in a natural state. Gravel beach shore types were documented along 12.4 km or 18% of the shoreline, with 67% of gravel beach areas remaining in a relatively natural state. Sand beach accounted for 10%, or 7.2 km of shoreline and were described as 48% natural. Stream mouths accounted for 8%, or 5.8 km of the total shore length, with 76% of stream mouth areas described as natural. Cliff/bluff shore type occurred over 2.7 km of shoreline, with 94% of the shore length remaining natural. Approximately 59 m of shore length were described as other, consisting of man-made materials.

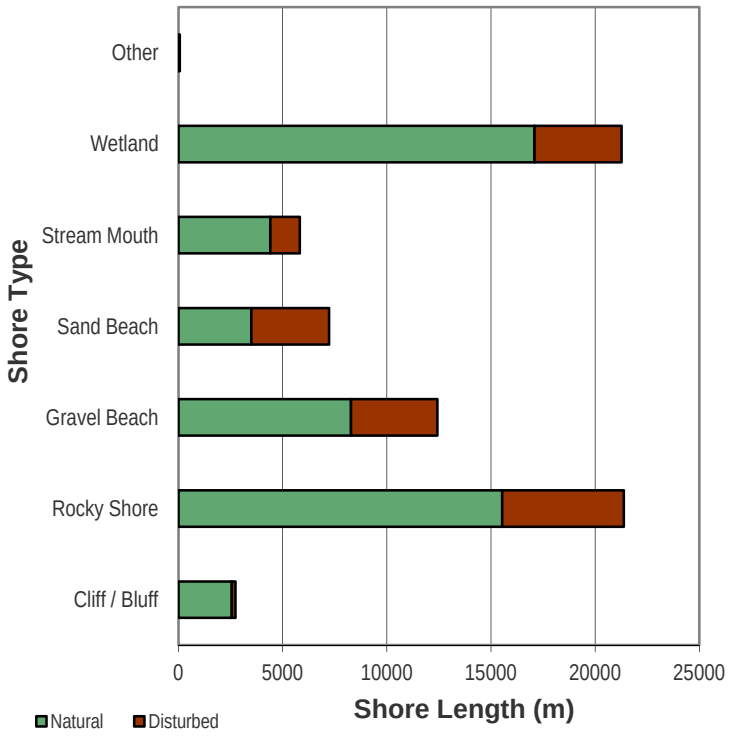


Figure 5 presents the length of natural and disturbed shoreline along each of the different shore types documented around Fraser Lake.

Photo 2: Looking towards an example of wetland habitat around Fraser Lake with an intact riparian area.

Photo 3: Looking towards an example of a rocky shore type along Fraser Lake.

Aquatic vegetation is loosely defined as any type of emergent, submergent, or floating vegetation that occurred below the high water level. Thus, the aquatic vegetation field includes true aquatic macrophytes and those plants that are hydrophilic or tolerant of periods of inundation during high water level. Studies have shown that even terrestrial vegetation during periods of inundation provides important food for juvenile salmonids and other aquatic life (Adams and Haycock, 1989).

There is approximately 25.2 km of shoreline that has aquatic vegetation, which represents approximately 36% of the total shoreline length (Figure 6). Most of the vegetation observed was emergent, including grasses and herbaceous vegetation below the high water level, which occurred along 36% of the shoreline or 25.2 km. Areas of submergent vegetation and floating vegetation were documented along 0.1% or 51 m, and 2% or 1.3 km, respectively. Ecoscape digitized areas of aquatic vegetation based on air photo interpretation and polygons of vegetation recorded on field maps. The total area of both dense and sparsely vegetated areas, including emergent, floating, submergent, low flood bench, and marsh aquatic vegetation types is approximately 1.6 km^2. Emergent vegetation was mapped over 1.4 km^2, floating vegetation was mapped over 183,925 m^2, and submergent vegetation was mapped over 29,911 m^2.

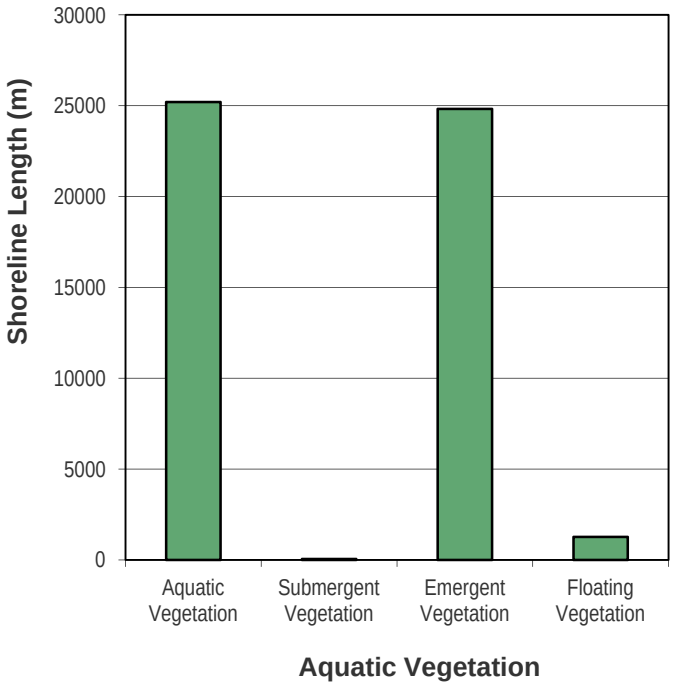


Figure 6 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Fraser Lake.

Docks were the most commonly observed type of shoreline modification, occurring within both rural and single family residential areas (Figure 7). There were a total of 115 docks counted during the assessment which equates to an overall density of 1.6 docks per km in Fraser Lake. There were a total of 20 shoreline segments which were recorded as having docks along the shoreline. These included Segments 1, 5, 6, 7, 8, 9, 12, 13, 15, 19, 21, 22, 25, 28, 29, and 30. The highest density of docks occurred in Segment 15 at 11.9 docks per km. Within the 20 shoreline segments observed to have moorages along the shoreline, the average density was 4.5 docks per km.

Photo 4. Looking towards foreshore modifications including retaining wall construction and riparian vegetation removal along Fraser Lake.

Retaining walls were the next most common type of modification with 36 recorded. A total of 17 groynes were documented along the shore length. There were 9 boat launches recorded, not including gravel access to the foreshore, which could facilitate boat launching. One (1) marina rail was recorded to occur along the Fraser Lake foreshore. Modifications to some degree occurred wherever privately held parcels occur along the lakeshore.

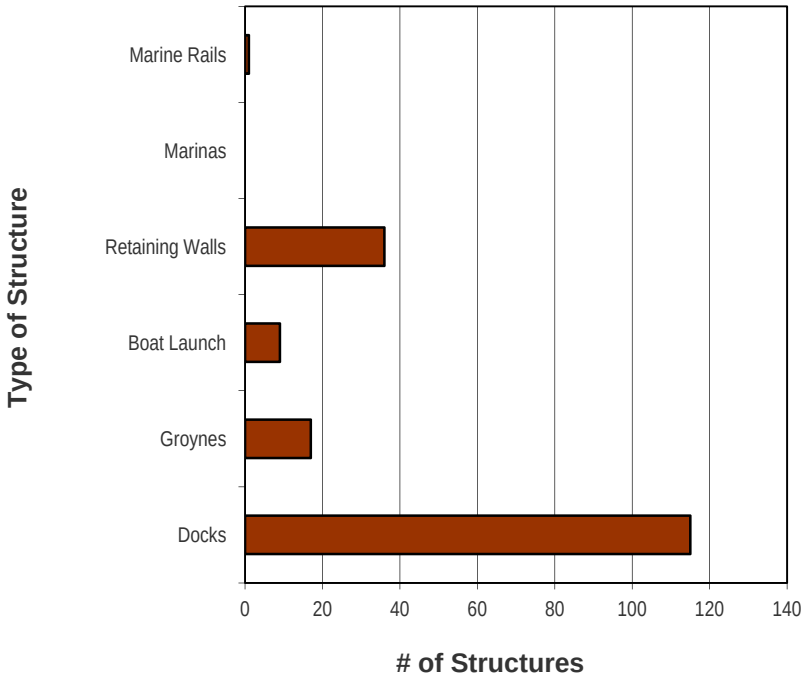


Figure 7 presents the total number of various shoreline modifications documented to occur around Fraser Lake.

The percentage of the shoreline that was impacted by roads, railways, retaining walls, and where substrate modification has occurred is typically recorded in the field. While some instances of percent substrate modification and transportation were completed in the database in the field, the percent retaining wall column was not populated. Where modifications occurred, but were not noted in the appropriate percent columns, values were estimated. These estimates allowed an approximation of the total shoreline length that has been impacted by these different activities (Figure 8). Railway occurs along much of the southern shoreline of Fraser Lake and was the most prominent shoreline modifier noted at 18%, or 12.6 km. It should be noted that the railway extends a greater distance along the lakeshore; however, the estimate accounts for areas where the railway influences below the HWL. Road influence within the riparian area was documented along 1% of the shoreline, or 602 m. Substrate modification was observed along approximately 3%, or 2.2 km of the shoreline. Substrate modification was variable and was most commonly associated with construction of groynes to create sand or gravel beaches, historic fills (e.g., retaining walls below HWL) or associated with road/railways (e.g., structural fill material, etc.). Retaining walls were found to occur along 540 m of shoreline, or 1% of the surveyed shore length.

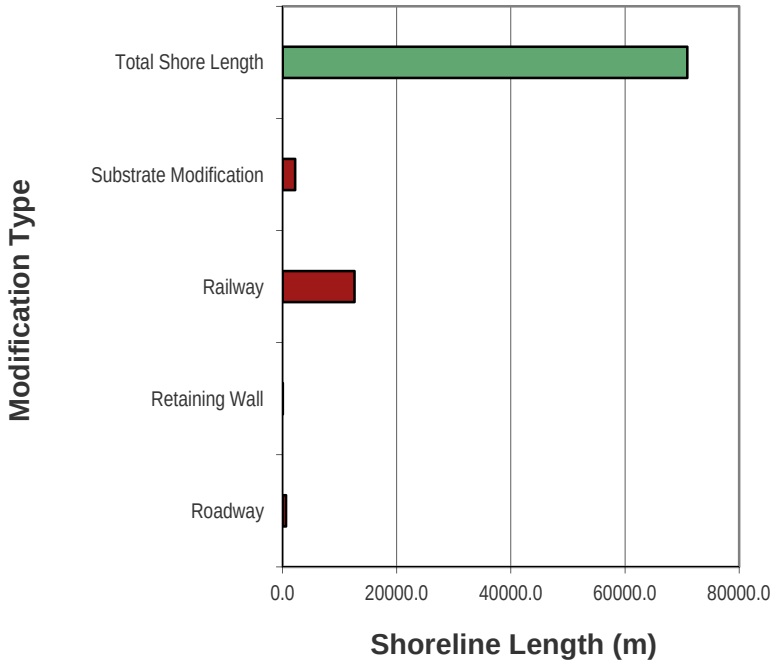


Figure 8 presents the total shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Fraser Lake.

The Level of Impact is a categorical description of disturbance along the shoreline. The following definitions were taken from the FIM methods (Appendix A) and are included for ease of reference.

1. *Level of Impact* - Level of Impact is a categorical field that is used to describe the general level of disturbance observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered the shoreline, including foreshore substrates, vegetation, or the shoreline itself (e.g., retaining walls). The Level of Impact is considered both looking at the length of the shoreline (i.e., along the segment) and the depth of the shore zone area to between 15 to 50 m back. In more rural settings, the assessment area is typically greater (i.e., 50 m), and in more developed shorelines the assessment area is less (i.e., 15 to 30 m). In cases of roadways or railways, one should generally consider the location of the rail or roadway along the segment (i.e., how far back is it set, is the lake in-filled). To facilitate interpretation of this category, air photo interpretation is recommended to better estimate disturbance.

   Disturbance categories include High (>40%), Medium (10-40%), Low (<10%), and None. Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The FIM report for Okanagan Lake defines *Level of Impact* as follows (Magnan and Cashin 2004):

   a. *Low* - Segments that show little or limited signs of foreshore disturbance and impacts. These segments exhibit healthy, functioning riparian vegetation. They have substrates that are largely undisturbed, have limited beach grooming activities, and no to few modifications.

   b. *Moderate* - Segments that show moderate signs of foreshore disturbance and impacts. These segments exhibit isolated, intact, functioning riparian areas (often between residences). Substrates (where disturbed) exhibit signs of isolated beach grooming activities. Retaining walls (where present) are generally discontinuous. General modifications are well spaced and do not impact the majority of the foreshore segment.

   c. *High* - Segments that show extensive signs of disturbance and impacts. These segments exhibit heavily disturbed riparian vegetation, often completely removed or replaced with non-native species. Modifications to the foreshore are extensive and likely continuous or include a large number of docks. Generally, residential development is high intensity. Modifications often impact a majority of the foreshore.

Fraser Lake was found to exhibit a low (<10%) level of impact over 24.6 km, or 35% of the shoreline (Figure 9). However, the shoreline was also noted to have a high (>40%) level of impact over 24 km, or 34% of the total shore length. Segments of Fraser Lake with a high level of impact were associated with land uses including single family, rural, agriculture, transportation and urban park. Approximately 15% or 10.8 km of shore length was found to have little to no impact (none). Areas of moderate (10-40%) impacts accounted for 16% of the total shore length, or 11.3 km.

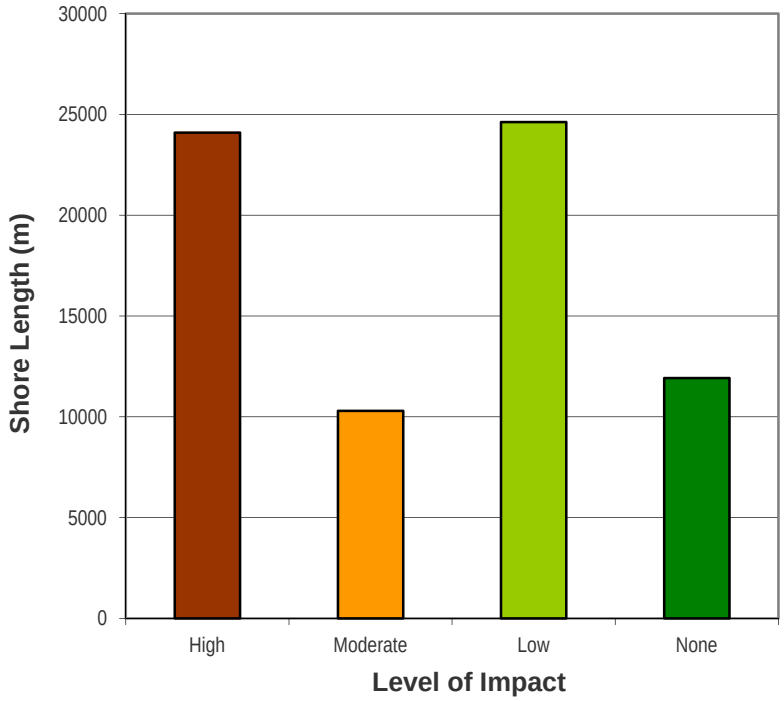


Figure 9 presents the level of impact (High, Moderate, Low, or None) observed along Fraser Lake.

5.2 Summary of Foreshore Modifications

Fraser Lake remains relatively natural over approximately 72.5% of the 70.9 km total shore length, with disturbance to some extent documented over 27.5% of the total shore length. Around 23% of the shoreline was described as Natural Area in terms of land use, with disturbance estimated around 3%. Privately owned rural and single family lakeshore residential property accounts for over 47% of the total shore length. While rural land was estimated to remain 85% natural, there is the potential for future development and associated anthropogenic impacts. Smaller, single family parcels were estimated to remain 37% natural, with higher levels of development and foreshore modifications. The FIM analysis highlights the necessity to begin to implement long term objectives for the lake to help conserve important natural areas that remain.

Common foreshore modifications include removal of native riparian and aquatic vegetation, construction of single family dwellings and permanent structures within close proximity to the lake high water level, transportation corridors along the foreshore with associated lake infilling and substrate modification, moorages, boat launches, groynes, and boat basins. Many of the privately held parcels along the lake appear to be used primarily for recreational purposes, and structures were often noted to be integrated into the natural landscape, retaining native tree canopy and riparian buffers. However, as development pressure along the lakeshore increases with time, smaller cabins and dwellings used for recreation may give way to larger single family dwellings used on a year-round basis. Inevitable larger building footprints will of course result in increased levels of disturbance and associated non-point source pollution. It is apparent that the current trend of reliance on best management practices and voluntary compliance with regulations and guidance documents is not resulting in adequate protection of important fish and wildlife habitats along the shoreline.

Varying degrees of foreshore development are present along Fraser Lake. Some of the main issues identified are summarized below:

- Within more intensely developed areas, landscaping with turf and removal of a native riparian buffer was common along individual lots. Native vegetation has largely been removed along some of the parcels, retaining some mature trees and shrubs between properties. While only one (1) segment was described as landscaped in the riparian class category, there were several others where distribution was described as patchy due to removal of riparian vegetation associated with development. In many cases, native vegetation removal has extended below the lake HWL with removal of aquatic vegetation along wetland shore types. Agricultural operations were also noted to result in removal of riparian vegetation, with livestock grazing unrestricted to the Fraser Lake

foreshore. Opportunities for riparian restoration and enhancement are present along many private properties.

- Docks were the most commonly observed shoreline modification, and it is possible that some of these docks have been constructed without appropriate moorage tenures or approvals. While the impact of individual docks appears small, the cumulative impacts are noticeable and measureable (i.e., lakebed substrate modification). Many of the docks included floating structures. Floating docks shade substrates and may limit habitat usage by fish, in addition to impacting aquatic vegetation. The presence of floating structures and docks in shallow water facilitates moorage in shallow water, which often results in prop scour and substrate disturbance.

- Retaining walls constructed of a variety of materials were noted to occur along privately held lakefront parcels. As mentioned above, it is probable that many of the retaining walls observed have been constructed without a Water Act or Fisheries Act approval.

6.0 RECOMMENDATIONS

6.1 Foreshore Protection

The following provides a summary of recommendations for foreshore protection along Fraser Lake. Some of the recommendations below are similar to other recent FIM reports that were completed. In cases of similarity, credit to the work should be given to the original authors. The following are recommendations for development of foreshore protection policies:

1. **An Aquatic Habitat Index (AHI) Analysis (Step 2) should be completed for Fraser Lake using the results of this project.** The FIM results provide a basis to complete an AHI for the Fraser Lake shoreline. The results of the AHI will identify and rank the relative habitat value of each shoreline segment and facilitate the completion of the Shoreline Guidance Document (Step 3).

2. **A Shoreline Guidance Document (Step 3) should be developed by local government, the Ministry of Forests, Lands and Natural Resource Operations, First Nations bands, and Fisheries and Oceans Canada for Fraser Lake that incorporates the results of this analysis.** The FIM and subsequent AHI provides a basis for identification of sensitive shoreline areas and a risk based approach to lakeshore management. The shoreline guidance document will facilitate inter-governmental cooperation for lakeshore management. Funding should be sought to complete these next steps. A staged approach in the development of this

guidance document may be required, with a series of interim measures developed to allow sufficient effort in the development of long and short term goals.

The Fraser Lake guidance document should build upon objectives, goals, and policies identified within the broader RDBN Shoreland Development Strategy October 2009 (RDBN 2009), as well as the Village of Fraser Lake Waterfront Development Plan (L & M Engineering Ltd 2009) and municipal OCP documents.

3. **FIM and AHI data should be integrated into existing watershed-based fish sustainability planning initiatives.** A substantial amount of work has been completed and is ongoing which may benefit from the spatially accurate documentation of current shoreline habitats and sensitivity analysis.

4. **The FIM results should be integrated with existing and future lakeshore management plans developed by all levels of government and First Nations to provide an integrated approach to shoreline management. FIM results should be incorporated into the existing Village of Fraser Lake OCP Bylaw No. 682, 2008 (Village of Fraser Lake 2008), and the Endako, Fraser Lake, Fort Fraser Rural OCP Bylaw No 1487, 2008 Schedule A (RDBN, 2011), as well as the RDBN Shoreland Development Strategy (RBDN 2009).** Local, provincial, and federal agencies may need to identify what the maximum proposed build out for Fraser Lake will be and develop a cross jurisdictional plan to achieve this goal. This decision should be made sooner rather than later because it is probable that there will be a continued incremental loss over time as rural properties are proposed for increased density. If the build out does not occur with coordination at all levels of government, the impacts cannot be effectively mitigated (i.e., it is better to work as part of a larger regional initiative than as solitary jurisdiction). Items to consider when developing more long term management objectives include:

    - Addressing substrate alteration occurring around the lake to prevent degradation of juvenile rearing, overwintering and spawning habitats, and wetland areas.
    - Implementing sufficient measures, including adequate budget, to provide for a long term watershed management approach.
    - Providing sufficient boat access (e.g., ramps, parking, etc.) in appropriate locations to offset concerns in very high and high value areas.
    - Addressing the presence of critical rearing and overwintering habitat for the Nechako white sturgeon. Currently, the entire lake is considered critical sturgeon habitat.
    - Addressing key wildlife corridors, species at risk habitat, and sensitive terrestrial ecosystems.

- Addressing waterfowl and shorebird productivity and implementing appropriate best management practices that will help avoid impacts to important breeding habitats.
- Addressing onsite sewage disposal systems as waterfront properties are redeveloped; undersized recreational lots without community sewage disposal options face aging and failure as properties are converted from seasonal recreational use to year-round residences (RDBN 2009).
- Addressing known data gaps including identification of key habitat elements around the Fraser Lake shoreline that are not included in this analysis.
- Identifying appropriate mechanisms for compliance and enforcement monitoring. Consistent and easily enforceable compliance mechanisms are required to address construction activities that are not in compliance with standard policy or best management practices.
- Include regulations and guidelines for new development, re-development, and management of existing development.
- Designate protection of critical shoreline areas (e.g., spawning zones, juvenile/adult migration corridors and rare species occurrences).
- Explore a memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities.
- Consider other shoreline development guidelines and lakeshore plans completed or currently being developed for Fraser Lake.

5. **Maintenance of riparian vegetation and sufficient natural riparian management areas/setbacks with property development.** Private parcels may currently be undeveloped or have minimal impacts, but will be vulnerable to redevelopment in the future. Numerous different possibilities exist for areas identified as environmentally sensitive, including Section 2.19 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.). Several options are identified within the RDBN Shoreland Development Strategy which speak to such possibilities. Further, site specific assessment of individual properties should occur to evaluate proposed activities and ensure maintenance and enhancement of sensitive aquatic and terrestrial ecosystems and habitat features. Official Community Plans should consider incorporation of Natural Environment or Sensitive Aquatic Development Permit areas, which may facilitate increased involvement in the RDBN review of proposed developments.

6. **Historical habitat impacts should be restored during re-development activities, with measures in place to ensure successful completion**. While Fraser Lake remains largely natural, this is something to consider with lakeshore development. In areas where past impacts and modifications have occurred, permitting for building, subdivision, or redevelopment of the property should be contingent upon

incorporation of habitat restoration, such as retaining wall removal, dismantling of groynes, riparian restoration, etc. Partnerships (i.e., multi agency partnerships with stewardship groups) should be formed or built upon to help facilitate habitat restoration around the lakes.

7. **Key shoreline linkages to sensitive terrestrial habitat should be identified. These habitat linkage areas are extremely important to maintain and should be identified as early as possible in the development process.** Maintenance of connectivity between the foreshore and sensitive terrestrial ecosystems is an important factor to consider when regulatory agencies are reviewing applications for redevelopment, including subdivision, which can result in habitat fragmentation and increased density of foreshore impacts. Detailed assessments and identification of core habitat areas for conservation should be done as early in the development process as possible to reduce potential impacts from land use decisions (e.g., zoning a property for commercial purposes without understanding what values are present may result in obligations for a minimum build-out that has significant impacts that are difficult to mitigate later on in the process such as at subdivision).

8. **Environmental information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information and air photos, are an extremely important part of the environmental review process because they provide extensive information regarding the current condition of an area. This information should be available to the public to increase the knowledge base and contribute to completion of environmental assessments and overall increase in lake stewardship. 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.

9. **Compliance and enforcement monitoring of approved works is required, with consequences for failure to construct following standard best practices or failure to apply for necessary permits.** There were several examples of historical and more recent site development observed during this survey that are not in accordance to best practices, which is consistent with observations during surveys of other interior lakes such as Nicola, the West Arm of Quesnel, Horsefly, Okanagan, Mabel, Shuswap, Windermere, Moyie, Monroe, and Mara Lakes.

10. **A communication and outreach strategy should be developed to inform stakeholders and the public of the FIM results and improve stewardship and compliance**. Initially, it is recommended that notice to the public and stakeholders is issued promoting the availability of this report and associated products available on the Community Mapping Network. The outreach strategy is required because

many people are not aware of the impacts of their activities and are also not fully aware of appropriate and governing legislation for development activities adjacent to shoreline areas. Funding should be sought to address outreach activities and address local government implementation.

11. **Shoreline erosion hazard mapping should be conducted for private lands to identify areas at risk. This mapping will streamline the review process and address the trend of construction of non-compliant retaining walls along the shoreline.** The shoreline erosion hazard mapping will also identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some variation of it (e.g., Guthrie and Law, 2005). This mapping should be integrated with the FIM data and be completed for each shoreline segment. Flooding, terrain stability, and alluvial fan hazard mapping should also be considered for developing areas along the lakeshore. It may be possible to utilize the existing FIM maps and other associated data (e.g., SEI or others) to identify areas more prone to shoreline erosion. 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, reports by engineers or biologists should accompany proposals for shoreline armoring to ensure that works are required, minimize impacts, and use bioengineering techniques.

12. **Storm water management plans need to adhere to best management practices and be considered in all future development applications.** While not specifically identified as an immediate item of concern on Fraser Lake, stormwater management is an important consideration as communities grow and associated development activity increases. Adequate detention, retention, and infiltration needs to take place, rather than direct discharge to waterbodies.

13. **Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources.** Development of land use alteration proposals should only be approved if the compromises or trade-offs will result in substantial, long-term net positive production benefits for biophysical resources. 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 unless suitable rationale and arguments are presented (e.g., it benefits the general public versus an individual).

14. **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 performance security bonding amounts should be collected. These bonds will

ensure objectives for the proposed works are met and that efforts are constructed to an acceptable standard. Compensatory works resulting from projects or portions of projects that could result in negative impacts to fish habitat must follow the DFO Decision Framework for the Determination and Authorization of a Harmful Alteration, Disruption or Destruction of Fish Habitat (i.e., HADD). The works must be consistent with the "No Net Loss" guiding principle of The DFO Policy for the Management of Fish Habitat.

15. **Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation or compensation is proposed.**

16. **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.

17. As indicated in the Village of Fraser Lake's Waterfront Development Plan, intensive commercial and recreational development should be concentrated in previously impacted areas with reduced or low habitat value, while still consulting with DFO and Provincial organizations regarding habitat protection and improvements (L & M Engineering 2009).

6.2 Future Data Management

Ongoing appropriate management of the data is important to ensure that data collected during this survey is kept available, accurate, and up to date. Future data collection should be integrated into the current GIS database and additions and edits made as required. The following are recommendations for future management of the FIM dataset:

1. **A single agency should take the lead role in data management and maintenance**. The responsible agency should manage and maintain the "master data set". Although the data may be available for download from numerous locations, one agency should be tasked with keeping the master copy for reference purposes. The CMN is currently publishing many of the data sets that have been collected. Sufficient funding must be allocated to CMN to keep up with management of the data because typically increasing datasets result in increasing costs.

2. **The shoreline segment numbers used in this report are the unique identifiers. Any new shoreline information that is collected should reference and become linked to the existing shoreline segment number.** This will help maintain consistency and connectivity between current and future data collection and

integration. The responsibility of maintaining this consistency will be that of the single agency described above.

3. **A summary column(s) should be added to the FIM dataset that flags new GIS datasets as they become available.** Examples of this include new location maps for rare species occurrences and fish distributions. Other examples include the addition of appropriate wildlife habitat use data. Where feasible, these new data sets should reference the shoreline segment numbers identified in this report.

4. **Review and update of the FIM data and mapping should occur on a 5 to 10 year cycle.** As the dataset provides baseline data of a snapshot in time, review and update of the FIM will be required to determine if shoreline goals and objectives are being achieved. Ideally, updates to the FIM dataset would be done as projects are approved and completed (i.e., real time).

6.3 Future Inventory and Data Collection

The following are recommendations for future biophysical inventory that will help facilitate environmental considerations in land use planning decisions:

1. **Data regarding shore and stream spawning locations for resident and anadromous fish species should be confirmed.** No occurrences of shore spawning were identified in available information or field data along the shoreline of Fraser Lake. Inventory of shore spawning reaches for lake trout and other species of interest should also be conducted along Fraser Lake. Existing fisheries databases such as those found on provincial FISS and FDIS sites should be reviewed to ensure fish assemblage data for Fraser Lake and its tributaries is up to date (ie. white sturgeon are not currently listed on provincial fisheries data as being present in Fraser Lake).

2. **An Aquatic Habitat Index (AHI) Analysis (Step 2) should be completed for Fraser Lake using the results of this project.** The FIM results provide a basis to complete an AHI for the Fraser Lake shoreline. The AHI, including completion of the juvenile rearing habitat index, is recommended to further identify and refine environmental sensitivity of shoreline segments. Given the identified importance of Fraser Lake for migratory bird species, known areas of sensitive wildlife habitat should be incorporated into the AHI analysis.

3. **The addition of new segment breaks should be determined in the future.** Some segments, predominantly the longer lengths, should be further assessed to determine if additional breaks would help better reflect the condition of the shoreline. Future mapping updates may determine new segment breaks along

long segments, segments with special features (e.g., shore spawning, stream mouths or wetlands), or as other information is collected.

4. **Complete Sensitive Habitat Inventory and Mapping (SHIM) for all watercourses around the lake**. SHIM is a GIS-based stream mapping protocol that provides substantial information regarding streams and watercourses. This mapping protocol provides useful information for fisheries and wildlife managers, planning staff, municipal engineering departments (e.g., engineering staff responsible for drainage), and others. Mapping should focus on significant salmonid rivers and streams first, on smaller tributaries containing less fish habitat second, followed by non-fish-bearing waters. This information is also extremely useful for Source Water Protection initiatives because it identifies potential contaminant sources in an inventory.

5. **Complete Wetland Inventory and Mapping (WIM) for all wetlands along the shoreline of the lake and associated tributaries.** WIM is another GIS-based mapping protocol that provides information regarding wetland communities. WIM mapping along Fraser Lake shoreline and associated tributaries is recommended. Mapping of wetlands is also important to ensure that corridors between aquatic and terrestrial habitats are identified. Wetlands are sensitive and productive components of natural ecosystems and these features should be inventoried and mapped. Completion of WIM would help to more accurately identify, classify and describe aquatic vegetation features that occur around the shoreline.

6. **Native beds of submergent and floating vegetation should be mapped in detail.** More detailed mapping, such as SHIM and WIM, would help improve identification and characterization of these sensitive features.

7. **A survey, on a home by home basis, should be conducted 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 properties. The assessment should provide them with sufficient information to help land owners work towards improving habitats on their property. This assessment is not intended to single out individual owners, but rather to help owners understand the importance of habitat values present on their properties.

7.0 CONCLUSIONS

This report documents the current condition of around 70.9 km of shoreline along Fraser Lake. The FIM assessment provides a summary of current and background information characterizing the condition of the shoreline and riparian communities that comprise the foreshore. Recommendations have also been provided to help integrate this information into local land use planning initiatives and management guidelines.

The most prolific shoreline modification was docks with 115 counted, resulting in an overall density of 1.6 moorages/km around the entire lake. The highest density of docks occurred in Segment 15 at 11.9 docks per km. Within the 20 shoreline segments observed to have moorages along the shoreline, the average density was 4.5 docks per km. Substrate modification was only estimated to occur over 3% of the total shore length, and was documented in association with modifications such as road cut and fills, railway, riparian and aquatic vegetation removal, and single family developments. Shoreline impacts associated with the railway proximity to Fraser Lake were noted over 18% of the shore length. While a vegetated buffer occurred along much of the railway, there are areas where riparian vegetation removal and substrate modifications have occurred associated with riprap armouring of the transportation corridor at or below the lake HWL. These impacts were considered to be the most significant habitat degradations observed around the lake.

There is approximately 73% of the shoreline that appears to remain in a relatively natural condition, representing approximately 51.4 km of shoreline. Over 47% of the Fraser Lake shoreline was identified as single family or rural land use, with 37% of single family segments and 85% of rural segments remaining natural. As development pressures increase and lots used primarily for recreation are redeveloped, anthropogenic disturbance along the foreshore will undoubtedly increase. With site redevelopment, onsite sewage disposal must be adequately addressed to mitigate negative cumulative effects and potential deterioration of water quality associated with undersized or failing septic systems.

Fish, wildlife, recreation, and water quality considerations make it essential to identify, manage and protect the shoreline area. The data collected during this assessment provides a baseline upon which further analysis, goals, and objectives can be created and monitored, in order to effectively manage this valuable resource.

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GLOSSARY OF TERMS AND ACRONYMS

Alluvial Fan / Stream Mouth – Alluvial fans are considered to be areas where a stream has the potential to have a direct active influence (e.g., sediment deposition or channel alignment changes) on the lake.

Allocthonous Inputs - Organic material (e.g., leaf litter) reaching an aquatic community from a terrestrial community.

Anadromous – Anadromous fish as sea run fish, such as Coho, Chinook, and Sockeye salmon.

Aquatic Habitat Index (AHI) -The index is a ranking system based upon the biophysical attributes of different shoreline types. The index consists of parameters such as shore type, substrate type, presence of retaining walls, marinas, etc. to determine the relative habitat value based upon a mathematical relationship between the parameters.

Aquatic Vegetation – Aquatic vegetation consists of any type of plant life that occurs below the high water level. In some instances, aquatic vegetation can refer to grasses and sedges that are only submerged for short periods of time.

Biophysical – Refers to the living and non-living components and processes of the ecosphere. Biophysical attributes are the biological and physical components of an ecosystem such as substrate type, water depth, presence of aquatic vegetation, etc.

Best Management Practice (BMP) - Is a method or means by which natural resources are protected during development or construction.

Emergent Vegetation - Emergent vegetation includes species such as cattails, bulrushes, varies sedges, willow and cottonwood on floodplains, grasses, etc. Emergent vegetation is most commonly associated with wetlands, but is also occurs on rocky or gravel shorelines.

Fisheries and Oceans Canada (DFO) – Federal agency responsible for management of fish habitats

Fisheries Productivity - The maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend.

Floating Vegetation -Floating vegetation includes species such as pond lilies and native pondweeds with a floating component.

Foreshore – The foreshore is the area that occurs between the high and low water marks on a lake.

Foreshore Inventory Mapping (FIM) -FIM is the methodology used to collect and document fish and riparian habitats and lake corridors and was performed by the Regional District of Central Okanagan and partners. A full discussion of this mapping can be found in Magnan and Cashin (2005).

Georeferencing - Georeferencing establishes the relationship between page coordinates on a planar map (i.e., paper space) and known real-world coordinates (i.e., real world location)

Groyne – A protective structure constructed of wood, rock, concrete or other materials that is used to stop sediments from shifting along a beach. Groynes are generally constructed perpendicular to the shoreline

Instream Features – Instream features are considered to be construction of something below the high water mark. Instream features may include docks, groynes, marinas, etc.

Lacustrine – Produced by, pertaining to, or inhabiting a lake

Lentic - In hydrologic terms, a non-flowing or standing body of fresh water, such as a lake or pond.

Life History – Life history generally means how an organism carries out its life. Activities such as mating and resource acquisition (i.e., foraging) are an inherited set of rules that determine where, when and how an organism will obtain the energy (resource allocations) necessary for survival and reproduction. The allocation of resources within the organism affects many factors such as timing of reproduction, number of young, age at maturity, etc. The combined characteristics, or way an organism carries out its life, is a particular species' life history traits.

Lotic – In hydrologic terms, a flowing or moving body of freshwater, such as a creek or river.

Non Anadromous – Non anadromous fish are fish that do not return to the sea to mature. Examples include rainbow trout (excluding steelhead), bull trout, and whitefish.

Retaining Wall – A retaining wall is any structure that is used to retain fill material. Retaining walls are commonly used along shorelines for erosion protection and are constructed using a variety of materials. Bioengineered retaining walls consist of plantings and armouring materials and are strongly preferred over vertical, concrete walls. Retaining walls that occur below the Mean Annual High Water Level pose a significant challenge, as fill has been placed into the aquatic environment to construct these walls.

Sensitive Habitat Inventory Mapping (SHIM) - The SHIM methodology is used to map fish habitat in streams.

Shore zone - The shore zone is considered to be all the upland properties that front a lake, the foreshore, and all the area below high water mark.

Streamside Protection and Enhancement Area (SPEA) - The SPEA means an area adjacent to a stream that links aquatic to terrestrial ecosystems and includes both the existing and potential riparian vegetation and existing and potential adjunct upland vegetation that exerts influence on the stream. The size of the SPEA is determined by the methods adopted for the Provincial Riparian Areas Regulation.

Stream Mouth / Stream Confluence / Alluvial Fan – Stream mouths are considered to be areas where a stream has the potential to have a direct active influence (e.g., sediment deposition or channel alignment changes) on the lake.

Submergent Vegetation – Submergent vegetation consists of all native vegetation that only occurs within the water column. This vegetation is typically found in the littoral zone, where light penetration occurs to the bottom of the lake. Eurasian milfoil is not typically considered submergent vegetation as it is non-native and invasive.