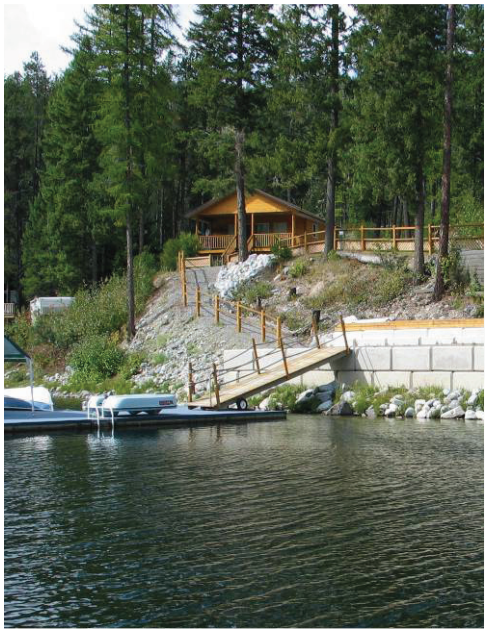
Foreshore Inventory and Mapping

MOYIE LAKE



Prepared For:
East Kootenay Integrated Lake Management Partnership

Prepared By:
Ecoscape Environmental Consultants Ltd.

November, 2009
File No.: 09-371

ECOSCAPE
Environmental Consultants Ltd.

FORESHORE INVENTORY AND MAPPING

East Kootenay Integrated Lake Management Partnership

Moyie Lake

Prepared For:

East Kootenay Integrated Lake Management Partnership

Prepared By:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
#102 – 450 Neave Court
Kelowna, B.C.
V1W 3A1

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Bruce MacDonald, Fisheries and Oceans Canada
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Bruce MacDonald (DFO), Peter Holmes, (MoE), Heather Leschied, (Wildsight), Karen MacLeod (RDEK)

The author of this report was:
Jason Schleppe, M.Sc., R.P.Bio. (Ecoscape)

The report was reviewed by:
Kyle Hawes, B.Sc., R.P.Bio. (Ecoscape)

Geographical Information Systems (GIS) mapping and analysis was prepared by:
Robert Wagner, B.Sc. (Ecoscape)

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EXECUTIVE SUMMARY

This report has been prepared based upon the belief that it is possible to manage our watersheds and their natural surroundings in a sustainable manner. The intent of this document is to provide relevant stakeholders with information to facilitate future land use planning and foreshore development guidance for shoreline areas around Moyie Lake. This project involved the following general process:

1. Shoreline Inventories following the Foreshore Inventory and Mapping (FIM) protocol (Appendix A) and additional fisheries and wildlife inventories to identify other sensitive features of concern. Inventories were conducted using a variety of methods and data was utilized from numerous different sources;

2. An Aquatic Habitat Index (AHI) was generated using the FIM data to determine the relative habitat value of the shoreline. This index follows similar methods that were developed for Okanagan Lake and Windermere Lake and is similar to other ongoing assessments along Shuswap Lake, Tie and Rosen Lakes, and Columbia Lake.

3. Shoreline Management Guidelines have been prepared for the shorelines surveyed to facilitate making informed land use decisions for our watersheds. The Shoreline Management Guidelines are intended to provide background information to stakeholders, proponents, and governmental agencies when land use changes or activities are proposed that could alter the shoreline thereby affecting fish or wildlife habitat.

The data provided in this document can be incorporated into land policy documents, such as Official Community Plans or Bylaws. The information collected during this assessment will be used as a baseline and allow development of specific objectives to be prepared for shoreline protection. Finally, once objectives have been prepared, the methodology will allow managers to assess and measure whether the specific shoreline objectives have been met over time.

The shoreline of Moyie Lake provides residents and tourists with excellent opportunities to live and recreate in a rural setting. Moyie Lake consists of a North and South Basin, with a very biologically diverse (i.e., productive) narrows region in the middle. The lake contains many important wildlife features, including several significant wetlands and flood bench communities which were mapped as part of this project. Moyie Lake also has several important stream tributaries that provide important spawning habitat for kokanee and salmonid species. In close proximity to Moyie Lake is Monroe Lake. Monroe is a smaller lake, with one cluster of development. Monroe Lake also contains important wetland habitats, and is surrounded by coniferous forests of varying structural stages due to recent forest fire events. Fisheries and Wildlife reports have been prepared for both Moyie and Monroe Lakes (under separate cover).

Foreshore Inventory and Mapping results (FIM) for this project provides valuable information regarding features, habitats, and other information for the shorelines of these lakes. A summary of the data collected indicates the following:

- It is estimated that 48% of the shoreline has a high level of impact which accounts for 17.5 km of shoreline. Areas of moderate and low impact account for 8% or 3 km and 45% or 16.6 km of the shoreline respectively. Impacts along the shoreline include lakebed

substrate modification, riparian vegetation removal, construction of retaining walls, docks and other anthropogenic features;

- The most predominant land use around the lake was rural (30.7%), followed by transportation (28.4 %) shorelines. Single Family residential areas were the third most commonly observed land use type, accounting for 17.9% of the shoreline. Other common land uses include natural areas and parklands;

- Sand beaches were the most rare shore type around the lake, accounting for less than 3% of the shoreline length. The most predominant shore types around the lake are Gravel and Rocky shores, which account for about 30% and 39% respectively. Wetlands and stream confluences were found along 16% and 5% of the shoreline respectively; and,

- Aquatic vegetation occurs along 25% of the shoreline length and is an important habitat feature for juvenile salmonids. Of this, emergent vegetation was the most commonly observed (e.g., emergent grasses, willows, or other areas with vegetation inundated during high water). Native beds of submergent vegetation were only documented along about 1% of the shoreline, and areas of floating vegetation were only observed along 2%.

The following summarizes habitat modifications observed:

- Docks were the most common modification observed, with a total of 108 structures recorded.
- Retaining walls were the next most common modification, with a total of 105 separate structures stretching over an estimated 4.6 km of the shoreline. In many cases, retaining walls extended beyond the high water level of the lake, and construction practices were not compliant with Best Management Practices.
- Groynes were not commonly observed, with only 2 structures recorded.
- There were a total of 10 boat launches and 5 marinas on this small lake.
- Substrate modification was observed on 36% of the shore length and was most commonly associated with retaining walls, transportation land uses, and historic mining activities.

The findings of the FIM indicate that the foreshore areas of Moyie Lake have been impacted by our current land use practices. The surveys indicate that in developed areas, impacts are greatest. It was readily apparent that where intense development was present most habitat features had been impacted. Despite these impacts, many areas around the shoreline remain in a relatively natural condition. The lake supports diverse wetland communities and has several important wildlife and fisheries habitats around stream confluences. Many of these wetland and stream confluence communities retain a natural characteristic (i.e., not heavily developed) and are at risk of impairment if not carefully considered during shoreline development activities.

The Aquatic Habitat Index (AHI) for Moyie Lake provides valuable information regarding the estimated habitat values of different shoreline areas. The following summarizes the results of the AHI analysis:

- The AHI found that approximately 15% of the shoreline is ranked as Very Low or Low habitat value. These areas are mostly found along highly developed shorelines that show little resemblance to the natural shore types they would have been;

- The AHI found that approximately 22% of the shoreline is ranked Very High and 31% is ranked as High. Many of these areas occurred in known shoreline spawning areas, stream confluences, wetlands, and other important habitat areas around the lake;

- Approximately 30% of the shoreline was of Moderate relative habitat value;

- Some shoreline areas have been documented to contain important burbot spawning habitats adjacent to them. Future detailed surveys may document other important shoreline features that should be considered;

- The AHI highlights the importance of the connection between our diverse stream side, wetland, and lakeshore habitats. Stream confluences and their adjacent features (e.g., shore marshes, large woody debris, and diverse riparian vegetation communities) are areas that tend to contain the highest fish and wildlife diversity, are extremely important for maintaining viable populations, and most importantly are water quality buffers that are required to preserve source drinking waters;

- The AHI also includes a restoration analysis. This analysis indicates that there are opportunities to repair impacted habitats. Habitat restoration opportunities include removal of groynes, the use of bioengineering in shoreline protection measures, and riparian revegetation. These habitat benefits will work to restore impacted habitats and reverse the current trends of habitat degradation. Habitat restoration opportunities should be pursued as part of any development or redevelopment applications. It may be useful to identify the potential for restoration opportunities in the standard terms of reference

Shoreline Management Guidelines have been prepared to facilitate informed land use planning decisions across multiple agencies, with the intention of streamlining the permitting and regulatory processes at these different agencies. Agencies participating in this project include the Regional District East Kootenay, Fisheries and Oceans Canada, and the Ministry of Environment. Vulnerability Zones for the shoreline areas of Moyie Lake have been prepared based upon the Habitat Index Results. The identification of these Vulnerability Zones allows a risk-based approach to shoreline management based upon habitat sensitivity. Based on this there is a higher risk of ecological degradation from developments proposed in shoreline areas with High and Very High habitat index scores. The Vulnerability Zones have been colour-coded for easy reference purposes and range from Red (Very High Habitat Value) to Grey (Very Low and Low Habitat Value). An activity risk matrix, which contains many of the most common applications received by the different agencies, has been developed. The matrix provides a summary of the risk of different activities within each Vulnerability Zone. A stepwise process has been developed, which is intended to guide proponents through the permitting process.

REPORT DISCLAIMER

The results contained in this report are based upon data collected during a brief one year inventory. Biological systems respond differently both in space and time. For this reason, the assumptions contained within the text are based upon field results, previously published material on the subject, and airphoto interpretation. The material in this report attempts to account for some of the variability between years and in space by using safe assumptions and a conservative approach. 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 shoreline areas and shore wetlands to understand, evaluate, classify, and reach their own conclusions. Data in this assessment was not analyzed statistically and no inferences about statistical significance are made if the word significant is used. Use of or reliance upon biological conclusions made in this report is the responsibility of the party using the information. Neither Ecoscape Environmental Consultants Ltd., nor the authors of this report, are liable for accidental mistakes, omissions, or errors made in preparation of this report because best attempts were made to verify the accuracy and completeness of data collected and presented.

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APPENDIX

1.0 INTRODUCTION

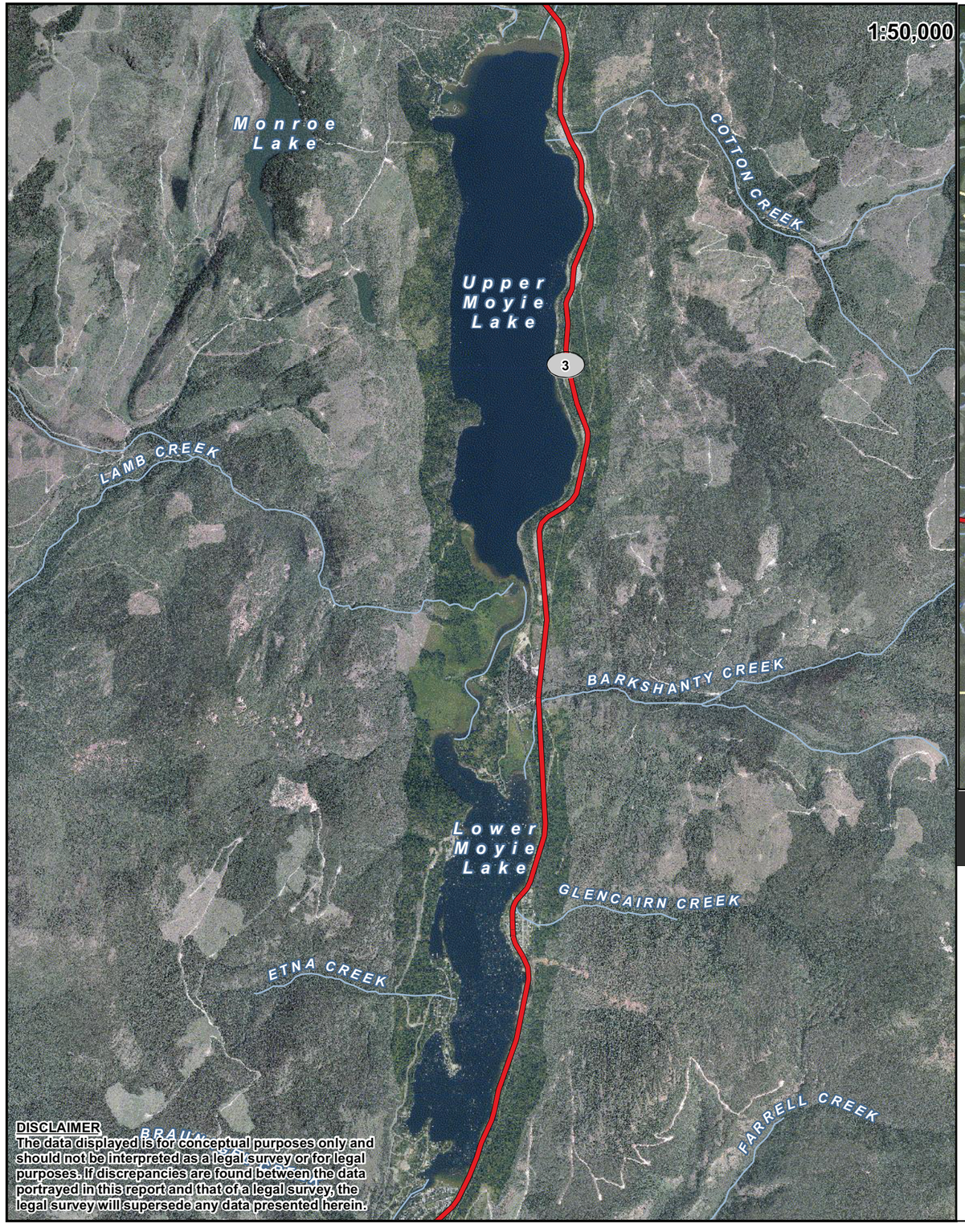
The Kootenay Region of British Columbia is regarded as a destination area offering scenic beauty and year-round recreational opportunities. This reputation has resulted in increased development pressure on the various lake shorelines in the region. This increase in development pressure has subsequently resulted in the need for development of land use policies such as Official Community Plans (OCP), Zoning Bylaws, and other landuse planning tools. It is widely acknowledged that development pressure has the potential to or has already impacted fish, wildlife, and/or water quality in many of the lakes. As a result of this, key stakeholders including Fisheries and Oceans Canada (DFO), BC Ministry of Environment (MOE), and the Regional District East Kootenay (RDEK) have gathered and presented data to ensure that land use decision making processes are consistent between the different levels of government and based on sufficient inventory to monitor and track objectives and goals using spatially relevant data (i.e., GIS).

It is a complex relationship between development pressure, the natural environment, and social, economic and cultural values. To balance these various community values, a solid understanding of aquatic and riparian resource values, land use interests, concerns of local residents and the long-term planning objectives is required. Thus, by collecting detailed, spatially accurate information of existing shoreline habitats and their condition, more informed land use planning decisions can be made that better balance the different pressures that exist. Foreshore Inventory and Mapping (FIM) is a standard shoreline mapping methodology that was employed to map the shoreline of Moyie Lake. This methodology has been standardized for mapping the shorelines of lakes in the province and provides the basis for integration of environmental information into land use policy documents.

2.0 PROJECT OVERVIEW

Moyie Lake covers about 891 hectares and supports important fish and wildlife habitats along the shoreline (Figure 1). The lake is a source of drinking waters, has important fisheries, and other associated environmental features that could be impacted by development. The intent of this project was to inventory the shoreline of the lake to understand the current condition of the shoreline. Without important inventory information such as this, it will not be possible to monitor whether management objectives for the lake have been met over time.

The mapping protocol will allow stakeholders to understand what the current condition of the shoreline is, to set objectives for better shore management in Official Community Plans or other policy documents, and measure and monitor changes in the shoreline overtime. Data collected during this assessment will be incorporated into a variety of planning policies at multiple levels of government to provide consistency in shoreline management policies between agencies. The methodology employed for this assessment is discussed in detail below and is an accepted standard that is being used to map shorelines around the province.



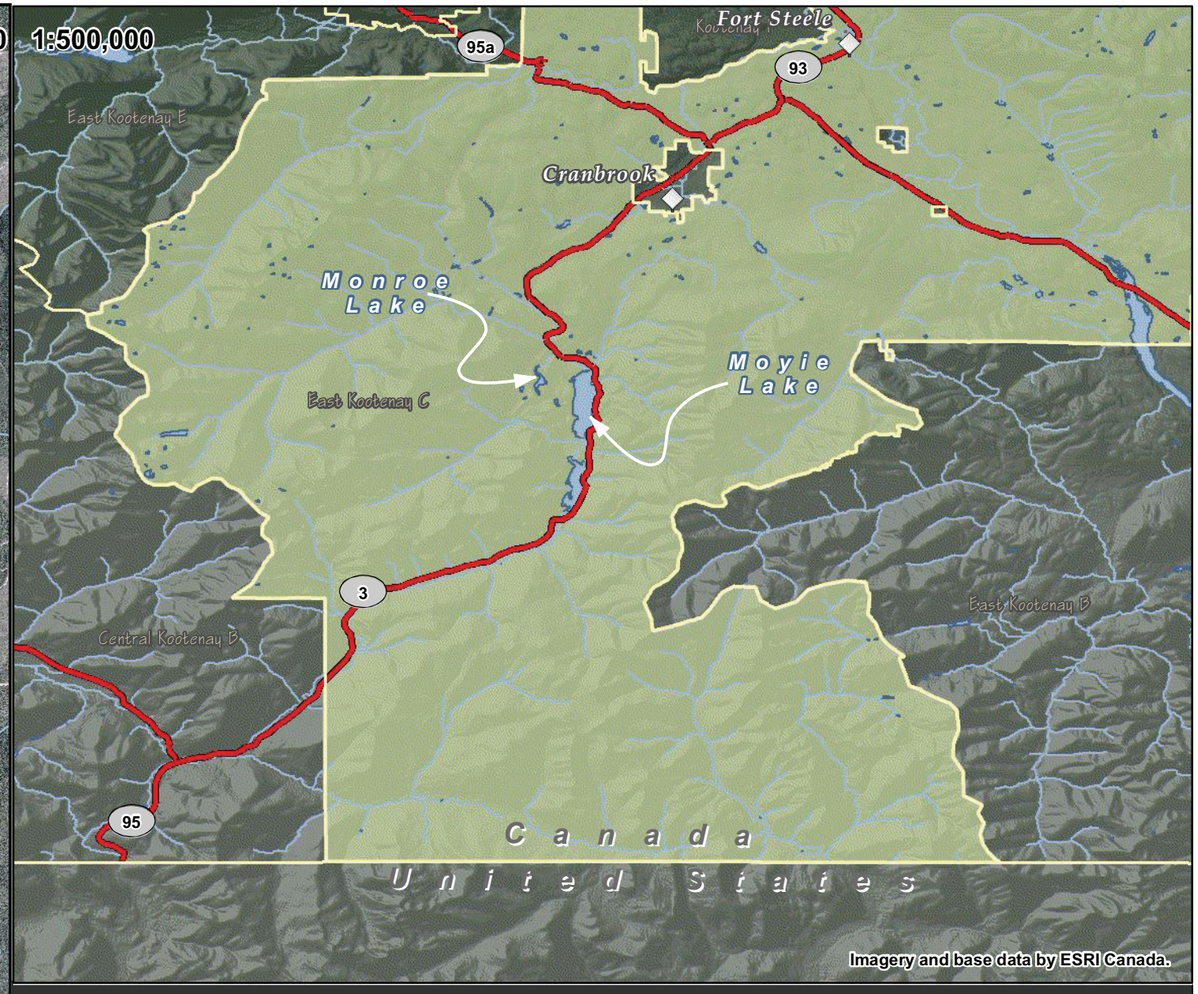


FIGURE 1

Location of Moyie Lake and Monroe Lake

Project:	Foreshore and Inventory Mapping
Location:	RDEK/MOE/DFO
Project No.:	09-371
Prepared for:	Regional District East Kootenay
Prepared by:	Ecoscape Environmental Consultants Ltd.
Drawn by:	Robert Wagner
Checked by:	Jason Schleppe
Projection:	NAD83-UTM Zone 11
Date:	November, 2009

N W E S

ECOSCAPE Environmental Consultants Ltd.

LEGEND

- City
- Municipal Boundary
- Regional District East Kelowna (Area 'C')
- Major Highway
- Streams and Rivers
- Lake

2.1 Project Partners

Numerous different parties have contributed to the success of this project. Foreshore Inventory and Mapping (FIM) protocols have been developed over the last five (5) years and have become a standardized approach to shoreline inventory. Numerous local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol. These contributing partners are recognized in Appendix A (Detailed methods).

This project was funded either directly or in kind by the following different agencies:

1. Fisheries and Oceans Canada (DFO)
2. Regional District of East Kootenay (RDEK)
3. East Kootenay Integrated Lake Management Partnership
4. Ministry of Environment
5. Wildsight

In support of this initiative, Ecoscape Environmental Consultants Ltd. (Ecoscape) also provided in-kind time, to the completion of this document. This contribution was made as part of our ongoing commitment to better shoreline management in the province.

2.2 Objectives

The project objectives were as follows:

1. Compile existing map base resource information for the Moyie Lake watershed;
2. Foster collaboration between the RDEK, DFO and the Province and utilize available expertise when possible;
3. Provide an overview of foreshore habitat condition on the lake;
4. Inventory foreshore morphology, land use, riparian condition and anthropogenic alterations;
5. Obtain spatially accurate digital video of the shoreline of the lake;
6. Provide access to the video and GIS geo-database through the RDEK and other sources;

7. Collect information that will aid in prioritizing critical areas for conservation and or protection and lake shore development;

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

9. Integrate information with upland development planning, to ensure protection of sensitive foreshore areas so that lake management planning is watershed based.

3.0 FORESHORE INVENTORY & MAPPING METHODOLOGY

The Foreshore Inventory and Field Mapping detailed methodology (FIM) 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 by the Community Mapping Network is an integral part of ecologically sensitive community planning. The following sections summarize specific information for the Moyie Lake FIM.

3.1 Field Surveys

FIM field surveys were conducted June 3, 4 and 5, 2008 on Moyie Lake. Fisheries and wildlife surveys around Moyie Lake were conducted on July 21, 23, and 24, 2008. A fall sampling program for fish and wildlife was also conducted on September 25 and 26, 2008. Pre field reviews were completed daily and mapping was conducted in an organized fashion. Field assessments were completed by the British Columbia Conservation Corps., MOE, DFO, and Wildsight staff. Field surveyors were each assigned data to collect during the surveys. Field data collection was completed using a Trimble GPS unit with SHIM Lake v. 2.4 (FIM Data dictionary name).

3.2 Methodology

All of the methods outlined in Appendix A for FIM projects were carried out for this assessment. Daily information collected was downloaded to a laptop as a backup. Once downloaded, the entire database was reviewed for accuracy and corrections were made as necessary. Ecoscape has reviewed the database provided and worked with data collectors to ensure accuracy of the database. 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.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for the entire shoreline and littoral zone. For the purposes of this assessment, aquatic vegetation included all plant forms and communities occurring below the lake highwater level. Although some of the plants are not truly aquatic, all are hydrophitic and contribute to fish habitat. Vegetation mapping was completed using air photos, shoreline videos, and site photographs. Aquatic Vegetation polygons are similar to Zones of Sensitivity identified by the Okanagan and Windermere projects. 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 watertable is typical in marshes, with early-season high watertables dropping through 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 emergents. 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 ecosystems occur on sites that are flooded for moderate periods (< 40 days) of the growing season, conditions that limit the canopy to tall shrubs, especially willows and alders. Annual erosion and deposition of sediment generally limit understorey and humus development.

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

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

1. Emergent Vegetation (EV) generally refers to grasses, *Equisetum* spp. (i.e., horsetails), sedges, or other plants tolerant of flooding. Coverage within polygons need to be consistent and well established to be classified as EV. These were generally not dominated by true aquatic macrophytes and tended to occur in steeper sloping areas that are intermittently flooded or are groundwater receiving sites.

2. Sparse Emergent Vegetation (SEV) refers to the same vegetation types as emergent vegetation, but in these areas coverage were generally not very dense or were very patchy.

3. Overhanging Vegetation (OV) was mapped where observed. Overhanging vegetation also occurred with Emergent Vegetation (EVOV) and with Sparse Emergent Vegetation (SVOV).

4. Submerged Vegetation (SUB) areas generally consisted of native pondweed (*Potamogeton*) species. These areas were uncommon and only occurred in a few shallow bay areas.

5. Floating Vegetation (FLO) areas generally consisted of species such as *native Potamogeton,* pond lilies, and other types of vegetation that floats.

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:

- Data and photos were backed up to a computer/laptop on a daily basis;
- Photos were taken and photo logs were used to facilitate data review and interpretation;
- Air photo interpretation was completed using high resolution air photos that were flown during the summer of 2008.
- During data analysis, numerous checks were completed to ensure that all data was analyzed and accounted for.
- The TRIM shoreline file was provided by the MoE. Ecoscape subsequently mapped the shoreline using air photo interpretation, attempting to map the shoreline within ±5 m horizontal accuracy. This shoreline is sufficiently accurate for planning purposes required within this document and is believed to be within 5 m of the mean annual high water level for at least 80% of the lake. Thus, caution should be taken when using this line to interpret the mean annual high water level of the lake using this GIS shoreline feature.

The following data fields were added to the FIM data dictionary

1. An Electoral Area field was added to identify the jurisdiction (e.g. Regional District) in which respective shoreline segments occur.

2. A Community Field was added to the database to allow future data analysis by community if desired.

3. The following fisheries fields were added.

a. Burbot spawning zones have been identified for Moyie Lake. There is currently a wealth of information regarding the fishery and this data has been incorporated into the FIM dataset (Prince, 2007; Neufeld, 2008; Prince and Cope, 2008). Burbot spawning areas along the shoreline have been identified and shore segments where they occur have been flagged. These fisheries fields are considered similar to the Zones of Sensitivity that were developed for the Okanagan and Windermere projects.
b. Juvenile Rearing areas were considered to be any wide littoral zones that juvenile fish would utilize to forage. Most of these areas occur in and around stream mouth areas or wetlands.
c. Staging / Migration – Juvenile and adult fish migration routes are important components of fish life cycles. Migration and staging areas generally occur in deeper water zones in close proximity to spawning streams.

4.0 AQUATIC HABITAT INDEX METHODOLOGY

An Aquatic Habitat Index (AHI) is a tool that is used to help assess the habitat value or environmental sensitivity of a shoreline. An index is a numerical or categorical scale used to compare variables with one another. Use of an index to assess shoreline sensitivity has been utilized on Okanagan Lake (Schleppe and Arsenault, 2006) and Windermere Lake (McPherson S, and D. Hlushak, 2008). Indices are also currently in preparation for Slocan, Shuswap, and others. The purpose of the AHI is to facilitate land use planning by identifying the relative sensitivity of a shoreline.

The AHI utilizes a number of different parameters collected during the FIM. The index uses a points based mathematical model to assign the relative habitat value to each parameter. Features that have impaired the habitat value (e.g., retaining walls) are assigned negative scores to better reflect the current condition of the shoreline. The intent of this analysis was to compare the shoreline to its natural state.

A subsequent analysis was conducted to determine the habitat potential of a segment. This analysis involved removing ALL negative habitat parameters to determine if shoreline restoration could achieve a measurable benefit. This Habitat Potential index can be used to help assess where restorative efforts should be directed. It should be noted that this habitat restoration analysis has not considered the habitat benefits of riparian restoration. Riparian restoration should occur whenever possible along shoreline areas and benefits of riparian restoration can be assessed in the future.

4.1 Parameters

The parameters of the index each reflect a certain type of habitat found along the shoreline. The parameters were broken down into four categories as follows:

1. Biophysical;
2. Fisheries;
3. Riparian; and,
4. Modifications.

The following table (Table 1) identifies the parameters and logic used in the Moyie Lake index.

Table 1. The parameters and logic for the Aquatic Habitat Index of Moyie Lake.

Category	Criteria	Maximum Point	Percent of the Category	Percent of the Total	Logic	Value Categories
Biophysical	Shore Type	20	33.9	18.9	(% of Segment) x (Shore Type Value)	Stream Mouth = Wetland (20) > Gravel Beach = Rocky Shore (15) > Sand Beach = Cliff /Bluff (10), Other (5)
	Substrate	10	16.9	9.5	(% Substrate) x (Substrate Value)	Cobble (10) > Gravel (8) > Boulder = Organic = Mud = Marl (6), Fines = Sands (4) > Bedrock (2)
	Percentage Natural	15	25.4	14.2	(% Natural) x (Natural Score)	
	Aquatic Vegetation	8	13.6	7.6	(% Aquatic Vegetation) x (Aquatic Vegetation Score)	
	Overhanging Vegetation	6	10.2	5.7	(% Overhanging Vegetation) x (Overhanging Vegetation Score)	
Fish	Burbot Confirmed Spawning	8	44.4	7.6	Present (8), Absent (0)	Present (8), Absent (0)
	Staging Area	5	27.8	4.7	Present (5), Absent (0)	Present (5), Absent (0)
	Rearing Area	5	27.8	4.7	Present (5), Absent (0)	Present (5), Absent (0)
Riparian	Band 1 (Riparian)	10	62.5	9.5	(Vegetation Bandwidth Category) x (Vegetation Quality x Vegetation Score)	**Vegetation Bandwidth Category** 0 to 5 m (0.2) < 5 to 10 m (0.4) < 10 to 15 m (0.6) < 15 to 20 m (0.8) < 20 m (1)
	Band 2 (Upland)	6	37.5	5.7	(Vegetation Bandwidth Category) x (Vegetation Quality) x (Vegetation score)	**Vegetation Quality Category** Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)
Modifications	Retaining Wall	-3.5	27.9	-3.3	(% Retaining Wall) x (-5)	(% Retaining Wall) x (-5)
	Docks	-4	30.3	-3.6	(# Docks) x (-0.1)	(# Docks) x (-0.1)
	Groynes	-0.25	2.0	-0.2	(# Groynes) x (-0.25 per groyne)	(# Groynes) x (-0.25 per groyne)
	Boat Launch	-3	23.9	-2.8	(# Launches) x (-1 per launch)	(# Launches) x (-1 per launch)
	Marina	-2	15.9	-1.9	(# Marina) x (-1 per marina)	(# Marina) x (-1 per marina)

The parameters selected for the index were similar to the other indices developed. A description of each is found below.

4.1.1 Biophysical Parameters Description

The following summarizes the biophysical parameters of the index:

1. Shoreline type – A shoreline type is related to many aspects of productivity. Previous habitat indices (e.g., Schleppe and Arsenault, 2006) have used a fish habitat specificity table to determine the value of a shoreline. A similar approach was used for Windermere Lake (McPherson and Hlushak, 2008). However, in these previous versions, wetlands were difficult to account for because these segments tended not to be valuable utilizing a fish habitat specificity approach. Difficulties arose mostly because wetlands tend to mostly affect aquatic habitats (e.g., water quality or nutrient input) or have high wildlife value (which is not apparent in a fish habitat specificity approach). Other aspects of the habitat specificity were fine. The general habitat specificity for Moyie Lake follows that of Windermere and Okanagan (i.e., values follow similar patterns for each different shoreline type), except that Wetlands were considered as valuable as Stream Mouths premised on biodiversity and productivity values as well as water quality benefits. Thus, for most shore types, the habitat specificities generated for other lakes with similar fish habitats in the province were used in this assessment.

2. Substrate – Substrates also relate directly to productivity. There are generally two types of productive substrates, those utilized for spawning, and those that produce more biomass. The substrate values and parameters used for Moyie Lake are similar to the Okanagan and Windermere Lakes. More information regarding the rational of this parameter, please refer to the indices developed for the Okanagan (Schleppe and Arsenault, 2006) and Windermere (McPherson S. and D. Hlushak. 2008) Lakes.

3. Percent Natural – This parameter is similar to the Okanagan and Windermere. However, the relative percentage of the parameter was modified accordingly during calibration of the index.

4. Aquatic Vegetation – In more recent versions of the FIM database, more detailed information regarding aquatic vegetation was collected. In the Moyie Lake system, all vegetation below the HWL is considered productive. Since the FIM now allows analysis of this parameter, it was added to the index. The benefits of aquatic vegetation are many and include substrate for food and growth, biomass production, and structural cover.

5. Overhanging Vegetation – In the more recent versions of the FIM database, more detailed information regarding overhanging vegetation was collected. In the Moyie Lake system, overhanging vegetation was not present in all areas. Since it provides nutrients (i.e., litter fall) and opportunities to forage (e.g., insect drop), it was added to the index.

4.1.2 Fisheries Parameters Description

The fisheries parameters used for the AHI were those described above in Section 3.2.2 – GIS and Data Management. The different parameters are considered important for fish production in the Moyie system and were prioritized in the AHI accordingly. These are similar to areas identified as Zones of Sensitivity in the Okanagan and Windermere projects. The following were the fisheries parameters added:

1. Burbot Spawning (Burb_Spawn) areas were provided by the Ministry of Environment and are based upon fish population surveys conducted during 2006 and 2007 (see Price, 2000; Price and Cope, 2008; Neufeld, 2000). This information was digitized and included into the FIM dataset. Shoreline spawning areas were given a high weighting in the index because they relate directly to the productive capacity of a given area within a lake. Further, these zones are often habitat limiting factors that fish have a high specificity for.

2. Juvenile rearing areas were identified and included in the index. These areas are extremely important for fish habitat and were given a moderate weighting in the AHI.

3. Staging areas are also important areas for migrating fish. Staging areas were digitized based upon liaison with DFO field staff through the course of field work and the assessment. Field staff indicated to Ecoscape where fish were known to stage or hold prior to migrations. This parameter was considered because staging fish can be impacted by adjacent land uses such as marinas.

4.1.3 Riparian Parameters Description

The riparian parameters added to the index were similar to those added in the Okanagan and on Windermere projects. However, the newer versions of the FIM provided a distinction between the lakeside vegetation (Band 1/Riparian) and the areas behind (Band 2/Upland). To address this new data available, the index was modified slightly. The index was modified to include a factor assessing vegetation quality (i.e., tall shrubs thickets or wetland areas have a higher quality than landscaped yards). As with the other indices, vegetation bandwidths were categorized and a relative value was assigned. The Band 1 vegetation, directly adjacent to the lake was weighted higher than the Band 2 vegetation, as this vegetation contributes more to productivity within the lake.

4.1.4 Habitat Modifications Parameters Description

Habitat modification descriptions prepared by Schleppe and Arsenault (2006) provided a good description of the rationale for inclusion of these different parameters. Other habitat modifications parameters, such as Percent Substrate Modification or Percent Roadway were not included in the analysis because they may compound (i.e., groynes typically constructed from shoreline substrate modification, therefore gets counted twice). The following is quoted directly (shown in italics) from Schleppe and Arsenault (2006)

completed by EBA Engineering Consultants Ltd. Further information on these parameters can also be found in the Windermere Lake assessment (McPherson and Hlushak, 2008).

Retaining Walls

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

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

Docks

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

Docks have also been documented to increase fish density due to fish's general congregation around structure, but decrease fish diversity in these same areas (Lange 1999). Coupled with this result, Lange also found that fish diversity and density were negatively correlated with increased density and diversity of shoreline development, meaning that increases in dock density may reduce fish abundance and diversity. Chinook salmon have been documented to avoid areas with increased overwater structures (e.g., docks) and riprap shorelines, and therefore, construction of these structures may affect juvenile migrating salmonids (Piaskowski and Tabor, 2000).

Regardless of the controversy, it is apparent that docks do affect fish communities and the degree of effects are most likely related to the intensity of the development, the scale of the assessment, and fish assemblage life history requirements. Different fish assemblages may

respond differently to increased development intensity, and fish assemblages containing salmonids may be more sensitive than southern or eastern fish assemblages (e.g., bass, perch, and sunfish, etc.). It is for these reasons that dock density was included in the index, and that docks were treated as a negative parameter, with increasing dock density considered as having more negative effects than lower dock densities.

Docks also provide hiding locations for predators, such as bass and northern pike minnows. It has been shown that predatory fish, such as bass, can alter habitat use by small bodied fish (e.g., cyprinids, juvenile salmonids) (MacRae and Jackson, 2001) and that development on lakes can reduce the abundance of refuge for these juvenile fish (Bryan and Scarnecchia, 1992). The above highlights how docks have the potential to alter habitats and fish assemblages. Docks are also associated with other foreshore developments (e.g., retaining walls, groynes, etc.), and therefore cumulative effects of these structures likely further impact fish assemblages in small lakes.

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. Reducing the movement of sediment materials along the shoreline can have a variety of effects on fish habitat, including increasing the embeddedness of gravels. Published literature regarding the specific effects of groynes on fish habitat are few, but because these structures are often considered Harmful Alterations, and Disruptions of Fish Habitat (HADD) as defined under the federal Fisheries Act, they are believed to have negative effects, mostly associated with the loss of area available for fish (e.g., Murphy 2001).

Boat Launches

Boat launches were considered to be a negative parameter within the AHI. Boat launches are typically constructed of concrete that extends below the high water level. The imperviousness of this material results in a permanent loss of habitat, which ultimately reduces habitat quality and quantity for fish. Concrete does not allow growth of aquatic macrophytes, and reduces foraging and/or refuge areas for small fish and macroinvertebrates. The extent of the potential effects of boat launches relates to their size. Thus, multiple lane boat launches tend to have a large effect on fish habitat than smaller launches with fewer lanes because there is more surface area affected. The AHI treated each different boat launch lane as one unit, and therefore one launch could have multiple boat ramps. The intent of using the data in this fashion was to incorporate the size of the structure (i.e., more ramps, decrease in available habitat).

Marinas

Marinas are a concentration of boat slips, offering a place of safety to vessels. Marinas likely have a variety of effects, but there is very little literature investigating the positive or negative habitat consequences of marinas. Large marinas also tend to have breakwaters, which can further affect wave action, sediment scour and deposition, and circulation. In general, when marinas are constructed in the littoral zone there tends to be a large increase in shading, which reduces the potential for aquatic macrophyte growth and therefore reduces the productivity of a particular shoreline area. Also, marinas tend to have other activities associated with them, including extensive boat movements, which can reduce the use of an area by more timid species

(e.g., rainbow trout). Other activities in marinas include fuelling stations, boat cleaning, bilge water, and sanitary waste disposal stations. Each of these activities has the potential to alter benthic communities, possibility altering the fish assemblage (i.e., congregations of more tolerant species and displacement of less tolerant species) and potential resulting in a loss in biodiversity, which can ultimately affect fish and/or fish habitat. Marinas also tend to be associated with other high intensity land developments, which may have a variety of effects including reducing water quality through inputs of chemicals, etc., increases in water turbidity, reduction in oxygen concentration, etc.

4.2 Index Ranking Methodology

The AHI was used to analyze the habitat value of individuals segments relative to other segments on the lake. The output of the index is a five class ranking system, ranging from Very Low to Very High. Two different runs of the index were completed as follows:

1. Current Value (AHI_CUR) – This is the current index value for each shore segment based upon the total biophysical, riparian, fisheries, and modifications present.

2. Potential Value (AHI_POT) – This is the habitat index value when the anthropogenic modifiers (e.g. retaining walls) are removed from the analysis; thereby scoring each segment based on the site potential / capability. This highlights segments where restoration is possible.

4.2.1 Calibration and Calculation of the Index

The output of the AHI is a five class ranking system, ranging from very low to very high. This ranking reflects the current value of the shoreline relative to other areas of the shoreline. Because of this, some areas are considered Very Low habitat value. Although these areas are considered of lower habitat value, they still provide intrinsic habitat that can be impacted by adjacent land use so care should be taken when assessing the actual wildlife or fisheries productivity of a particular shoreline area. To calculate the Current Value of the shoreline using the habitat index, the total number of points for each of the different parameter (e.g., Shore Type, Retaining Wall, etc.) among the various categories (e.g., Fisheries, Riparian, and Biophysical) was summated (see Table 1, Section 4.1.1). This provided a score for each shore segment mapped during the FIM.

To calibrate the index, numerous iterations (in excess of 50 iterations) were run. For each iteration, the value of the different parameters was altered and the minimum, maximum, median, and distribution of scores was reviewed. This data was then viewed spatially along the shoreline for each shore segment. After reviewing the distribution of the data from the iterations, logical breaks were used to determine the category for Very High, High, Moderate, Low, and Very Low.

Ultimately, the value of habitat is a continuum, and there is room for some interpretation of this information. This index calculates the relative value of a shore segment to other shore segments within this lake, factoring in current modifications. Further review, addition, and

improvements to the index are encouraged and this database has been designed to allow inclusion and update of information. The ultimate purpose of the index is to act as a flagging tool so that important habitats are identified and considered during a land use decision process.

5.0 DATA ANALYSIS

5.1 General

General data analysis and review was completed for the FIM database. Data collected was reviewed and analysis focused on shore segment length. Analyses for this project were generally completed as follows:

1. The shoreline length for the 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.

The following sections provide specific details for the biophysical analyses.

5.2 Biophysical Characteristics and Modifications Analysis

Biophysical characteristics of the shoreline segments were analyzed. For definitions of the different categories discussed below, please refer to Appendix A (Detailed Methods) for a description / definition. The following summarizes the different analyses that were completed:

1. Percent distribution of natural and disturbed shoreline;
2. Total shoreline length that remains natural or has been disturbed for each land use identified along the shoreline;
3. Total shoreline length that remained natural or has been disturbed for each shore type that occur along the shoreline;
4. Total length of shoreline that contained aquatic vegetation, emergent vegetation, floating vegetation, or submergent vegetation;
5. 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,
6. Total shoreline length of different shoreline modifiers (roadways, substrate modification, and retaining walls) was determined

5.3 Fisheries and Wildlife Sampling

Fisheries and wildlife sampling events were conducted on July 21, 22, and 23, 2008. A fall sampling period also occurred on September 25 and 26, 2008. These sampling events were conducted to add further data to the FIM data set, facilitate calibration of the index, and add additional sighting information.

The fisheries surveys for this assessment consisted of beach seining, minnow trapping, and snorkel surveys. The surveys focused on identifying important fish habitats and data was used to better understand fish utilization within the different shore segments. Yellow perch and pumpkinseed sunfish were invasive species that were identified in Moyie Lake. Invasive fish species are a cause for concern because of potential impacts they can have on native fish species. Impacts of invasive species are well documented and can include competitive exclusion (for habitat), predation, or competition for food.

Wildlife inventories along the shoreline focused on identifying important habitat features that may not have been captured completing the boat surveys during the FIM. Inventories identified adjacent wetlands, predominant native forest cover species, shrub cover species and coverage and incidental sightings of wildlife fauna. Where possible, this qualitative information was incorporated into the FIM data.

5.4 Aquatic Habitat Index Analysis

A brief summary of the shoreline lengths, shore types, and percent of the shoreline that is ranked as Very High to Very Low is presented. The summary provides information regarding the AHI results (Very High to Very Low), shore type, percent of the shoreline and shore length. The results of the habitat index are best viewed graphically and are presented in the Moyie Lake Figure Binder 1 at the end of this document.

6.0 RESULTS

The following section provides an overview analysis of the Moyie Lake system. Data is presented graphically in the text for ease of interpretation. Data tables for the different analyses are presented in Appendix B.

6.1 Biophysical Characteristics of the Lakes

Foreshore Inventory and Mapping was completed on 37,585 m (37.6 km) of shoreline on Moyie Lake. The total length of disturbed shoreline was 18,641 m (18.6 km) and the total length of natural shoreline was 18,944 m. This level of disturbance represents nearly 50% of the total shoreline length (Figure 2).

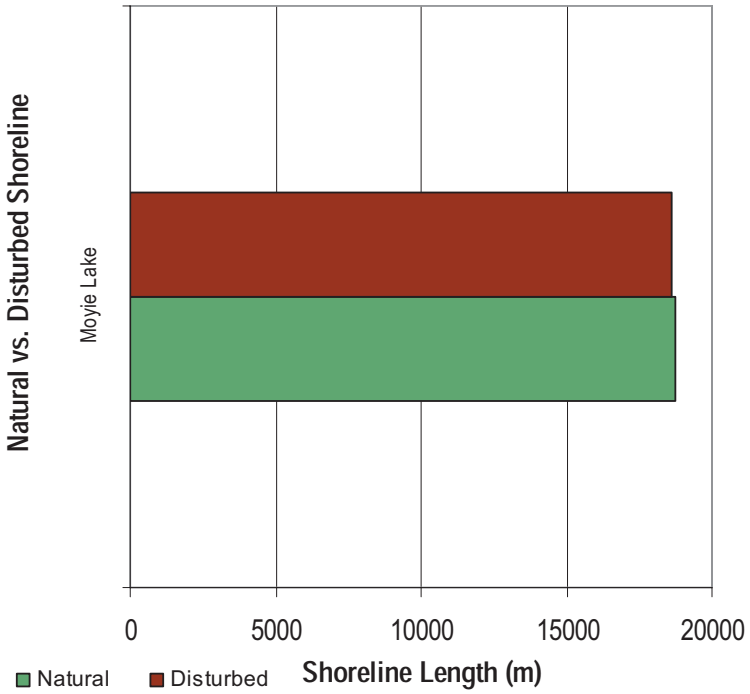


Figure 2 The total shoreline length that is either natural or disturbed on Moyie Lake.

Rural areas were the most prevalent land use along the Moyie Lake shoreline, representing approximately 30% of the shoreline or 11.4 km. Within these rural areas, the shoreline was generally 70% natural and 30% disturbed. Transportation (roads and rails) was the second most prevalent land use, occurring along 28% of the shoreline or 9.8 km. Single family residential areas represented approximately 8 km of shoreline, which accounted for about 18 % of the shoreline length. Within these residential areas, over 53% of the shoreline was disturbed.

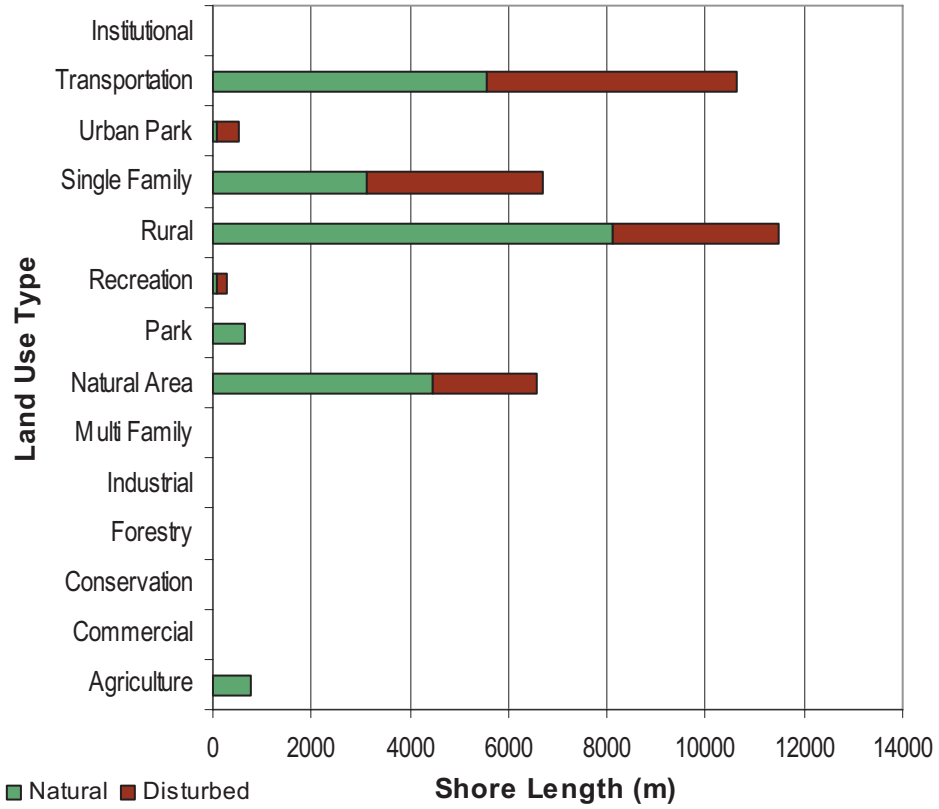


Figure 3 presents the natural and disturbed shoreline length by the different types of land us occurring around Moyie Lake.

The most predominant shore types observed were gravel beaches and rocky shores, which accounted for 30% (~11 km) and 39% (~15 km), respectively. Rocky shores and gravel beaches also tended to have a high level of disturbance, with approximately 42% and 48% of the shore length being disturbed respectively. Wetlands were the third most prominent shoreline type observed, accounting for about 16% of the shoreline, or approximately 5.8 km. Wetland shore types were also highly disturbed, with 30% of the shore length being impacted by some form of modification. Sand shore types were not very common and represented only 3% of the total shoreline length. Stream confluences accounted for 5.1% of the shore length (1.9 km), and these areas were disturbed along approximately 42% of their length.

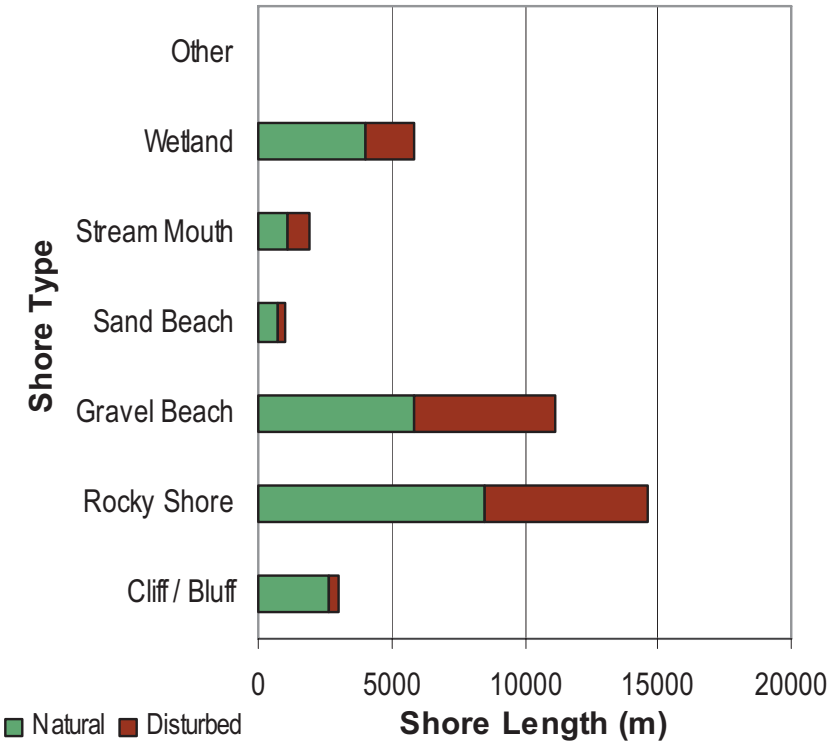


Figure 4 presents the length of natural and disturbed shoreline along each of the different shoreline types on Moyie Lake.

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 (e.g., willow species). Studies have shown that even terrestrial vegetation, during periods of inundation provides important food for juvenile salmonids and other aquatic life and this is why it has been included (Adams and Haycock, 1989). There is approximately 8.9 km of the shoreline that has aquatic vegetation, which represents approximately 24% of the total shoreline length. The total area of both dense and sparsely vegetated areas with aquatic vegetation (floating, emergent, or submergent) is 543,666 m^2. Most of the vegetation that was observed was either emergent shrubs or grass like vegetation and this emergent type of vegetation accounted for 24% of the Moyie shoreline or 8.3 km. The areas of native submergent and floating vegetation were rare on Moyie Lake, only accounting for close to 4% or 1.2 km.

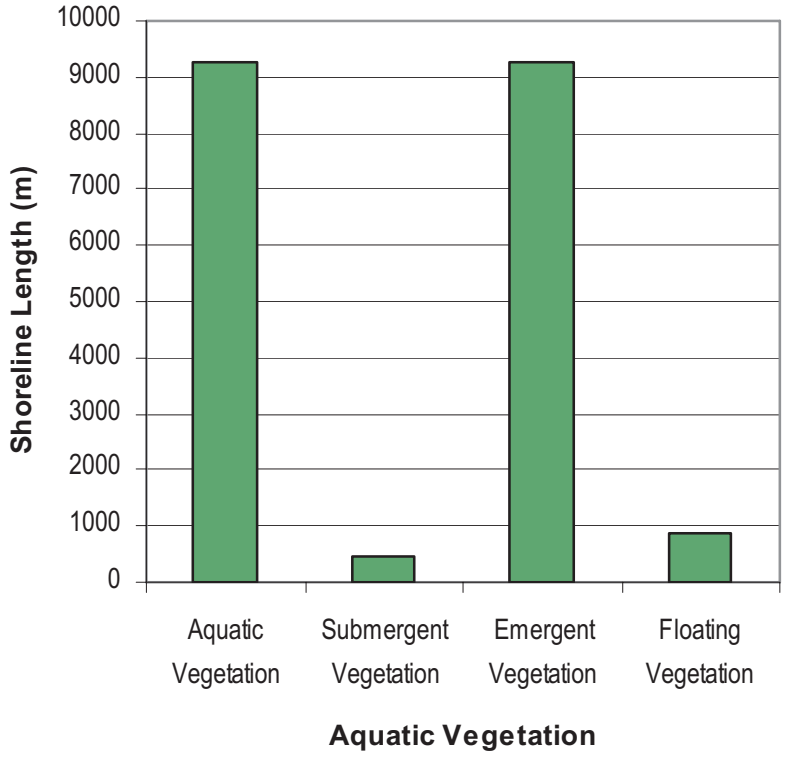


Figure 5 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Moyie Lake.

Docks were the most commonly observed type of shoreline modification. There were a total of 106 docks on Moyie Lake. Retaining walls were the second most common modification observed, with 84 retaining walls being observed. Groynes were infrequent occurrences on the lake, with only 2 being observed. There are a total of 5 marinas with greater than 6 boat slips and 10 boat launches. There was a total of 3 marine rails observed on Moyie Lake. The above summarizes the current structures that occur on, over, and around Moyie Lake.

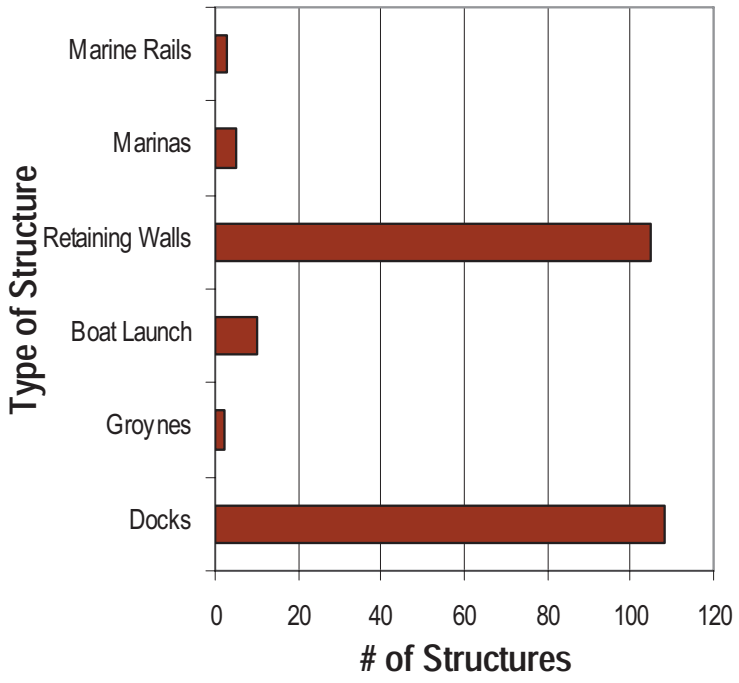


Figure 6 presents the total number of different shoreline modifications that occur around Moyie Lake.

The percentage of the shoreline that was impacted by transportation (roads, railways), retaining walls, and substrate modification was recorded to allow an estimation of the approximate shoreline length that has been affected by these different mechanisms (Figure 7). By far, substrate modification was the most substantial impact that was observed along the shoreline. In total, it is estimated that 36% or 13.2 km of shoreline has experienced some form of substrate modification. Substrate modification was variable and was most commonly associated with road or railways (i.e., structural fill material) or beach grooming activities. However, there are also mine tailings that occur in some locations around the lake. Retaining walls were the next most substantial impact to the shoreline and it is estimated that 13% or 4.6 km has been impacted by retaining walls. Retaining walls were observed both above and below the high water level (i.e., some walls had a visible water line indicating that they have encroached below the high water level). Finally, transportation related impacts (i.e., roadways and railways) accounted for 11% or 4 km and 12% or 4.3 km of the shoreline.

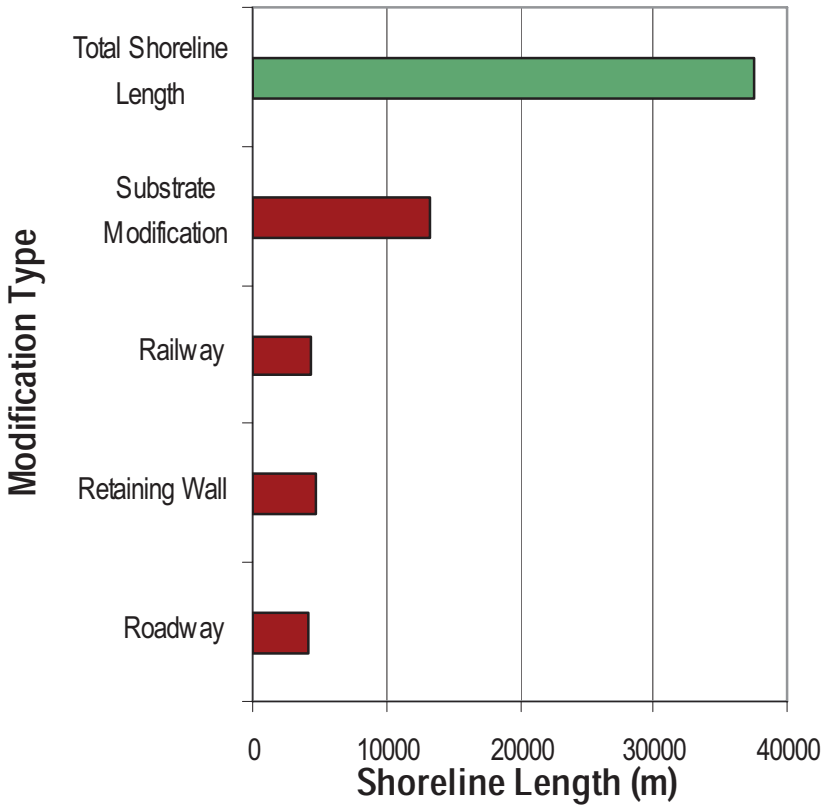


Figure 7 presents the total shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Moyie Lake.

The foreshore modifications by the different mechanisms described above have resulted in a high level of impact around approximately 47% or 17.8 km of the shoreline. Areas of moderate and low impact account for about 8% (2.0 km) and 44% (15.8 km) of the shoreline respectively.

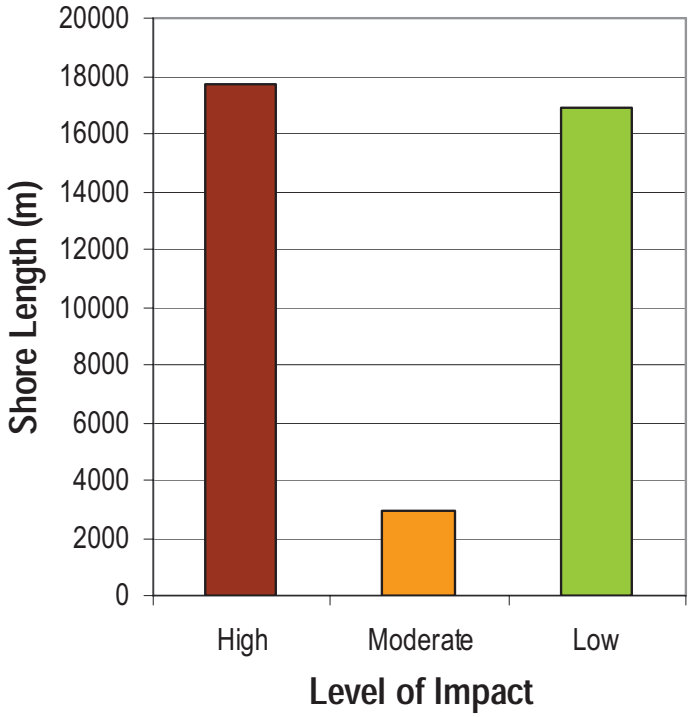


Figure 8 presents the level of impact (High, Moderate, Low, or None) observed along Moyie Lake.

6.2 Summary of Foreshore Modifications

The foreshore of Moyie Lake has experienced varying degrees of impacts. In general, steeper sloped areas (i.e., cliff bluff shorelines) tended to be more natural whereas lower gradient shorelines tended to have a higher level of impact. The following section is intended to summarize foreshore modifications that were observed during the field surveys in point form:

- Substrate modification and construction of retaining walls was the most significant impact observed adjacent or below the high water level of the shoreline. The construction of these features has likely resulted in the loss of aquatic vegetation (actual loss has not been determined), and a loss in productivity due to substrate modification. This impact is similar to other interior lakes that have been surveyed including Windermere, Okanagan, and Shuswap.

- In many areas it is apparent that emergent shrubby vegetation below the high water level (e.g., willows and cottonwoods), grasses and sedges, and other types of aquatic vegetation has been impacted. It is believed that most of this vegetation removal is the result of beach creation (i.e., beach grooming), substrate modification, or from road and railway fills. The losses of soil material that aquatic vegetation grows in will likely take years or decades to naturally regenerate, it at all. The continued losses of this vegetation will further impact juvenile salmonids during high water in the spring when they are known to feed upon organisms within the vegetation (Adams and Haycock, 1989).

- Riparian vegetation disturbance has changed the vegetation type from natural broadleaf or coniferous associations to landscaped, lawn, or un-vegetated associations. The significant losses of riparian vegetation have not been quantified as part of this assessment, but are considered significant. There are significant opportunities for riparian habitat enhancements along the shoreline of the lakes.

- Private boat launches have been constructed on Moyie Lake, resulting in a permanent loss of fish habitat in gravels that have been covered by concrete or significantly compacted / disturbed by boats and trailers. These boat launches were almost all associated with vehicular access, which has impacted riparian vegetation. It is conservatively estimated that these boat launches have resulted in the loss of at least 180 m^2 of lost foreshore habitat (i.e., below high water level) and 300 m^2 of riparian habitat (assuming the average boat launch is 3 m wide and 6 m long and has vehicular access through a 10 m wide riparian zone). It is likely that most of these boat launches were constructed without a provincial *Water Act* or federal *Fisheries Act* approval.

- Retaining walls were documented in nearly all developed areas. Retaining walls were constructed out of varying materials. In some instances, substrates from the lakebed were used to construct the walls. It is probable that some of the retaining walls constructed around the lake were not required to protect the shore from erosion and have been constructed purely for aesthetic purposes (i.e., landscaping). Thus, construction of some of these walls could have been avoided. In many cases, shoreline protection could have been achieved by utilizing bioengineering approaches to help mitigate impacts of the walls. Retaining walls constructed at or adjacent to the high water level should generally only occur to help reduce losses of land from shoreline erosion.

- Roadway and railway impacts were prevalent along many areas. In these areas, there was little evidence of bioengineering to soften constructed edges along the shoreline. However, in cases where the roadway was offset from the high water level, riparian conditions between the roadway/railway and the lakes tended to be better than those riparian areas observed in single family residential areas.

- Docks were the most prevalent of shoreline modifications. These overwater structures varied in size and were built using a variety of materials. Based on field

inventory many of these structures may not be compliant with current Standard Best Practices.

6.3 Wildlife and Fisheries Summary

Moyie Lake has been documented to contain several different fish species including kokanee, rainbow trout, burbot, largescale suckers, longnose dace, mountain whitefish, westslope cutthroat trout, and bull trout (Dolly Varden[1]) (www.fishwizard.com). Native species that were documented during field surveys for this assessment included mountain whitefish, kokanee, redside shiners, largescale suckers, and lake chub (Appendix F). Non native species identified during this survey included the pumpkinseed sunfish. Yellow perch, although not sampled are also likely present (pers. comm., Bruce MacDonald, DFO). Similar to other studies like this, cyprinid species (minnows including redside shiners and lake chub) were the most common, representing nearly 82% of the relative abundance of species sampled. Cyprinids were documented in all shore segments / types surveyed, highlighting the general adaptive and tolerant nature of these species. Largescale suckers were also quite commonly observed, representing 8% of the relative abundance of fish species sampled. Like other interior lakes, it is not uncommon for the fish communities to be dominated by coarse fish such as minnows and suckers. Pumpkinseed sunfish were the most predominant non native fish observed, having a relative abundance of 9%. Salmonid species (rainbow trout, kokanee, and mountain whitefish) were not commonly observed, and only represented 1% of the fish species sampled during the brief survey.

The small sample sizes collected during these surveys do not provide sufficient data to accurately identify shoreline usage along the different shore segments or types by either fish or wildlife (i.e., it is not possible to determine significant differences in shoreline usage by different species). However, previous works in Windermere and Okanagan Lake, which had larger sampling efforts in lakes with similar fish assemblages, provide supporting evidence which can be used to make general conclusions. General conclusions can also be reached using published literature accounts. In general, sensitive fisheries areas include the narrows region between the north and south basins of Moyie Lake, all stream confluences and wetlands, and rocky or gravel shoreline areas that provide important spawning grounds (i.e., identified burbot spawning grounds). There are few productive littoral regions in Moyie Lake and therefore, any large littoral zone, stream confluence, island, or wetland area is important as a rearing zone for juvenile fish. Finally, fisheries sensitive zones also occur in deeper regions adjacent to stream mouths, where rainbow trout, kokanee, and bull trout likely stage prior to spawning migrations. Spatially, these different areas have been identified and the locations are identified in the Moyie Figure Binder.

[1] Dolly Varden and bull trout are very similar species and the species are often mistaken for each other (McPhail, 2007). Both species have been listed here, although it is unknown whether Moyie Lake contains one, both, or a hybrid species.

A variety of wildlife species were noted during the field assessment, including many different songbirds, waterfowl, birds of prey, reptiles, and mammals. A summary of the different wildlife species known to occur along the different shoreline segments can be found in Appendix F. Conclusions for wildlife can be made using a habitat suitability approach, which is typically preferable in cases where surveys are limited. Wildlife surveys generally indicated that wetland areas, such as the narrows region of the lake, had the greatest wildlife species diversity, whereas highly developed areas had very low diversity ratings. Well established riparian areas, such as low flood benches associated with stream confluences were also important habitat areas for different wildlife.

Key wildlife habitat features are present in many areas around the lake, and include important wetlands and shore marshes, riparian habitats, wildlife trees, and wildlife corridors. Baseline information collected during this survey provides an overview of some of the wildlife features present around the lake. However, detailed inventories should be completed for any significant changes in land (e.g., re-zoning or subdivision applications) to ensure that important wildlife habitat attributes are recorded, mapped, and protected during the development process.

6.4 Aquatic Habitat Index Results

The attached Figure Binders (Figure Binder 1) presents the spatial results of the assessment. The figure binder has been prepared to show a summary of all the information contained within this report. Appendix C provides the results of the AHI in tabular format.

Most of the Moyie Lake shoreline currently is high value habitat (33%), followed closely by Moderate Value Habitat (28%) (Table 2). Very High Value habitat accounts for (22%) and this is mostly attributed to important stream confluences and wetland areas in the narrows region of the lake. Low and Very Low habitats account for 18% of the shoreline length. The above analysis highlights the importance of shoreline areas adjacent to Moyie Lake including important wetland communities, in conjunction with many natural coniferous forest areas and spawning habitats for burbot.

The Potential Value summary presents what that habitat value would be if some of the modifications were removed from shoreline areas around Moyie Lake (Table 2). This analysis follows other lake habitat assessments, and may be somewhat misleading. It is important to note that this analysis does not consider riparian improvements and this is the most probable cause of the similar results (i.e., the analysis only considers removing constructed features such as groynes). In general, there was a shift from Very Low upwards. However, the results of the analysis indicate that there would be little transition in upwards movement of categories if modifications were removed. Subsequent analysis may help better interpret where restoration may be more feasible and result in the most improvement. It is our opinion that the results presented above are found because riparian improvements are not included in the analysis and the little weighting given to habitat modifications in the AHI.

Table 2. Summary of the Current Value and Potential Value shoreline lengths, segments, and percentage of the shoreline for the different habitat index categories for Moyie Lake (Very High to Very Low)

Categories	Current Value			Potential Value		
	# of Segments	Shoreline Length (m)	% of Shoreline	# of Segments	Shoreline Length (m)	% of Shoreline
Very High	7	8487.8	22.6	7	8487.8	22.6
High	5	12139.4	32.3	5	12139.4	32.3
Moderate	15	11350.9	30.2	15	11350.9	30.2
Low	2	2467.3	6.6	2	2467.3	6.6
Very Low	2	3139.8	8.4	2	3139.8	8.4
Total	31	37585.1	100.0	31	37585.1	100

The sensitivity of the shoreline was considered in terms of the different shore types that exist around the Moyie Lake (Table 3). The Very High value shorelines were prevalent on stream confluence areas and wetlands, which accounted for 78% and 15% of the total Very High shoreline length respectively. High Value shoreline segments were most prevalent on Rocky shores (67%) and Cliff (18%) shorelines. Moderate Value habitats were most common Gravel shorelines (49%), but were also quite prevalent on Stream confluence (23%) segments and Rocky (22%) shorelines.

Table 3. Summary of the Aquatic Habitat Index results for the different shore types for the Current Value of the Moyie Lake shoreline. All shore lengths are in meters.

Categories	Current Value			Cliff / Bluff		Rocky		Gravel		Sand2		Stream Mouth		Wetland		Other	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline
Very High	7	8487.8	22.6	0.0	0.0	0.0	0.0	524.7	6.2	0.0	0.0	6474.9	76.3	1488.2	17.5	0.0	0.0
High	5	12139.4	32.3	2193.2	18.1	8330.0	68.6	600.3	4.9	0.0	0.0	1015.9	8.4	0.0	0.0	0.0	0.0
Moderate	15	11350.9	30.2	417.6	3.7	2327.6	20.5	5074.6	44.7	104.2	0.9	3426.9	30.2	0.0	0.0	0.0	0.0
Low	2	2467.3	6.6	0.0	0.0	493.5	20.0	1338.1	54.2	635.7	25.8	0.0	0.0	0.0	0.0	0.0	0.0
Very Low	2	3139.8	8.4	0.0	0.0	2296.2	73.1	843.6	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7.0 STATE OF THE FORESHORE

The lakeshore of Moyie contains important habitats for fish and wildlife species. The lake systems are also source drinking waters for many different people. This combination of important fish, wildlife, and water quality considerations make it extremely important to identify, manage and protect these important economic resources. The following assessment provides overview information necessary to begin to manage these resources effectively. This work will allow a baseline upon which goals and objectives can be created and monitored.

Moyie Lake occurs in two basins (North and South), separated by a biologically productive narrows region with important stream confluences and wetlands. The North Basin is 583 ha in size, while the South Basin is 316 ha in size. Important tributaries to this moderate size interior lake include Lamb, Cotton, and Barkshanty Creeks. As with other shoreline studies, lower gradient areas tended to have higher disturbance. Lamb Creek was a notable exception, with the floodplain relatively intact. The most notable disturbances that were observed were foreshore modifications typically in the form of substrate alteration (e.g., boat launches or groynes) and riparian vegetation disturbance. Large scale industries, such as commercial moorages and forestry log yards, were not present. There are historic mine tailing piles that do occur in some locations around the lake. Finally important water quality observations were documented between the basins. The North Basin was found to have a higher water clarity (or lower turbidity) than the South Basin, possibly the result of historical fires in the Lamb Creek watershed.

The shoreline areas have been historically impacted by development practices. However, many regions around the lake are still relatively rural and natural and not highly developed. These natural areas include diverse wetland communities, important burbot spawning areas, and stream confluences. These areas are also associated with the greatest wildlife diversity. The important habitat features around the lake are prone to impacts from future development (if previous trends continue) and require careful planning if these areas are to continue to be of importance to fish and wildlife.

Biological systems are extremely difficult to predict and manage. Currently, these fish and wildlife ecosystems are experiencing rapid changes due to a variety of factors including but not limited to land development (e.g., water consumption may be exceeding the capacity of some streams, etc.) and climate change. At this point, it appears that the significant biological resources around the lake are maintaining viable populations. Determining the threshold upon which the cumulative effects of development will have measurable and noticeable impact on fish and wildlife species is very difficult and therefore a conservative approach is required. The Recreational Carrying Capacity of a lake is defined as the point where a lakes ability to accommodate recreational use (e.g., boating) and residential occupation can occur without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors[2]. Determining carrying capacities in our interior

[2] Recreational carrying capacity differs from biological carrying capacity. Biological carrying capacity refers to the population size (i.e., # of individuals) a particular environment or system can sustain over the long term.

lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values of residents.

7.1 Key Considerations

Environmental land use planning is difficult because of the inherent stochastic nature of biological systems (i.e., it is not easy to predict the responses of living animals to changes in their environment, particularly when the environment they live in is also changing). Given this key consideration, a conservative approach must occur. The following sections of this document have been prepared using precautionary principles to adjust for the inherent variability of living systems as part of a sustainable approach to land use planning and management. The data set that has been developed and utilized to prepare these guidelines can be updated as more information becomes available as part of a long term, adaptive management response which will better integrate our communities with their natural surroundings.

8.0 SHORELINE MANAGEMENT GUIDELINES FOR MOYIE LAKE

Shoreline Management Guidelines for Moyie Lake (Guidelines) are intended to streamline land use decision making processes between different agencies and stakeholders. Guidelines have been prepared by the East Kootenay Integrated Lake Management Partnership (EKILMP) for Windermere Lake, and this document was used as a template (EKILMP, 2009). This document will not be referenced at every instance to promote readability and similarities may exist between these documents because of the template developed for Windermere Lake. The original authors of the text should be credited for completion of this document.

The EKILMP partnership consists of a variety of different partners, including local, provincial, and federal governments, non-profit organizations, and local first nations. The EKILMP was formed in 2006 with the purpose of creating better policies for management of key lakes in the Kootenay region. The intent of the partnership is to better balance the environmental and developmental needs of residents.

8.1 Management Guidelines Overview

The Guidelines utilize a risk based approach to shoreline management. This approach determines the risk of a proposed activity in each of the identified Vulnerability Zones. Vulnerability Zones relate to the environmental sensitivity of the shoreline, as determined by the AHI. Vulnerability Zones have been color coded to help more easily understand the risk matrix.

The following is a “How To” Guide to Development Planning along the Moyie Lake Shoreline:

1. Determine the Shoreline Vulnerability Color Zone your application is situated in using Figure Binder 1. See Section 8.1.1 below.

2. Determine what the Risk is of your proposed activity using the risk matrix (see Section 8.1.2 below.) If the proposed activity has not been identified within the table, please assume the activity is High Risk and contact FrontCounter BC or the Regional District of East Kootenay for further advice and information. If your identified activity is considered High Risk, determine if you can move your activity to a different colour zone or select a lower risk activity.

    a. If a Species at Risk is present or identified by a Qualified Environmental Professional, the risk of proposed activities is greater. If identified, the Modified Column for Species at Risk should be used.

3. Use the flow chart contained in this document to determine your application review needs based upon the risk of your proposed activity.

8.1.1 Step 1 - Shoreline Vulnerability Color Zones

The Shoreline Vulnerability Color Zones are best viewed graphically, as they relate to specific shoreline areas. The Shoreline Vulnerability Color zones are based upon fisheries and wildlife information collected during field surveys and the Aquatic Habitat Index that was prepared for the shorelines. Figure Binder 1 contains the Shoreline Vulnerability Zones.

The following provides a brief summary of the different Vulnerability Color Zones.

Red Shoreline

Defined by: Very High by 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 Aquatic Habitat Index analysis process. This zone includes most creek mouths, wetland areas, and zones essential for fish and/or wildlife populations around the lake. Red Zones are considered very high habitat value because of their biophysical characteristics which create habitats of high diversity. These areas are considered integral to the maintenance of a healthy ecosystem. Wetlands, stream confluences, and other important identified habitats (e.g., spawning features) are all identified as Red Zones. Red Zones account for 22.6% of the total shoreline length of Moyie Lake and 18.6% of the Monroe Lake Shoreline.

EKILMP recommends that these areas be designated for conservation use, and that no development that can impact these sensitive communities occur within them. Low impact water access recreation and traditional First Nation uses are permissible in these areas, but permanent structures or alteration of existing habitats is not considered to be acceptable. Habitat restoration may be appropriate in these areas where warranted. Invasive aquatic plant removal is acceptable, provided there is an approved aquatic plant removal program including trained persons. Please contact a plant specialist if uncertain of a plant species.

Orange Shoreline

Defined by: High Value Habitats identified by the Aquatic Habitat Index.

Background:
These shoreline segments have been identified as High Value Habitat Areas for fish and/or wildlife. These are made up of areas that are relatively natural; possibly have high value spawning habitats and/or other features that could be impacted by proposed land uses or activities. These areas are sensitive to development, continue to provide important habitat functions, but may be at risk from adjacent development pressures. Activity Risks in this zone will trigger the requirements to have an environmental assessment conducted by a Qualified Professional (QP). 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 risks associated with them. Orange shorelines account for 32.3% of Moyie Lake and 61.2% of Monroe Lake.

Yellow Shoreline

Defined by: Moderate Value Habitats identified by the Aquatic Habitat Index

Background:
These areas have generally experienced more intensive development disturbance and pressures. Generally, these areas do not contain critical habitat features required by fish and wildlife to maintain viable populations. However, these areas still maintain important general living habitats that are important to fish and wildlife that and they should be considered when changes to land uses are proposed. Yellow shorelines account for 30.2% of Moyie Lake and 20.2% of Monroe Lake.

Development is more appropriate on these shorelines, and should incorporate protection of habitat features that remain. Intensive development below the high water mark and/or within riparian areas could have unacceptable environmental impacts without proper planning. Restoration may be an option in some areas that have experienced some developments. Development may proceed for low risk activities provided a Best Management Practices (BMP) or Regional Operating Statement (ROS) is followed. High risk activities without a BMP or ROS will require a report from a Qualified Professional (QP).

Grey Shoreline

Defined by: Low and Very Low Habitats identified by the Aquatic Habitat Index

Background:
These are shorelines identified by the Aquatic Habitat Index analysis have a lower ecological value. However, they still may contain valuable habitats requiring some protection, such as in-lake wetlands, or gravel/cobble substrate areas. Grey shorelines account for 15.0% of Moyie Lake and 0% of Monroe Lake.

Residential 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. For example, a retaining wall redevelopment may be moved back from the High Water Mark (HWM) and/or incorporate re-vegetation, bioengineering or other fish and wildlife features in the design.

8.1.2 Step 2 - Activity Risk Matrix and Analysis

Different shoreline activities have been assigned risk ratings based on the potential level of risk that they may have on fish and wildlife habitat values. Risks have been determined based upon the different habitat values present and typical requirement to complete the proposed activity. The table below provides the risks of different activities in each of the different shoreline Vulnerability Zones identified. Risks have been determined as Not Acceptable (NA), High (H) or Low (L). To account for the limited survey information, a species at risk modifier column has also been provided and should be used in cases where a species at risk has been identified in the project area.

Table 1: The following table displays the activity risk matrix for each different shoreline colour zone.

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.)[1]	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
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
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
Mooring buoy	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 key habitat area attributes – upland or aquatic.
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.

In cases where multiple activities with differing risk are proposed, the combined risk may increase. In these cases, proponents should default to the highest risk identified and retain a Qualified Professional (QP) to help determine if the overall risk has increased. If your activity is not listed, contact FrontCounter BC for advice. The Activity Risk Table also distinguishes between activities above the high water mark (HWM) and below the HWM. The HWM as opposed to the 'natural lake boundary' is the standard practice used by DFO when considering impacts to fish and wildlife values because the natural lake boundary often contains very important emergent vegetation communities that are important to fish and wildlife.

This following provides background, descriptions and examples of the Activity Risk Ratings. The risk ratings identify the potential risk activities pose to fish and wildlife. Activities identified as Not Acceptable (NA) or High (H) have the greatest potential whereas activities identified as Low (L) risk have a reduced potential to impact fish and wildlife populations. This process recognizes that there is a greater possibility that High Risk activities may not be approved by regulators due to the potential impacts of the activity. The process also identifies that important habitats do exist in degraded and developed areas and that 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 and they generally occur in Red or Orange zones or are activities that have a high potential to impact fish or wildlife populations even in lower value habitat areas. These activities listed have potential to negative impact fish and wildlife habitats and it is extremely difficult or impossible to mitigate or compensate for the activities. Applications for these types of development in the zones identified will not be considered.

High Risk Activities

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

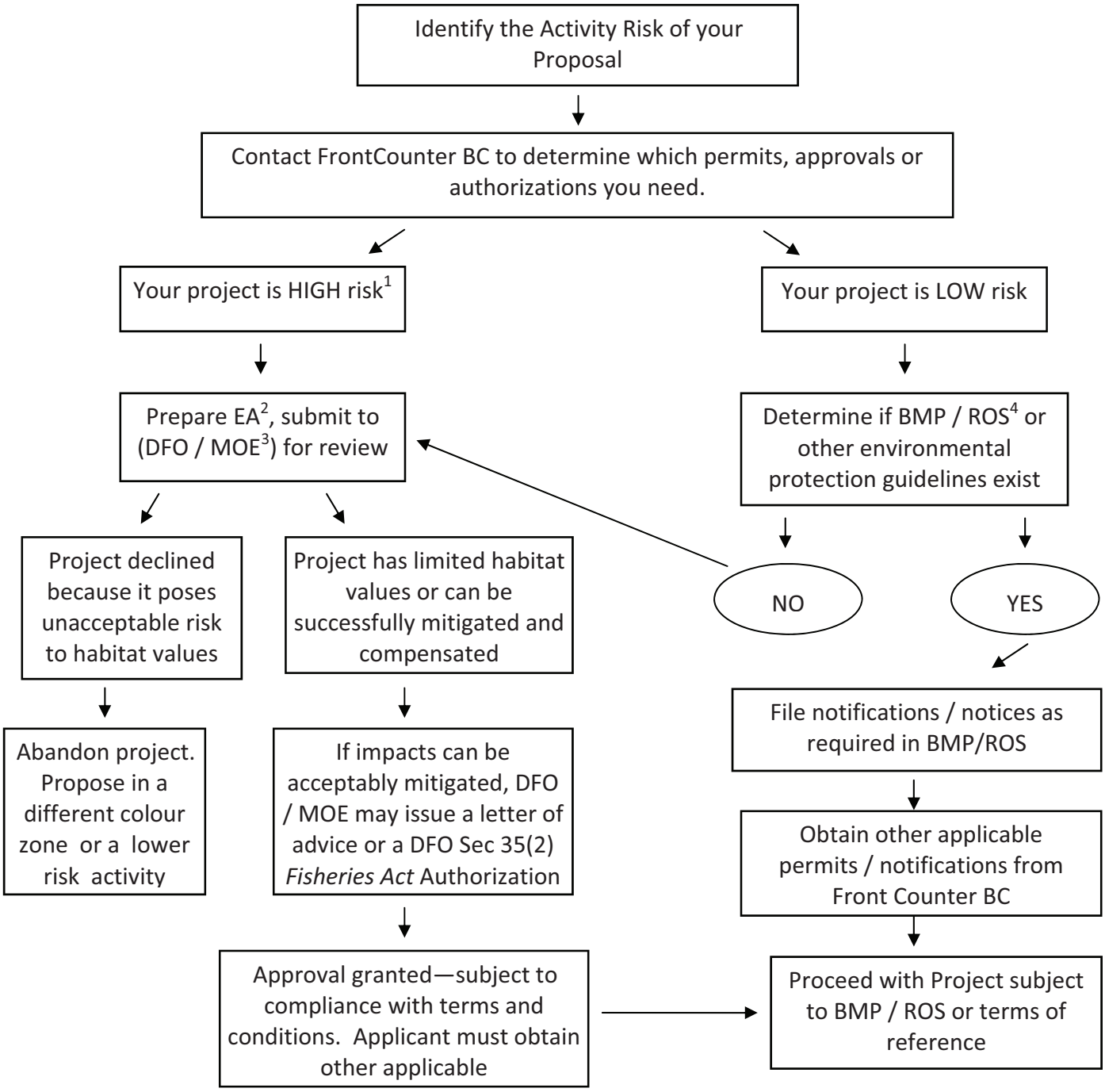
Low Risk Activities

With appropriate design and planning, Low Risk activities could be incorporated along the foreshore with minimal impacts on fish and wildlife habitat values. These activities are to follow BMP and/or ROS, 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).

8.1.3 Step 3 - Decision Process Flow Chart

The flow chart below provides an outline for 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 Transport Canada, BC *Water Act*, BC *Lands Act*), which are the responsibility of the applicant. Additional potential legal requirement listings are provided in Appendix H. If these Guidelines are followed, the intent is that the subsequent permitting process(es) should be more streamlined for the applicant.

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



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

[2] Environmental Assessment

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

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

8.2 Mitigation and Compensation Considerations

In order to assess impacts of a proposed project, it may be necessary to retain a QP who could assess habitat values and sensitivities in the area. Information contained in this report will help with this task; however, further studies will likely be necessary to address site specific issues and because of the limitations of information currently available. The DFO principle of "no net loss" within the Policy for the Management of Fish Habitat 1986 applies to all proposals where there is the potential for a 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:

8.2.1 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.

8.2.2 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 key/high value habitat. Minimization involves the reduction of adverse effects of development on the functions and values of the habitat at all project stages (including planning, design, implementation and monitoring), to the smallest practicable degree. Considering any planning efforts, DFO must deem a HADD to be acceptable before work can commence.

8.2.3 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 "make up for" the unavoidable loss of or damage to habitat functions and values. Habitat compensation may be an option for achieving "no net loss" when residual impacts of projects on habitat productive capacity are deemed harmful after relocation, redesign or mitigation options have been implemented. After reviewing the project proposal and the potential impacts to fish habitat, DFO may determine that the impacts are not acceptable if the habitat to be affected is critical habitat or compensation is not feasible. In addition, compensation for deposit of a deleterious substance into water frequented by fish is not acceptable. Habitat

compensation involves replacing the loss of fish habitat with newly created habitat or improving the productive capacity of some other natural habitat. Depending on the nature and scope of the compensatory works, habitat compensation may require, but not be limited to, several years of post-construction monitoring and evaluation. In the event that functional objective of the compensation are not achieved (i.e., due to failure or inadequate maintenance), additional remediation or redevelopment of the compensation works may be required to achieve 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.

9.0 RECOMMENDATIONS FOR FUTURE CONSIDERATION

9.1 General

The following are other recommendations that could be incorporated into foreshore protection policies:

1. **Environmentally Sensitive Areas should be identified because they are extremely important**. For instance, 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 for a variety of reasons. As the example above portrays, keeping environmental development permit areas up to date is important. EDP's are most accurately determined by appropriate inventory work such as the FIM, Sensitive Ecosystem Inventory (SEI, see below) and SHIM. It is recommended that areas that have been determined as environmentally sensitive be added to the Development Permit Areas within any policy documents applicable (e.g., OCP, Bylaws, etc.). It is important that addition of new inventory data be simple and easy to implement because the budgetary constraints for inventory often result in projects being completed over a series of years as data is collected. *All lakeside areas identified in this report should be designated as development permit areas.*

2. **Environmentally sensitive areas should be included in Official Community Plans, Bylaws, and policy documents within the different agencies.** The AHI provides a basis for identification of shoreline environmentally sensitive areas. It is possible to incorporate the AHI into OCP documents in a variety of ways. The Guidance Document provided outlines how referrals and development proposals should proceed. The following provides our recommendation for how Very High and High Habitats are considered:

    - Very High and High Value Areas –These areas are considered to be the most valuable areas of the shoreline and comprise approximately 55% of the shoreline. Intensive development along these areas is strongly discouraged because it is likely very difficult to mitigate for potential impacts and not likely possible to compensate for losses to these habitat areas. Explicit terms of reference (mentioned below) for proposed significant changes in land use (i.e., large subdivisions) should be developed collectively for all projects or on a case by case basis (dependant upon resources available). If possible, an interagency approach and terms of reference would streamline the referral and review process.

3. **Standard terms of reference for professional reports should be developed for environmental assessments of development applications.** This document will ensure consistency in environmental reporting across agencies and jurisdictions. The 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 will 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 and the Terms of Reference will help address the uniqueness of different areas. The inventories and data within this document should be provided as part of the terms of reference (i.e., the GIS data, air photos, and other biological information contained in this report should be provided)

4. **Habitat restoration opportunities should be achieved wherever possible by identifying them during the development review processes.** In highly urbanized areas, examples include removal of retaining walls, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, etc. It may be useful to identify the potential for restoration opportunities in the standard terms of reference discussed above. There is significant opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lake.

5. **Core habitat areas are extremely important to maintain and should be identified as early as possible in the development process.** Detailed assessments and identification of core habitat areas for conservation should be done as early in the development process as possible. Numerous different 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.).

6. **A Land Act Section 16 Map Reserve should be established on all areas identified as having very high value (Red Zones) wherever possible.**

7. **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. This information should be available to the public, including all air photos, GIS files, and other electronic documents. 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.

8. **An Environmental Advisory Commission or other suitable body should be created and be included in the development review process to involve local residents.** The RDCO has created an Environmental Advisory Commission, which functions similar to an Advisory Planning Commission. The commission was created based upon the belief that local residents should contribute to the stewardship of their natural resources. In the Columbia-Shuswap Regional District (CSRD), the Shuswap Lake Integrated Planning Process (SLIPP) process has incorporated both political and resident representatives. This may provide an avenue to address the environmental concerns of residents and act as an advising committee to relevant stakeholders and governmental agencies.

9. **Establish a Moyie Lake Stewardship Committee.** This committee could help be a liaison for local people to express their concerns to governmental agencies. Similar types of committees are being established elsewhere.

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

11. **A communication and outreach strategy should be developed to inform stakeholders and the public of the findings of this study and improve stewardship & compliance**. Initially, it is recommended that notice of the availability of this report and associated products are available on the Community Mapping Network. Ecoscape understands that this project has and will continue to have a communication and outreach strategy.

12. **Lake shore erosion hazard mapping should be conducted for private lands to identify areas at risk, which will stream line the review process and reverse the damaging trend of unnecessary hard armoring and construction of retaining walls along the shoreline of the lakes.** 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, would be preferred (Guthrie and Law, 2005). This mapping should be integrated with the FIM data, and be completed for each segment. Flooding, terrain stability, alluvial fan hazard mapping 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 proposal for shoreline armoring to ensure that works are required, minimize impacts and use bioengineering techniques.

13. **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 comprehensive storm water management plans. 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 non condition foreshores and impacts to shore spawning areas. It is recommended that storm water management plans be required as part of development processes.

14. **Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources, if feasible.**

15. **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, if feasible.**

16. **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.**

17. **Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation is proposed. Habitat enhancement should only be considered when effective mitigation efforts are feasible (e.g., avoidance) and a strong business case proving mitigation feasibility has been prepared.**

18. **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.

19. **Development of land use alteration proposals should only be accepted if the compromises or trade-offs will result in substantial, long-term net positive production benefits for biophysical resources.**

20. **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.

9.2 Future Data Management

Future data management is extremely important. This assessment has integrated much of the available information into one concise GIS dataset. However, future works will be conducted and they should be integrated into this data wherever possible. The following are recommendations for future use of the FIM dataset:

1. **One agency should take the lead role in data management and upkeep**. This agency should be responsible for holding 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.

2. **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, etc. Other examples include the addition of appropriate wildlife data. Where feasible, these new data sets should reference the shore segment number (see below).

3. **The Segment Number is the unique identifier. Any new shoreline information that is provided should reference and be linked to the shore segment number.**

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

2. **Wetlands are extremely productive and important components of our ecosystems and these features should be inventoried**. Numerous low flood and mid flood benches and shore marshes were mapped during this survey. Detailed Wetland Inventory and Mapping (WIM) of these features are recommended. Detailed mapping of terrestrial wetlands is also important to ensure that linkages between foreshore and upland areas are achieved.

3. **Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM) are useful terrestrial mapping tools and these inventories should be completed**. These assessments help land managers identify sensitive terrestrial zones which can be integrated into the FIM, SHIM, and WIM GIS datasets.

4. **An inventory of high value habitat islands in urbanized areas should be conducted.** In many cases, small sections of higher habitat quality were observed in segments ranked Moderate to Low. These areas were typically areas that had well-established native vegetation or relatively natural shorelines. Development applications proposed in these "islands" of higher habitat quality should avoid disturbance to these "islands" as much as possible. A survey of these small "islands" would clarify which segments contain "islands" and would help aid planning objectives. This could form part of a riparian mapping exercise.

5. **A carrying capacity analysis of the lake should be completed.** Biological systems are extremely difficult to predict and manage. Currently, these fish and wildlife ecosystems are experiencing rapid changes due to a variety of factors including but not limited to land development (e.g., water consumption may be exceeding the capacity of some streams, etc.) and climate change. At this point, it appears that the significant biological resources around the lake are maintaining viable populations. Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is very difficult and therefore a conservative approach is required. The Carrying Capacity of a lake is defined as the point where a lakes ability to accommodate recreational use (e.g., boating) and residential occupation without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors. Determining carrying capacities on our large, interior lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values of residents.

6. **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 important habitat values present on their properties.

7. **Native beds of submergent and floating vegetation should be mapped in detail.** Native beds of submergent and floating vegetation were rare on Moyie Lake. More detailed mapping, maybe as part of a Wetland Inventory and Mapping project, would help better classify and described these rare, sensitive features. A good example of these communities is located in Segments 5.

10.0 CONCLUSIONS

The following report has documented the current condition of the Moyie Lake shoreline. The assessment provides substantial background information summarizing the current condition of the upland and terrestrial zones and foreshores of the lake. An AHI was developed that used biophysical information collected during the survey to rank the relative environmental sensitivity of the shore zone areas around the lakes. Recommendations are presented to help integrate this information into local land use planning initiatives.

The Shoreline Management Guideline presented in this document will facilitate a risk based approach to land use management that uses conservative principles because of the inherent variability in living ecosystems. The risk of common shoreline activities has been prepared based upon Vulnerability Zones which were developed using the shoreline habitat sensitivity determined by the AHI. This approach will help proponents and government agencies better integrate proposed developments with their natural surroundings and provide consistency in the review process.

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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. For example, the Ministry of Environment have been recently creating documents containing guidelines for work in and around water.

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 methodology used to collect and document fish and riparian habitats lake corridors and was performed by the Regional District of Central Okanagan and partners. A full discussion of this mapping can be found in Regional District of Central Okanagan (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 / Alluvial Fan / Stream Confluence – 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.

MOYIE LAKE

FORESHORE INVENTORY AND MAPPING
FIGURE BINDER

#102 – 450 Neave Ct. Kelowna BC. V1V 2M2 ph: 250.491.7337 fax: 250.491.7337 ecoscape@ecoscapeltd.com

FORESHORE INVENTORY AND MAPPING

Standard Methods for Completion of Foreshore Inventory And Mapping Projects

Prepared By:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
#102 – 450 Neave Court
Kelowna, BC
V1V 2M2

ECOSCAPE
Environmental Consultants Ltd.

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District of Invermere
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BC Real Estate Foundation
Okanagan Basin Water Board
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With proper management, we may begin to find a balance within our ecosystems. Without the ongoing support for inventory and mapping initiatives, the objective of sustainable development and balance will not be achieved.

Helpful comments and reviews of this document were completed by:

Brad Mason, Community Mapping Network
Interior Reforestation Ltd.

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1. Official Community Plans;
2. Shoreline Management Plans;
3. Land and Resource Management Plans;

For a complete review of background information or for use of a GPS/GIS software/hardware, readers should refer to the SHIM (Mason and Knight, 2001) and the Technical Addendum in Part 3 of the Central Okanagan FIM (Magnan and Cashin, 2004). These documents provide in depth documentation of background information for use of GPS/GIS technologies for mapping habitat features and watercourses. A brief summary of some GIS techniques is found in Appendix D.

2.1 Development of the Foreshore Inventory and Mapping Protocol

The following provides a summary of projects that have currently been completed using this methodology in British Columbia:

Table 1: Foreshore Inventory and Mapping of Lakes Completed to Date

Lake	Region	Year Completed
Okanagan Lake (Central portions)	Okanagan	2004
Osoyoos Lake	Okanagan	2002
Winderemere		2006
Skaha Lake	Okanagan	2008
Shuswap	Thompson	2008
Nicola Lake (Video)	Thompson	2006
Mara Lake	Thompson	2008
Moyie Lake	Kootenay	2008
Monroe Lake	Kootenay	2008
Rosen	Kootenay	2008
Tie	Kootenay	2008
Columbia	Kootenay	2007
Wasa	Kootenay	2008
Windemere	Kootenay	2008
Charlie	Peace	2008
Swan	Peace	2008
Dragon	Cariboo	2008
Sheridan	Cariboo	2008
Williams	Cariboo	2008
Bigelow	Skeena	2008
Call	Skeena	2008
Kathlyn	Skeena	2008
Lakelse	Skeena	2008
Round	Skeena	2008
Seymore	Skeena	2008
Tyhee	Skeena	2008
Gun	Thompson	2008
Montana	Thompson	2008
Pinantan	Thompson	2008
Sakinaw	Lower Mainland	2008
Ruby	Lower Mainland	2008
Sproat	Vancouver Island	2008
Horne	Vancouver Island	2008
Kemp	Vancouver Island	2008
Langford	Vancouver Island	2008
Prospect	Vancouver Island	2008
Cowichan Lake (Video)	Vancouver Island	2006

Since 2004, when the methodology was first developed for Okanagan Lake, land resource managers at local, provincial, and federal levels have begun to utilize data collected during FIM. Data collected during these inventories has been incorporated into Official Community Plans, has been used to prepare Aquatic or Ecological Habitat Indices (e.g., Schleppe and Arsenault, 2006; McPherson and Hlushak, 2008), and has been used to facilitate making informed land use decisions. The baseline inventory information collected can also be used for monitoring purposes, to develop land management objectives for a shoreline, and to develop shoreline management plans and policies.

Development of the data dictionary, or database, for FIM has undergone several different iterations over the past few years. Contributors to the ongoing FIM projects, the database and methodology are summarized in the acknowledgements section of this document. All funding partners who have provided to the development of the FIM protocol should be given recognition for the investments towards improved lake management.

During the summer of 2008, meetings were coordinated with the RDCO, Regional District of Okanagan Similkameen, City of Kelowna, MOE, and DFO to update the data dictionary to reflect current usage of the database and to ensure data collected is most appropriate to guide shoreline management. As part of these meetings, it was determined that there was a need to standardize the methodology for FIM, as recommended in the FIM report prepared for the central regions of Okanagan Lake (Magnan and Cashin, 2004). The following document is intended to provide this standardization by:

1. Providing an overview of field assessment techniques and methodologies;
2. Providing a detailed summary of the most recent FIM Data Dictionary (SHIM LAKE v. 2.6) (full dictionary is in Appendix C);
3. Reconciling previous versions of the database with the most current version so end users understand how the different fields have been adapted over time (see Appendix B for tabular summary);

3.0 FOREHORE INVENTORY AND MAPPING OVERVIEW

Foreshore Inventory and Mapping is generally a three step process, as follows:

1. Shoreline Video Documentation;
2. Shoreline Data Collection;
3. Data Analysis and Reporting.

During the Video Documentation (Step 1), a video is collected for the entire shoreline of a lake. The video is stamped with GPS coordinates that can be used to help with determination of where you are along the shoreline. The video documentation is typically referred to as Pass 1. During this pass, assessors should make note of significant features and begin to asses where shore segment breaks will be made.

Shoreline Data Collection (Step 2) is where most of the field data for the assessment is collected. This is often referred to as Pass 2. During this stage, data is entered into the

GPS data dictionary for all applicable fields. Other information that may be collected includes shoreline habitat mapping (e.g., delineating the extent of shore marshes on air photos), mapping significant changes in substrates within a segment, etc.

During the Data Analysis and Reporting stage, data is transferred to a computer and then is processed. During this step, data is reviewed and corrections are made as necessary. It is preferred if data collectors also process data, as they have had first hand experience with field collection. This review and correction of the data acts as a quality assurance process and is one of the most important steps in the process. Finally, data is transferred to the shoreline, and segment breaks are adjusted so that they occur where intended during the field assessment.

Once these steps have been completed, this work is often times followed by more detailed data collection such as shoreline wildlife habitat mapping, shore marsh habitat mapping, shore spawning mapping, etc. Other data bases have also been developed that are currently being used to assess compliance with best management practices and permitting. With the accumulation of multiple data sets, end users then may also pursue Aquatic Habitat Index (AHI) development (e.g., Schleppe and Arsenault, 2006; McPherson and Hlushak, 2008). The focus of this document is to detail data collection for items 1 through 3 above. However, recommendations are presented to help facilitate future data management and integration (see Section 7.0).

4.0 FIELD ASSESSMENT

The field assessment, as discussed above, typically occurs during two steps. The following sections will provide methodology for pre field requirements, shoreline video documentation, and shoreline data field collection.

4.1 Pre-Field Overview

During the pre field overview, assessors should gather as much background information as possible. The pre field overview will help guide the field assessment to ensure that all information is collected.

During the pre field overview, the following information should be gathered, if possible:

1. The most recent digital (GIS) air photographs of the entire shoreline. Air photos are valuable to help determine segment breaks, assess land uses, and to help assess important features such as the location of stream mouths. Air photos are available for most areas of the province and have been flown at varying times. Preferably, air photos will be included in budgets for these projects to ensure the most recent information is available.

2. Any topography information for the shoreline. Topographic information is available for almost all areas of the province from the TRIM mapsheets and can be

obtained digitally (GIS files). This information can help assessors determine reach breaks and assess slope.

3. Local cadastre information for private holdings that occur along the shoreline. This information is typically available digitally (GIS or AutoCAD files) from the local government, first nations offices, or regional districts.

4. Jurisdiction and Zoning information from local government, first nations, and regional districts. This information can help assessors determine land uses and segment breaks. In some instances, this information is available digitally (GIS files), but may also be available as map sheets from the local jurisdiction.

5. Any provincial parks boundaries, conservations areas, or other known features that occur along the shoreline. Much of this information is available from the Land and Data Warehouse, provided by the Integrated Land Management Bureau.

Once the above information has been collected, assessors should prepare field maps that can be used to document information during their survey. Field maps should show all available information possible in a concise manor. Field maps are not required to complete the assessment, but are extremely valuable as they provide a method to record field observations that can be digitized in GIS later. Field maps are especially valuable to help with defining the locations of important shore marsh habitats and stream mouths, because often times the location of these features is not spatially accurate. Matching field map grid sheets to the local government sheets can be helpful.

If field maps are generated, assessors can provide a pre field assessment of the shoreline. During this assessment, possible segment breaks and other information can be set up to assist with the field inventory.

4.2 Shoreline Video

The purpose of recording lake shoreline video is to assist in classifying lake shore substrates, land use and land cover. Detecting change over time as a result of development or natural disturbance can then be examined. The video can also be used to classify or validate the classification of shoreline segments and to assist in quantifying structures such as boat ramps and retaining walls. Depending on the lake, it may be appropriate to capture video at a particular elevation such as high or low water. For example, if video is captured during high water, the number of retaining walls that become submerged or partially submerged can be enumerated.

The selection of a boat is critical. If possible, choose a boat that is stable under windy conditions and that has a small draft to avoid grounding when navigating near the shore. An appropriate power supply such as a car or RV battery should be used with a power inverter to ensure there is adequate power for all of the recording equipment.

The following is a guide for recording georeferenced lake shoreline video. Video equipment is constantly being improved as well as recording methods. However, the tools are only as good as the operator so nothing replaces training, personal experience and practice. There are several models and several setup options for recording shoreline video so the following is to be used only as a guide.

Almost any digital video camera can be used successfully; however, users must become familiar with the video camera controls prior to going into the field. The video should be recorded no more than 50 m from shore if possible. One to two homes should be in the view of the video at one time. Do not use the digital zoom and try not to use the optical zoom if possible, otherwise the video will become blurry especially in rough conditions. The video should be recorded on dry, calm days if possible. A general rule is that the larger the waves, the poorer the quality of the resulting video. Other considerations include:

- good image stabilization
- analog output (mandatory)
- durability for use in the field conditions
- easy to use and reach buttons
- a lens shroud to protect from direct sunlight
- a polarized lens
- an excellent tripod with easy to use controls
- tape or harddrive storage media

Geo-referencing the video output by tagging each frame with a latitude and longitude is recommended. In addition, a GPS track line should be recorded at the same time using one second intervals. This will allow synchronization of the video with the GPS trackline for each shoreline segment.

Analog output from a digital video camera connects to a GPS stamper unit such as Horita or SeaTrak (figure 1). GPS output also connects to the GPS stamper unit. Output from the GPS stamper unit is recorded onto a digital video recorder or a personal computer. In the case of a digital video recorder, the use of a digital video player is useful in order to ensure the video output is correct.

Video files should be edited to remove any unwanted frames. A digital video recorder is very efficient for doing this task. Alternatively, video can be edited using video editing software such as Pinacle or Adobe on a PC.

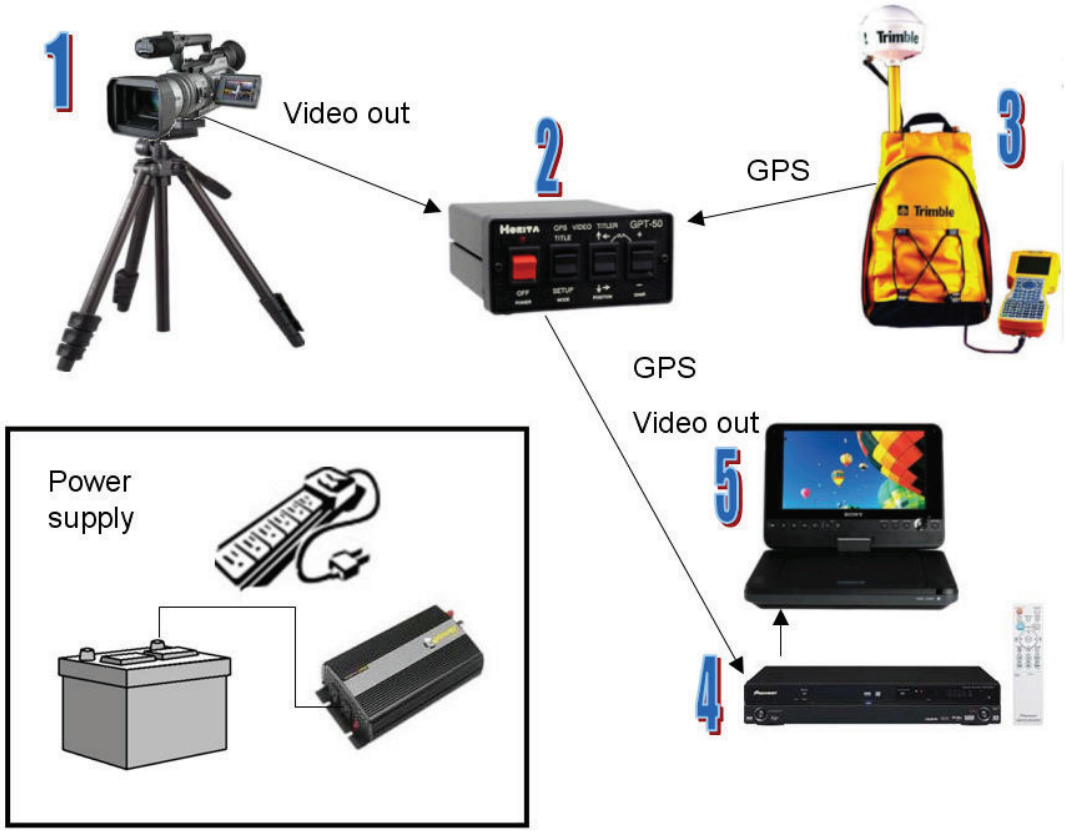


Figure 1: Shoreline video setup. 1) Digital video camera, 2) GPS stamper unit, 3) GPS data logger and receiver, 4) Digital video recorder, 5) Digital video player

4.3 Shoreline Data Field Collection

The shoreline field data collection involves the following different categories of information:

1. *Lake Reference* – This section of the data dictionary includes summary information for the lake being assessed and the crew assessing the information.
2. *Segment Class* – This section of the data dictionary includes a summary of the dominant features of the shore segment, such as land use, shore type, slope, etc.
3. *Shore Type* – This section includes specific information regarding the different shore types that occur along the shore segment.
4. *Land Use* – This section includes specific information regarding the different land uses that occur along the shore segment.
5. *Substrates* – This section includes specific information regarding substrates that occur along the shore segment.
6. *Vegetation Band 1* – This section includes specific information regarding the first distinctive band of vegetation. This section was previously called Riparian (See Appendix A).

7. *Vegetation Band 2* – This section includes specific information regarding the second distinctive band of vegetation. This section was previously called Upland (See Appendix A).
8. *Littoral Zone* – This section contains specific information regarding littoral zone features of the shore segment.
9. *Modifications* – This section contains specific information regarding shoreline modifications, such as retaining walls and docks that exist along the shoreline.
10. *Flora and Fauna* – This section contains specific information regarding flora and fauna information, such as veterans and snags that exist along the shoreline segment.

Within each of the different sections above, data fields allow assessors to enter specific information into the GPS unit. A field crew of three to four people (plus a boat skipper) is optimal for these assessments. As there are many items that need to be counted and there is some interpretation required, at least one crew member should be very familiar with the database and have a good understanding of the methodology to guide other members of the crew. During the assessment, crew members will assume different roles, such as counting docks, paying attention to substrates, etc. and it is preferred if crew members focus on their particular tasks rather than trading off part way through the assessment. If assessors intend on trading of tasks part way through, they should thoroughly discuss their criteria and ensure that the other is familiar with their task. A paper photo log should also be completed. Assessors should take as many representative photos as possible of the shoreline to aid with data management and quality assurance review.

The following is a list of some of the field equipment that should be taken on the field assessment vessel:

1. Four to Eight Thumb Counters;
2. Field Maps for the entire shoreline (if available);
3. At least one GPS Unit with the data dictionary loaded (with a back up if available);
4. Digital Camera, or preferably a Digital Camera with GPS stamp;
5. Water proof field paper for field notes and data sheets (in case GPS unit fails);
6. Binoculars for viewing shore substrates and other features;
7. Required Safety Equipment such as life vests, rain gear, etc.

The following sections will provide specific information for interpreting and entering data into the data fields of the GPS unit. Appendix A provides a summary of the following sections in tabular format.

4.3.1 Lake Reference

The Lake Reference section is intended to provide background information regarding the lake that is being assessed, field conditions during the assessment, and the crew completing the assessment. The following is a summary of data fields and methods for this section of the dictionary (summarize in Appendix A).

1. *Lake Name* – This field is for the local lake name (gazetted or common name).

2. *Lake Level* – This field is for the level or elevation of gauges lakes on the date of the assessment. On gauged lakes, lake level is typically the geodetic level (i.e., above sea level) of the lake the day the assessment was completed. However, each gauging station will be benchmarked to a certain level and this standard should be used. This will help people utilizing data understand at what water level the data was collected. This field should be left blank if the lake level is unknown or if the lake is not gauged. Some lake levels are available online at http://scitech.pyr.ec.gc.ca/waterweb/formnav.asp

3. *Secchi Depth* – This field is for entering the Secchi depth. Secchi depth is a measure of the point where a 20 cm weighted white line disappears from view when lowered from the shaded side of a vessel and that point where it reappears upon raising it. This measurement should be made at mid-day as the results are more variable at dawn and dusk. Secchi depths vary depending upon the time of year measured and productivity of a lake, particularly in lakes with increased particulate matter (e.g., algae). This measurement is not required, but can be included if assessors have the necessary equipment to complete it.

4. *Organization* – This field is to enter the organization that is completing the work. Organizations include government, non-profit organization, or companies who are responsible for collection of the field data.

5. *Date and Time* – This field is for the date and time. These fields allow assessors to enter the date and time of the assessment. Some GPS units may enter this information automatically.

6. *Crew* – This field is for the crew completing the field assessment. Assessors should enter the initials of all crew members on the vessel who are completing the assessment.

7. *Weather* - The weather is a categorical field. Available options include Light Rain, Heavy Rain, Snow/Sleet, Over Cast, Clear, Partly Cloudy, and other. This field should be filled in with the most appropriate weather observed throughout the day. If the Other category is chosen, field assessors should identify the weather in the comments field.

8. *Air and Water Temperature* – The air and water temperature fields allows assessors to enter in the temperature during the assessment.

9. *Jurisdiction* – The jurisdiction field is to identify the governmental entity that has predominant governance over the shore segment being assessed. Typically, this would be a local government, regional district or First Nations band. In some cases, the shoreline may occur along crown land or within a provincial park. If possible, field assessors should break segments at all major changes in jurisdiction to allow

for better management of shore line segments. If a segment break is not included at a change in jurisdiction, the jurisdiction with the predominant length of shoreline should be listed here and the secondary jurisdiction should be noted in the comments field.

10. *Comments* – The comments field is for assessors to enter any relevant information regarding the lake information.

4.3.2 Segment Class

The Segment Class section is intended to provide a summary of the dominant land uses, shore types, and other characteristics of the entire shore segment. The following is a summary of data fields and methods for this section of the dictionary (summarize in Appendix A).

1. *Segment Number* – The shoreline segment number is a field that identifies the shore segment. The shore segment if the fundamental unit of FIM and each shore segment is characterized by attributes (e.g., land use, shore type, vegetation) that are similar. Typically, shore segments begin at 1 and continue until the entire shoreline has been mapped. However, in some instances, shore segments may begin at another number, particularly in cases where only portions of a lake are mapped at various different time periods. Shore segments should generally have a similar land use, shore type, vegetation, and substrates. The minimum length of shoreline for a shore segment is 50 m and there is no maximum to the length of a shore segment. Generally, assessors will create more segments in densely developed areas due to changes in vegetation cover and land use than they will under more natural conditions, when shorelines tend to be more similar for longer stretches.

   Determining Shore Segment Breaks

   Shore segments should consider the following different criteria:

   a. Shore Type is a primary characteristic (defined below) that should be used to assess shore breaks;
   b. Land Use is another primary characteristic (discussed below) that should be used to assess shore segments. Changes from residential development to single family development, for instance, could warrant a segment break.
   c. Vegetation is another characteristic that can be used to determine segment breaks. Significant differences in vegetation coverage are typically associated with changes in land use also, but sometimes can be due to differences in property management.
   d. Stream Mouths are extremely important shore types and should be given their own segments for important fish habitat streams.

2. *Shore Type*– Shore type is a categorical field that describes the predominant shore type that occurs along the length of the shore segment (i.e., the highest percentage

of the linear shoreline length). Shore types include Cliff/Bluff, Rocky Shore, Gravel, Sand, Stream Mouth, Wetland, and Other. If other is selected, comments should be included to describe the shore type observed. Definitions for each of the above shore types are found in the Shore Type Section discussed below.

3. *Shore Type Modifier* – The shore type modifier field is used to describe significant shoreline activities that influence the shoreline. The field is categorical and choices include Log Yard, Small Marina (6-20 slips), Large Marina (greater than 20 slips), Railway, Roadway, None, and Other. If Other is selected, the comments field should be used to identify the modifier. If the field is left blank, users should assume that there is no shoreline modifier.

    a. *Log Yard* – A log yard is an area where logs are temporarily stored until they are moved to a lumber mill. Log yards typically have large log breakwaters, log booms, and associated loading / unloading facilities.
    b. *Large and Small Marina* – A marina is any type of location where boats are moored. A boat slip is where each boat is moored and each finger of a dock may be used to moor two boats (i.e., one on each side). Marinas can either be on pile supported or floating structures. Marinas may have associated breakwaters, fueling stations, boat launches, etc. Also, marinas can be associated with commercial or multi family dwellings.
    c. *Railway* – Railways constructed within 5 to 10 m or below the high water level are another shore type modifier. Railways should only be considered a modifier if they are within 0 to 15 m of the shoreline and there is no private holdings between the railway and the shoreline. Decommissioned railways can be considered a railway modifier.
    d. *Roadway* – The roadway modifier identifies shore segments where a roadway occurs directly adjacent to the shoreline. Roadway should only be considered a modifier when they are within 10 to 15 m of the shoreline and there are no private holdings between the roadway and the shoreline. Boat launch access roads are not considered a roadway modifier.

4. *Slope*– Slope is a categorical determination of the slope or gradient of the shoreline. Categories include Low (less than 5%), Moderate (5-20%), Steep (20-60%), Very Steep (>60%), and Bench. A Bench is a shoreline that rises, typically steep or very steep, has a flat area typically greater than 15 horizontal meters, and then becomes steep or very steep again. On bluff shore types, where the shoreline rises sharply and then flattens, the categorical statement should describe the steep portion of the shoreline (i.e., do not use bench).

5. *Land Use* – Land use is a categorical field that is used to describe the predominant land use observed along the segment. Categories include Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single Family, Rural, and Urban Park. Land use can be determined based upon a combination of field observation, review of zoning and bylaw maps,

and air photo interpretation. Please refer to detailed definitions of the different land use types to better understand the different categories below.

6. *Level of Impact* - Level of Impact is a categorical field that is used to describe the general disturbance that is 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). 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, typically the assessment area is greater (i.e., 50 m) and in more developed shorelines, typically 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 infill, etc.). 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%), or None. Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The RDCO Foreshore Inventory and Mapping report defines the *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, 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.

7. *Livestock Access* - Livestock access is a categorical field that is used to determine whether livestock, such as cattle, have access to the foreshore. Choices include Yes, No or blank. If the field is left blank, one should assume that cattle do not have access.

8. *Disturbed* – The disturbed field allows assessors to enter the percentage of the shoreline that is disturbed by anthropogenic influence. This is a measurement of the approximate length and depth of the shore zone that has been disturbed. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the percentage

disturbed should correspond to the level of impact (i.e., a high percentage of disturbance should translate into a High level of impact). The summation of the Percentage Disturbed and the Percentage Natural should equal 100%. If air photo field maps are available, use of a scale ruler can help assessors determine the percentage that has been disturbed. Although this field is somewhat qualitative, assessors should do their best to be consistent and to be as quantitative as possible.

9. *Natural* – The natural field is the percentage of the shoreline that is natural. This is a measurement of the approximate length and depth of the shore zone that remains in a natural condition. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the Percentage Natural should correspond to the level of impact. The summation of the Percentage Disturbed and the Percentage Natural should equal 100%. If air photo field maps are available, use of a scale ruler can help assessors determine the percentage that has been disturbed. Although this field is somewhat qualitative, assessors should do their best to be consistent and to be as quantitative as possible.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

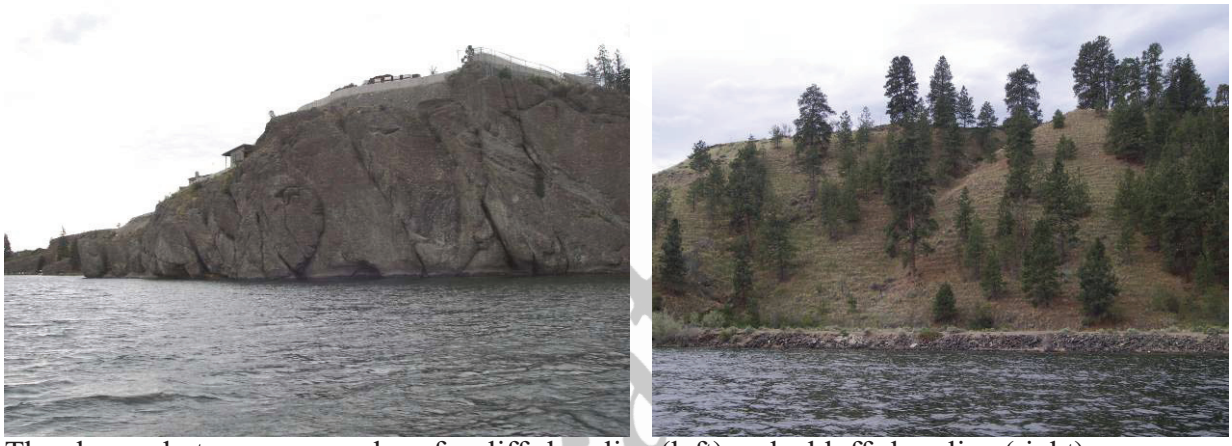
4.3.3 Shore Type

The Shore Type section is intended to provide a summary of the different shore types that may occur over the entire shore segment. In many cases, one shore type will be predominant in a segment, with other shore types occurring to a smaller extent. Examples of this include rocky shorelines, with intermittent gravel beach areas in depositional areas. The shore type section allows assessors to enter in the approximate percentage of the shore segment that is occupied by the different shore types.

When determining the percentage of a segment that a shore type occupies, assessors should utilize whatever data is available to them. During the field assessments, scaled air photos can be used to determine the approximate percentage. If field maps are not available, assessors should use best judgment to estimate the percentages. As segment lengths become longer, it becomes more difficult to estimate the percentage of a segment a particular shore type occupies. Given this, an assessor should be cognizant of the distance traveled, boat speed, and other factors when judging the percentage of the segment.

Initial shore type fields were developed by the Resources Inventory Committee (RIC, 2001) and were subsequently refined and adapted for the FIM of Okanagan Lake (Magnan and Cashin, 2004). The shore types below were again refined during the summer of 2008 in discussions with the MOE, DFO, and local government stakeholders and consultants. The most significant change in SHIM Lake v.2.6 is the removal of the Vegetated Shore Type. This shore type was removed because all shore types describe physical aspects of the shoreline whereas the vegetated shore type described vegetation characteristics. The following is a summary of data fields and methods for this section of the dictionary (summarize in Appendix A).

1. *Cliff / Bluff Shoreline*– The Cliff / Bluff field allows assessors to enter the percentage of the segment, based upon the shore segment length, that is a cliff or bluff shore type. A cliff shore type is typically very steep with substantial vertical elements that are greater than 70º or 275%. A bluff shore type is typically steep or very steep, and then flat for a substantial distance, typically formed by the fast recession of water levels during glacial periods. Bluff substrates tend to consist mostly of silts and clays.



The above photos are examples of a cliff shoreline (left) and a bluff shoreline (right).

2. *Rocky Shoreline* – The Rocky Shoreline field allows assessors to enter the percentage of the segment, based upon the shore segment length, which is rocky. Rocky shores consist mostly of boulders and bedrock, with components of large cobble and some gravels. These shores tend to occur on steeper shorelines. Previous versions of the data dictionary called these shorelines low rocky shorelines or possibly (but less so) vegetated shorelines.

The photo above is an example of a typical rocky shoreline. Sometimes, a rocky shoreline may contain less bedrock and larger boulders. Substrates on these shoreline should consist predominantly of larger cobbles, boulders, and bedrock.

3. *Gravel Shoreline* – The Gravel shoreline field contains the percentage of the segment, based upon the shore segment length, that is a gravel beach. Gravel beach shorelines tend to occur on Low or Moderate slopes, and substrates are predominantly gravels and cobbles. These shore types may also contain small percentages of boulders and / or bedrock. Often times, gravels beaches and rocky shores occur along one segment, with gravel shore types occurring in depositional areas (i.e., in bays) and rocky shores (i.e., at points) occurring in erosion areas. Previous data base versions may have also referred to these shorelines as vegetated shores.

The photo above shows a typical gravel beach. Notice that substrates consist mostly of gravels and cobbles. Gravel shorelines may also have boulders and periodic patches of bedrock in some instances. In previous database versions, a shoreline such as this may also have been referred to as a vegetated shore.

4. *Sand Shoreline* – The Sand Shoreline type contains the percentage of the shoreline, based upon the shore segment length, which is a sand beach. Sand beach shorelines tend to occur within low gradient areas and consist predominated of sands and small gravels. These shore types may also contain some gravel shoreline areas in places that are more exposed to wind and wave action (e.g., points).

The photo above shows a typical sandy shoreline.

5. *Stream Mouth* – The Stream Mouth field contains the percentage of the shoreline, based upon the shore segment length, which is a stream confluence. A stream mouth is defined as the space where there is a confluence between a lake and a stream or a river and the stream has direct influence on sediment movements and deposition or is part of the active floodplain. Typically, the stream mouth segment is larger for rivers and smaller for creeks. A separate segment should be created for significant fisheries streams, such as those known to contain spawning populations of anadramous salmon.

The photo above is the Adams River on Shuswap Lake. This is a good example of a stream mouth segment.

6. *Wetland* – The Wetland shore type field contains the percentage of the shoreline, based upon the shore segment length, which is a shore marsh wetland. A wetland segment typically occurs on low gradient sites, the littoral zones is wide and shallow, substrates are predominantly silts, organics, or clays, and there is emergent vegetation present. The Wetlands of British Columbia defines a shore marsh as a seasonally or permanently flooded non tidal mineral wetland that is dominated by emergent grass like vegetation. The BC Wetland book contains descriptions of some of the wetland shore types that may be observed along lake shorelines

The photo above shows an example of a wetland shore type. Notice the significant amounts of emergent vegetation. The Wetlands of British Columbia A Guide to Identification (MacKenzie and Moran, 2004) book provides specific classifications for the different types of marshes that occur.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.4 Land Use

The Land Use section allows assessors to provide more detail regarding existing land uses. Land use categories have been created to generally correspond with a broad range of local government zoning bylaws. Other categories have been created to correspond with provincial, non-profit, and federal government land use types (e.g., natural areas parks, conservations areas, etc.). In many cases, shore segments will have only one land use type. However, in some instances, land uses may slightly vary along a segment and the differences do not warrant creation of a new shore segment. These fields allows users to enter the percentage of the shoreline, based upon the shore segment length, which the different land uses occupy.

When determining the percentage of a segment that a shore type occupies, assessors should utilize whatever data is available to them. During the field assessments, scaled air photos can be used to determine the approximate percentage. If field maps are not available, assessors should use best judgment to estimate the percentages. As segment lengths become longer, it becomes more difficult to estimate the percentage of a segment a

particular shore type occupies. Given this, an assessor should be cognizant of the distance traveled, boat speed, and other factors when judging the percentage of the segment.

1. *Agriculture* – The agriculture land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for crop based agricultural or as active livestock range lands (i.e., extensive holding areas, large numbers of cattle etc.). Livestock pastures that are not active rangelands (i.e., a few cows or horses) are typically considered a rural land use and not an agriculture land use (see rural). These lands are typically part of the Agriculture Land Reserve or aprovincial range tenure.

2. *Commercial* - The Commercial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for commercial purposes. Commercial purposes include retail, hotels, food establishments, marinas with fuel, stores, etc. Commercial areas tend to occur along highly impacted shorelines. Where feasibly, significant commercial areas should be part of one segment because the land use on these shore types has a different assortment of potential impacts. Commercially zoned, but yet to be constructed areas, may also warrant there own segment.

3. *Conservation* - The Conservation land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for conservation of critical or important habitats. Examples of conservation shorelines include lands held by the Land Conservancy, biological reserves, etc. Conservation lands cannot occur on privately held shorelines, unless conservation covenants or other agreements are in place to protect areas in perpetuity.

4. *Forestry* - The Forestry Land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for forestry. These areas are typically crown lands that are part of active cut blocks or forestry operations. Log Yards are considered an industrial land use and are not considered a Forestry Land because they tend to have associated industrial infrastructure.

5. *Industrial* - The Industrial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for industrial purposes. Examples of industrial purposes include log yards, processing facilities, lumber mills, etc. These shorelines are typically heavily impacted by infrastructure, impervious surfaces, buildings, etc.

6. *Institutional* - The Institutional land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for institutional purposes. Examples of institutional land uses include schools, public libraries, etc.

7. *Multi-Family Residential* - The Multi-Family land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for

multi-family residences. Multi-family developments are typically condominiums, apartments, or town homes.

8. *Natural Areas* - The Natural Areas land use field is the percentage of the shoreline, based upon the shore segment length, which are predominantly undisturbed crown lands. These areas do not occur in provincial or federal parklands and cannot be privately held.

9. *Park* - The Park land use field is the percentage of the shoreline, based upon the shore segment length, which are predominantly natural areas parklands. These parks areas can be provincial, federal, or local government parks. These parks tend to be relatively undisturbed and natural. They differ from urban parks (discussed below), which are used intensively for recreational purposes (e.g., public beaches).

10. *Recreation* - The Recreation land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for recreational purposes. Examples include public or private campgrounds, areas of known cabin rentals, etc. In some cases recreational shoreline may also be referred to as a single family land use, depending upon how much information is known about them. Generally, if a shoreline contains privately held cabins that are rented out occasionally, these should be referred to as single family land uses rather than recreational.

11. *Rural* - The Rural land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for rural purposes. These shorelines are typically large lots, private estates, or hobby farms. Differentiation between rural and single family land use can be difficult when lots are narrow but deep (i.e., buildings appear dense on the shoreline but extend quite far back). When doubt exists between a rural designation and a single family land use, assessors should be consistent in their judgments and refer back to local government zoning or bylaws to help decide on the appropriate land use type.

12. *Single Family Residential* - The Single Family Residential land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used for single family residential purposes. Typically, single family residential occurs in more densely developed areas. However, seasonal use cottages or cabins can often be considered single family residential areas if the dwellings have associated outbuildings, docks, and other features consistent with more densely developed areas. In areas where the there are numerous seasonal use cabins and cottages, assessors should consider this single family residential if lots have smaller lake frontages and land uses and buildings are consistent with single family types of development. If lake frontages for seasonal use cabins and cottages are quite large, the land use would be considered rural. The differentiation between rural and single family in these cases can be difficult and assessors should be consistent in their determination.

13. *Urban Parklands* - The Urban Park land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used as an urban park. Examples of this land use include public beaches, picnic areas, etc. Shorelines dominated by this land use tend to have limited riparian vegetation and contain extensive areas of turf in the understory.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.5 Substrates

The substrate section of the data dictionary allows assessors to enter in detailed information regarding foreshore substrates. Shore substrates are important for a variety of reasons and can influence primary productivity. When describing shore substrates, assessors should describe a *representative distribution* of substrates along the shoreline. It is acknowledge that shore substrates are variable along shore segments; with many areas have concentrations of coarse or fine materials. Thus, this section provides a description of the distribution of substrates and may not be representative of particular micro-sites that occur along the segment.

When assessing substrates, the entire shore segment should be considered. In many cases, small amounts of a particular substrate type may be observed (e.g., one small bedrock outcrop along a gravel shoreline). In these cases, a value of 1% should be used to acknowledge the presence of this substrate type along the shore segment.

Shore substrates are best viewed at low water levels because more of the foreshore is visible. However, often assessments do not coincide with these periods. Thus, binoculars are extremely helpful to help determine substrates along a shoreline. They allow assessors to better assess particle size to appropriately fill in data fields. Assessors may also wish to exit the vessel and visually inspect the shoreline substrates. The data fields in the data dictionary allow assessors to enter in detailed information for highly visible shorelines and summary information for less visible shorelines (e.g., Gravels can be entered as total gravels or sub described as fine and coarse gravels). As segment lengths become longer, it becomes more difficult to estimate the percentage of a segment a particular shore type occupies. Given this, an assessor should be cognizant of the distance traveled, boat speed, and other factors when judging the percentage of the segment.

The following are descriptions of the different substrate type fields that occur within the data dictionary. Substrate definitions below are derived from the SHIM manual (Mason and Knight, 2001) and Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (2001)

1. *Marl* - The Marl substrate field allows assessors to enter the relative percentage of marl occurring along the shoreline. Marl is a substrate that is typically white in color, associated with clear lakes and consists of loose clay, precipitated calcium

carbonate, mollusk/invertebrate shells, and other impurities. Marl substrates would often be associated with fines, mud, or organics depending upon the lake.

2. *Mud* - The Mud substrate field allows assessors to enter the relative percentage of mud occurring along the segment. Mud is a substrate that is typically dark in color and consists of a mixture of silts, clays, and finely decayed organic material that is not typically discernable.

3. *Organics* - The Organic substrate field allows assessors to enter the relative percentage of organic materials that occur along the shoreline. Organic substrates are typically associated with wetland sites and consist of detritus material that is identifiable to some extent (e.g., sticks, leaves, etc.). Organics generally do not form a large proportion of the substrates unless the shore segment is an extremely productive wetland.

4. *Fine Substrates* - The Fine Substrate field allows assessors to enter the relative percentage of fines that occur along the shoreline. Fines consist of silts and clays and these substrates are typically less than 0.06 mm in size. Fines are differentiated from mud because there is little to no organic content.

5. *Sand Substrates* - The Sand substrates field allows assessors to enter the relative percentage of sands that occur along the shoreline. Sands are any particle that contains granular particles visible to the naked eye. These particles are typically .06 to 2 mm in size.

6. *Gravel Substrates* - The Grave substrates field allows assessors to enter the relative percentage of gravels that occur along the shoreline. Gravels are particles that range from 2 mm to approximately 64 mm. Thus, they are the size of a lady bug to the size of a tennis ball or orange. This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine or coarse gravels (see below).

7. *Fine Gravel Substrates* - The Fine Gravel substrates field allows assessors to enter the relative percentage of fine gravels that occur along the shoreline. Fine gravels are particles that are 2 mm to approximately 16 mm or the size of a ladybug to the size of a grape. This field should only be used when assessors have good visibility and can confidently identify fine gravels. If this field is used, the general gravel category should *not* be used.

8. *Coarse Gravel Substrates* - The Coarse Gravel substrates field allows assessors to enter the relative percentage of coarse gravels that occur along the shoreline. Coarse gravels are particles that are 16 mm to approximately 64 mm or the size of a grape to the size of a tennis ball or orange. This field should only be used when assessors have good visibility and can confidently identify coarse gravels. If this field is used, the generally gravel category should *not* be used.

9. *Cobble Substrates* - The Cobble substrates field allows assessors to enter the relative percentage of cobbles that occur along the shoreline. Cobbles are particles that are 64 to 256 mm in size (tennis ball to basketball).

10. *Fine Cobble Substrates* - The Fine Cobble substrates field allows assessors to enter the relative percentage of fine cobbles that occur along the shoreline. Fine cobbles are particles that are 64 to 128 mm in size (tennis ball to coconut). This field should only be used when assessors have good visibility and can confidently identify fine cobbles. If this field is used, the general cobble category should *not* be used.

11. *Coarse Cobble Substrates* - The Coarse Cobble substrates field allows assessors to enter the relative percentage of course cobbles that occur along the shoreline. Coarse cobbles are particles that are 128 to 256 mm in size (coconut to basketball). This field should only be used when assessors have good visibility and can confidently identify coarse cobbles. If this field is used, the general cobble category should *not* be used.

12. *Boulder Substrates* - The Boulder substrates field allows assessors to enter the relative percentage of boulders that occur along the shoreline. Boulders are particles that are greater than 256 mm in size (bigger than a basketball). These substrates can not typically be lifted by one person as they are too heavy.

13. *Bedrock Substrates* - The Bedrock substrates field allows assessors to enter the relative percentage of bedrock that occurs along the shoreline. Bedrock is consider any rock where blocks are larger than 4 m or is solid, un-weathered underlying rock.

14. *Embeddedness of Substrates* - Embeddedness is a categorical field that allows assessors to enter the approximate embeddedness of substrates. Embeddedness is a measure of the degree to which boulders, cobbles and other large materials are covered by fine sediments. Categories for embeddedness include None (0%), Low (0 to 25%), Medium (25-75%), High (>75%), or Unknown. When assessors are unclear of the embeddedness they should either complete measurements of foreshore substrates or leave the field as unknown.

15. *Substrate Shape* - Shape is a categorical field that allows assessors to identify the shape of larger particles such as cobble or boulders. Angular shapes refer to naturally occurring angular rock material that has not been substantially weathered. Blast rock refers to angular blast rock materials, such as rip rap. Smooth materials are rocks that are generally rounded. This field should be used to describe the predominant substrates that occur along the shoreline (e.g., if 85 % of the substrates are round and smooth, and 10% are blast rock, the field should be used to describe the 85%).

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.6 Vegetation Bands (Vegetation Band 1 & 2)

The Vegetation Bands sections of the data dictionary are intended to allow assessors to describe lake side vegetation that occurs. The data dictionary includes two sections, Vegetation Band 1 and Vegetation Band 2, which are almost identical. The addition of a second Vegetation Band occurred during the summer of 2008 because in many cases there are two distinctive vegetation zones that exist adjacent to lakes. Other dictionaries have called these two sections Riparian and Upland. The riparian zone, tends to occur in moist areas, and often transitions to drier upland areas. Also, in many wetlands, there is a wide band of emergent shrubs and willows, and then a riparian zone beyond the wetland features. When assessing Vegetation Bands, assessors should consider everything within 50 m of the shoreline and possible the band of emergent riparian vegetation associated with wetland features. The approximate length of the bands considered is the sum of Vegetation Band 1 and 2 Bandwidths.

Vegetation bands can be extremely variable along a segment. Assessors should focus on the primary or dominant vegetation observed along the segment and people utilizing the data must understand that this overview inventory cannot describe every micro-site that may exist. When assessing the different bands, assessors should consider both the linear length and depth of the bands. The intent is to describe a representative section of the shore segment.

In highly urbanized or impacted areas, it is often difficult to define a clear band. In these cases, it is generally preferred to limit the assessment to the first row of development, which often times results in describing only one vegetation band. In other cases, shorelines may not contain two distinctive bands of vegetation. In these circumstances, assessors should only describe the shoreline with one vegetation band, leaving the second band blank. The comments field is a useful section that allows assessors to describe exactly what is being described. Also, the bandwidth fields (discussed below) are helpful because they give an indication of the width of the band.

The following sections describe all fields that occur in Vegetation Band 1 and 2. Fields are duplicated in Vegetation Band 2 and are therefore only described once here. Please refer to Appendix A for a tabular description of information below.

1. *Vegetation Class* - The Vegetation Band 1 Land Cover Class is a description of the predominant vegetation class present. Categories are largely derived from the SHIM Module 4 (Mason and Knight, 2001).

    a. The Coniferous Class occurs where tree cover is at least 20% of the shore zone area and at least 80% of the trees are coniferous.

b. The Broadleaf Class occurs where the tree cover is at least 20% and at least 65% of the trees are broadleaf or deciduous.
c. The Mixed Forest Class occurs where tree cover is at least 20% and there are no more than 80% coniferous trees and no more than 65% broadleaf trees.
d. The Shrubs Class occurs where tree coverage is less than 10% and there shrubs cover at least of 20%. Shrubs are defined as multi-stemmed woody perennial plants.
e. The Herbs / Grasses Class occur where there is less than 10% tree coverage and less than 20% of shrubs.
f. The Exposes Soil Class occurs where recent disturbance, either anthropogenic or natural, has occurred and mineral soils are exposed.
g. The Landscape Class refers to urbanized areas where most natural vegetation has been replaced by at least 30% coverage of ornamental trees, shrubs, and other vegetation.
h. The Lawn Class occurs in urbanized areas where turf grasses cover at least 30% of the shore zone area and landscaping with ornamental shrubs or trees is less than 30% coverage.
i. The Natural Wetland Class occurs where shore marshes dominate the shore zone area and they have not been significantly influenced by human disturbance.
j. The Disturbed Wetland Class occurs where shore marshes predominate the shore zone area and they have experience significant disturbance (i.e., greater than 30%).
k. The Row Crops Class occurs in agricultural areas where crops are growing. If sites are agricultural, but are not used for row crops (e.g., pasture lands), they should be described as Herbs/Grasses and comments should be used to indicate the agricultural nature of the shore segment.
l. Un-vegetated Sites occur where there is less than 5% vegetation cover and at least 50% of the vegetation cover is mosses or lichens. Un-vegetated sites tend to occur on rocky, exposed shorelines.

2. *Vegetation Stage* - The Vegetation Band 1 Stage is a description of the structural stage of the dominant vegetation. Categories are largely derived from the SHIM Module 3 and the Field Manual for Describing Terrestrial Ecosystems (MOE, 1998). On highly developed shorelines, assessors should attempt to describe the structural of the dominant vegetation type observed.

a. The Sparse Stage describes sites that are in the primary or secondary stages of succession, with vegetation consisting mostly of lichens and mosses, and the total shrub coverage is less than 20% and tree coverage is less than 10%.
b. The Grass / Herb Stage describes sites where shore zones are dominated by grasses and herbs, as a result of persistent disturbance of natural conditions (e.g., grasslands).
c. The Low Shrubs stage describes sites that are dominated by shrubby vegetation less than 2 m in height.

d. The Tall Shrubs Stage is dominated by vegetation that is 2 to 10 m in height and seedlings and advance regeneration may be present.
e. The Pole / Sapling Stage describes sites that contain trees greater than 10 m in height, typically densely stocked, and there is little evidence of self thinning or vertical structure.
f. The Young Forest Stage describes sites that are typically less than 40 years old (but could be as great as 50 to 80 years depending upon the forest community), self thinning is evident, and the forest canopy has begun to differentiate into distinct layers.
g. The Mature Forest Stage describes sites that are typically 40 to 80 years old (but could be as high as 140 years), and the understory is well developed with a second cycle of shade trees.
h. The Old Forest Stage describes sites that are typically greater than 80 years old and the stands are structurally complex. Old Forests contain abundant coarse woody debris at varying stages of decay. Old Forests are at least 80 years in age, but may be as old as 250 years and should be considered relative to the forest community assessors are in.

3. *Shrub Cover* - The Shrub Coverage categorically describes shrub coverage within the shore zone. Shrubs are defined as multi-stemmed woody perennial plants. Sparse sites have less than 10% shrub coverage. Moderate shrub coverage occurs on sites that have between 10 to 50% coverage. Abundant shrub coverage occurs on sites that have greater than 50% shrub coverage.

4. *Tree Cover* - The Tree Cover categorically describes tree coverage within the shore zone. Sparse sites have less than 10% tree coverage. Moderate tree coverage occurs on sites that have between 10 to 50% coverage. Abundant tree coverage occurs on sites that have greater than 50% tree coverage.

5. *Distribution* - The Distribution field is used to describe whether the vegetation band described is continuous along the entire shore segment. Categories include Continuous and Patchy (for sites where the dominant vegetation band occurs in patches along the segment). An example of a patchy distribution is a shore segment where most areas are extensively landscaped, with the exception of a few shore lots which remain relatively natural. In this case, the dominant landscaped area would be described and comments would be used to identify residual natural areas.

6. *Bandwidth* - The Vegetation Band 1 Bandwidth field is used to provide an estimate of the approximate width of the band being described. In cases where bandwidth varies along the segment, a representative width should be used to describe the shore segment. The intent of this field is to provide a general description of the width of the vegetation band that is being described and users of the database need to consider this when assessing data within the database.

7. *Overhanging Vegetation* - The Overhanging Vegetation field is used to describe the percentage of the shore segment length that contains significant overhanging

vegetation. Overhanging vegetation should be considered as if the lake was at full pool or the mean annual high water level.

8. *Aquatic Vegetation* - The Aquatic Vegetation field is used to describe the percentage of the shoreline that contains emergent, submergent, and floating aquatic vegetation. This field is the combined length of aquatic vegetation along the segment, not considering overlapping areas.

9. *Submergent Vegetation* - The Submergent Vegetation field is used to describe the percentage of the shoreline segment that contains submergent vegetation. Submergent vegetation includes species such as milfoil, *Potamogeton* spp., etc.

10. *Submergent Vegetation Presence* - The Submergent Vegetation Presence field is used to indicate whether submergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.

11. *Emergent Vegetation* - The Emergent Vegetation field is used to describe the percentage of the shoreline segment that contains emergent vegetation. Emergent vegetation includes species such as cattails, bulrushes, varies sedges, willow and cottonwood on floodplains, grasses, etc.

12. *Emergent Vegetation Presence* - The Emergent Vegetation Presence field is used to indicate whether emergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.

13. *Floating Vegetation* - The Floating Vegetation field is used to describe the percentage of the shoreline segment that contains floating vegetation. Floating vegetation includes species such as pond lilies, etc.

14. *Floating Vegetation Presence* - The Floating Vegetation Presence field is used to indicate whether floating vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.7 Littoral Zone

The Littoral Zone section of the data dictionary includes biophysical information about the littoral zone within the segment. Air photos are extremely helpful for determining the width of this zone, but are not necessary. The data fields in this section are quite easy to fill out and interpretation is not that difficult.

1. *Littoral Zone* - The Littoral Zone Width Category provides a general classification of the littoral zone. Wide littoral zones are greater than 50 m. Moderate littoral zones are 10 to 50 m in width, and narrow littoral zones are less than 10 m wide.

2. *Large Woody Debris* - The Large Woody Debris (LWD) presence field allows assessors to indicate whether LWD is present along the segment. Categories include less than 5 Pieces, 5 to 25 Pieces, and greater than 25 Pieces.

3. *Large Woody Debris Number* - The LWD count field allows assessors to enter the total number of LWD pieces counted along the shore segment. Only significant pieces of LWD, which are contributing to fish habitat, should be counted.

4. *Littoral Zone Width* - The Littoral Zone Width field allows assessors to enter the average littoral width of the segment. This field can be determined using air photo interpretation or field measurements. Typically, the field is rounded to the nearest 5 m as the number is intended to be representative of the segment.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.8 Modifications

The Modifications section allows assessors to enter a summary of all of the different types of shoreline modifications that may occur along the shore segment. Most of the categories described in this section are features or structures that are counted. However, some of the fields require assessors to pay attention to the percentage of the segment that modifications are observed along. As mentioned above, assessors need to be cognizant of boat speed, distance traveled, and this relationship to the feature in question. Again, use of air photos to estimate and scale shoreline length to determine the percentage is extremely beneficial and improves the accuracy of measurements.

1. *Retaining Walls* - The Retaining Wall count field is the total number of retaining walls occurring along the segment. Retaining walls should only be counted if they are within 5 to 10 m of the high water level. Retaining walls must have a vertical element that is greater than 30 cm and must be retaining earth to some degree. On steep sloping sites, more than one retaining wall may be present (i.e., the property is tiered). In these cases each retaining wall is counted.

2. *Percent Retaining Walls* - The Percent Retaining Wall field indicates that approximate percentage of the shore segment length where retaining walls occur.

3. *Docks* - The Docks Count field is the total number of pile supported or floating docks or swimming platforms that occur along the segment. Properties may have more than one dock present and each different structure is considered a separate dock. For instance, a property could have one swimming float and one dock.

4. *Docks per Kilometer* - The Docks per Kilometer field is determined during post processing. This field is calculated by dividing the total number of docks observed by the total length of the shore segment.

5. *Boat House* - The Boat House count field is used to count boat houses that occur along the segment. Boat Houses are structures that are specifically designed to house boats or watercraft. Boat Houses can either be located on land or as structures over the water. If only structures over the water are counted, assessors should be consistent and make note of this so end users are aware of what definition was used for a boat house. If structures on land are considered as boat houses, a rail or boat launch should be present that land owners use to launch the boat to the lake. Garages that house boats should not be counted as boat houses because there is not an associated launch structure.

6. *Groynes* - The Groyne count field is used to count any structure that is perpendicular to the shoreline that is impacting regular sediment drift along the shoreline. Groynes can be constructed out of concrete, rock, piles, wood, or other materials. Docks or other structures that are acting as groynes, and affecting sediment movement should be included in the groyne count. Rock lines that are too small to significantly impact sediment movement should not be counted as a groyne.

7. *Groynes per Kilometer* - The Groynes per Kilometer field is determined during post processing of data. This field is calculated by dividing the total number of groynes observed by the total length of the shore segment.

8. *Boat Launch* - The Boat Launch count field is the total number of boat launches that were observed along the shoreline. Generally, only permanent boat launches are counted (e.g., made of concrete). However, on small systems assessors may choose to count gravel boat launches as these may be the only type present. Assessors should document criteria used to determine what constitutes a boat launch during the assessment.

9. *Percent Rail Modifier* - The Percent Rail Modifier field is used to describe the percentage of the linear shore segment length that contains railways in close proximity to the shoreline.

10. *Percent Road Modifier* - The Percent Road Modifier field is used to describe the percentage of the linear shore segment length that contains a roadway in close proximity to the shoreline.

11. *Marine Railways* - The Marine Rail count field is the total number of marine rails that occur along a shore segment. Marine Rails are a track system that is used to remove boats from a lake during the winter months.

12. *Marinas* - The Marinas Field is the total number of large and small marinas that were documented along the shoreline. A marina is considered to be any pile supported or floating structure that has slips for 6 or more boats.

13. *Substrate Modification Presence* - The Substrate Modification Presence field is used to document whether substrate modification is occurring along the shore segment. Substrate modification includes any type of importation of sands, significant movement of natural substrates (e.g., to construct groynes), or earthworks.

14. *Percent Substrate Modification* - The Percent Substrate Modification field is the estimated percentage of the shore segment where substrate modification has occurred.

The remaining fields that are included in the data dictionary are described in Appendix A. These fields do not have any specific methodology and are for information purposes.

4.3.9 Flora and Fauna

The Flora and Fauna sections contain specific information for flora and fauna observations and data along the shore segment. The fields in this section are quite self explanatory and are either count or comments fields.

1. *Veterans* - The Veterans field is a categorical field to describe the number of veteran trees that occur along the shore segment. Veteran trees are defined as a tree that is significantly older than the dominant forest cover and provides increased structural diversity. Categories include no, less than 5 trees, 5 to 25 trees, and greater than 25 trees.

2. *Snags* - The Snags field is a categorical field to describe the number of dead standing snags that occur along the shore segment. Snags are defined as dead standing trees that provide increased structural diversity. Categories include no, less than 5 trees, 5 to 25 trees, and greater than 25 trees.

3. *Flora and Fauna Comments* – These fields are important to note observations made. Examples of important observations are known spawning areas, osprey or other birds of prey nesting locations, etc. Significant features should be individually mapped if possible, especially sensitive nesting areas, etc.

5.0 DATA PROCESSING AND QUALITY ASSURANCE

The data processing and quality assurance portions of these projects are extremely important. It is preferred if assessors carry out these steps because they have firsthand knowledge of the shoreline and its condition. Although data entry into the GPS unit results in minimal errors (i.e., forgotten fields, etc.), there is often times small items that are

missed or accidentally overlooked. It is during the data processing stages that data gets reviewed and finalized.

5.1 Data Processing

Data processing for FIM projects is slightly different than SHIM (Mason and Knight, 2001). Module 5 of the SHIM manual provides very detailed information regarding accuracy requirements for stream mapping. This manual should be referred to as it contains useful information regarding standard GPS receivers, data logging, and other requirements that field assessors need to know and be able to do. The methodology below is intended to provide assessors with a summary of the post processing steps that occur as part of a FIM project and does not contain a summary of methods for use of the GPS or GIS software.

5.1.1 Accuracy and Determining the Shoreline Location

Typically accuracy targets for stream mapping are 5 m (Mason and Knight, 2001). These targets are realistic for stream mapping, but are not possible while carrying out boat surveys of a shoreline. Generally, boat surveys are done 20 to 30 m from the actual shoreline being measured. Thus, there is an immediate accuracy issue, as the line feature being collected with the GPS unit is already inaccurate because it is 20 to 30 m from the shoreline. Thus, precision mapping with the GPS is not required for FIM projects (i.e., PDOP values) because of the inherent data inaccuracies.

Accuracy of shore segment information ultimately relates to the accuracy of the shoreline. Mapped shorelines and the spatial data associated with them should be attached the approximate high water level of the shoreline. The above highlights how accuracy is not feasible with a FIM boat survey. Thus, shoreline accuracy with these surveys is typically obtained using air photo interpretation, detailed topographic modeling, or by using existing lake shoreline information. Each of the above provides a different level of accuracy, and typically a combination approach is preferred. Accuracy of the shoreline segment features can affect the following:

1. The length of the shoreline segment;
2. The location of segment breaks;
3. Calculation in the data base such as docks per kilometer.

The first step in post processing is to accurately identify the location of the approximate high water level of the lake being assessed. This can be accomplished, as mentioned above, by using one or a combination of the following:

1. Creation of the shoreline by air photo interpretation using changes in vegetation, retaining walls, and other visible features;
2. Using a topographical model and spatial analyst software to calculate an elevation, which can be used for a shoreline (e.g., 343 m asl is often used for Okanagan Lake); and,

3. Using existing TRIM shoreline;

There are distinct advantages and disadvantages to each of the above. Advantages of air photo interpretation are that it tends to be quite accurate with good air photos. However, it also tends to be quite time consuming to complete. Use of spatial analyst software is possible, but often the data available to create the model is not very accurate and the software is extremely costly. Use of the TRIM shorelines is very cost efficient, but this line work can often be quite inaccurate (i.e., up to 20 linear m in some instances). Given the above, assessors must consider the accuracy requirements of their assessments to ensure that the desired accuracy is achieved. Assessors should attempt to achieve the 5 m accuracy recommendations of SHIM and utilize whatever means necessary within allowable budgets to achieve these results. GIS software allows data to be updated as increased accuracy becomes possible.

5.1.2 Segment Breaks

Segment breaks are often determined in field assessments by marking field air photos that were produced for the survey because it is more efficient than manually marking the point using the GPS. These visual markers allow segment breaks to be easily added to the shoreline once it has been determined (above) and allows field crews to be very specific about where the break is being made from the boat. If air photo field maps are not possible, assessors are strongly encouraged to manually mark the segment break using a point feature on the GPS unit. Using offset features, it is possible to mark this from the vessel. This is recommended because it is the most accurate ways to ensure the segment break occurs where desired on lakes without high resolution air photos.

Once the shoreline has been mapped, and segment breaks have been determined, the database should be "transferred" to the shoreline. This process involves moving the spatial line features to the shoreline with the appropriate breaks. Some databases include the transferred GPS settings (e.g., PDOP data). This data can be retained, but is somewhat unnecessary because it is associated with line features collected in the boat survey and not associated with the manually determined shoreline features discussed above.

5.2 Data Management and Quality Assurance

Data management is extremely important. One of the typical GPS settings used is a copy feature that allows assessors to quickly begin a segment. However, use of this feature can result in data field carry over (i.e., substrate data from Segment 25 is carried over to Segment 26. The assessor forgets to zero a substrate percentage and the number carries over. The substrates total now exceeds 100%). Therefore, once data has been collected, it must be proofed. This process involves review of photos, data fields, etc. The following are specific items that should be reviewed:

1. Lake Reference – Errors in data collection are not common in this section. Clean up of spelling and comments is most common.

2. Segment Class – In this section, the shore type and shore modifier fields are most important and percentages in other sections should be consulted to confirm. Review percentages and ensure that photo numbers are correct. Video time can be entered if available.
3. Shore Type – Field pictures and air photos should be reviewed in conjunction with field data entered. Typically, only minor adjustments are required to ensure data adds to 100%.
4. Land Use – Land use is often more difficult to determine in rural areas. Often times, digital data is lacking and land use is assessed by field interpretation. Review of local government zoning is helpful as it provides a basis for interpretation. Assessors should do their best to document land uses as observed, and adjustments should be made as necessary.
5. Substrates – Field photos can be reviewed, to assist in final determination of substrates. Generally, these fields just need to be reviewed to determine that they add to 100%. Substrates are intended to provide a broad overview of the distribution of segment.
6. Vegetation Bands – Review of field photos is extremely helpful to review these fields. Having a large number of photos can help assessors in ensuring these sections are accurate. Adjustments should be made as necessary.
7. Littoral Zone – These fields are usually quite accurate. A review of air photos to look at the littoral zone widths will help improve accuracy.
8. Modifications – In these fields, the docks per kilometer and groynes per kilometer need to be calculated. These field as calculated as follows:
    a. Dock (or groynes) per Kilometer = # of Docks / Shore Segment Length

   Other items to pay attention to are modifiers. Airphotos and photos should be carefully reviewed to confirm these fields.
9. Flora and Fauna – These fields usually just need to be briefly reviewed and added as necessary.

Review and finalization of the spatial location of the shoreline, segment breaks, and associated data is very important and assessors should do their best to review data sets.

6.0 REPORTING

Reporting for FIM is a budget dependant item. Reporting is not as important as field data collection, review, and verification. Thus, a variety of different reporting can be completed and the reporting completed varies with budgets and time allotted for the project. Reporting should focus on identification of key concerns observed along the shoreline and data analysis should be used to corroborate findings.

6.1 Data Analysis

Data analysis can be completed in numerous different ways using FIM databases. Most reports prepared to date have followed the templates developed by the RDCO for the central regions of Okanagan Lake. There reports contain numerous different graphs, figures, and correlations prepared using the dataset, and all help with understanding and

interpreting data. Important correlations can lead to a better understanding of modified shorelines.

Integration of biophysical data with spatial data and analysis is also important. These types of analyses often follow and examples include the various different aquatic habitat indices that have been developed. Ultimately, the shore segments described above provide a basis for long term monitoring and data analysis for lake shorelines because new spatial and biophysical data may be appended to the database from future assessments.

7.0 RECOMMENDATIONS FOR ONGOING DATA MANAGEMENT

The following are recommendations for management of these data sets:

- One location should be determined to hold the master database for the different lake systems being assessed. Spatial data management is a big responsibility and one authority should be determined to hold master data sets. However, municipalities, consultants, non-profit organizations, and the public should all have access to data. Local governments are also good at holding and managing data sets because often times they routinely utilize data on a day to day basis. Regardless, one government body should maintain responsibility for data sets.

- As new data is gathered (e.g., AHI), it should be appended to the FIM database. Sub databases should be considered (e.g., detailed substrate mapping, more detailed modifications inventories, etc.) as they are developed. Any sub data bases should be referenced in the FIM Database as a field or column of data. The **Shore Segment Number** should be used as the unique identifier for all sub data sets created. Examples of this include geo hazard assessments, shore spawning assessments, substrate mapping, etc.

- Funding should be allocated at all levels to facilitate ongoing data management and collection. These inventories form the basis for all future land management and land use decisions for large lakes. They will help managers at all levels of government work within a unified framework for understanding environmental data and managing the complex aquatic systems associated with our large interior lakes.

- The most recent data base version is SHIM LAKE v. 2.6. This report has attempted to identify and consolidate versions of the dictionary. Future revisions of the methodology should provide a reference guide for changes / additions.

8.0 REFERENCES

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Appendix A – Foreshore Inventory and Mapping Field Code Definitions

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Lake Reference	LAKE_NAME	Lake Name		Alphanumeric	Local lake name	
	LAKE_LEVEL	Lake Level		Numeric	On gauged lakes, lake level is the geodetic level (i.e., above sea level) of the lake the day the assessment was completed. This will help people utilizing data understand at what water level the data was collected. This field should be left blank if the lake level is unknown or if the lake is not gauged.	
	SECHI_DEPT	Secchi Depth		Numeric	Secchi depth is a measure of the point where a 20 cm weighted white line disappears from view when lowered from the shaded side of a vessel and that point where it reappears upon raising it. This measurement should be made at mid-day as it results are more variable at dawn and dusk. Secchi depths vary depending upon the time of year measured and productivity of a lake, and in lakes with increased particulate matter (e.g., algae).	Meter
	ORGANIZATI	Organization		Alphanumeric	Organization is the government, non-profit organization, or companies who are responsible for collection of the field data.	
	DATE_	Date		Alphanumeric	Date field data was collected.	
	TIME_	Time		Time	Time field data was collected.	
	CREW	Crew		Alphanumeric	The initials of all field crew, including boat skippers, should be included.	
	WEATHER	Weather		Categorical	The weather is a categorical field. Available options include Light Rain, Heavy Rain, Snow/Sleet, Over Cast, Clear, Partly Cloudy, and other. This field should be filled in with the most appropriate weather observed throughout the day. If the Other category is chosen, field assessors should identify the weather in the comments field.	
	AIR_TEMP_	Air temperature		Numeric	Air temperature is the temperature observed during the assessment.	Celsius
	WATER_TEMP	Water Temperature		Numeric	Water temperature is the water temperature observed during the assessment. This field is not mandatory.	Celsius
	JURISDICTI	Jurisdiction		Alphanumeric	Jurisdiction is the governmental entity that has predominant governance over the shoreline being assessed. Typically, this would be a local government, regional district or native band. In some cases, the shoreline may occur along crown land or within a provincial park. If possible, field assessors should break segments at all major changes in jurisdiction to allow for better management of shore line segments. If a segment break is not included at a change in jurisdiction, the jurisdiction with the predominant length of shoreline should be listed here and the secondary jurisdiction should be noted in the comments field.	
	COMMENTS	Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
Segment Class	SEGMNT_NUM	Shoreline Segment Number		Numeric	The shoreline segment number is a field that identifies the shore segment. Typically, shore segments begin a 1 and continue until the entire shoreline has been mapped. A shore segment is an area of with similar land use, shore type, vegetation, and substrates.	
	SHORE_TYPE	Shore Type		Categorical	Shore type is a categorical field that describes the predominant shore type that occurs along the length of the shore segment (i.e., the highest percentage of the linear shoreline length). Shore types include Cliff/Bluff, Rocky Shore, Gravel, Sand, Stream Mouth, Wetland, and Other. If other is selected, comments should be included to describe the shore type observed.	
	SHORE_MODI	Shore Type Modifier		Categorical	The shore type modifier field is used to describe significant shoreline activities that influence the shoreline. The field is categorical and choices include Log Yard, Small Marina (6-20 slips), Large Marina (greater than 20 slips), Railway, Roadway, None, and Other. If other is selected, the comments field should be used to identify the modifier. If the field is left blank, users should assume that there is no shoreline modifier.	
	SLOPE	Slope		Categorical	Slope is a categorical determination of the slope or gradient of the shoreline. Categories include Low (less than 5%), Moderate (5-20%), Steep (20-60%), Very Steep (>60%), and Bench. A bench is a shoreline that rises, typically steep or very steep, has a flat area typically greater than 15 horizontal meters, and then becomes steep or very steep again. On bluff shore types, where the shoreline rises sharply and then flattens, the categorical statement should describe the steep portion of the shoreline (i.e., do not use bench).	

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Segment Class	LAND_USE	Land Use		Categorical	Land use is a categorical field that is used to describe the dominant land use observed along the segment. Categories include Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single Family, Rural, and Urban Park. Land use can be determined based upon a combination of field observation, review of zoning and bylaw maps, and air photo interpretation. Please refer to detailed definitions of the different land use types to better understand the different categories.	
	LEV_OF_IMP	Level of Impact		Categorical	Level of impact is a categorical field that is used to describe the general disturbances that are observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered shoreline including foreshore substrates, vegetation, or the shoreline (e.g., retaining walls). Level of impact is considered both looking at the length of the shore line (i.e., along the segment) and the depth of the shore zone area to between 15 to 50 m back. In more rural settings, typically the assessment area is greater (i.e., 50 m) and in more developed shorelines, typically the assessment area is less (i.e., 15 m). In cases of roadways or railways, one should generally assess the location of the rail or roadway along the segment. 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%), or None. Consistency of determination is very important and assessors should consistently use the same criteria to determine the level of impact.	
	LIVEST_ACC	Livestock Access		Categorical	Livestock access is a categorical field that is used to determine whether livestock, such as cattle, have access to the foreshore. Choices include Yes or No or blank. If the field is left blank, one should assume that cattle do not have access.	
	DISTURBED	Percentage of the Shoreline that is Disturbed		Numeric	Percentage of the shoreline that is disturbed is a measurement of the approximate length and depth of the shore zone that has been disturbed. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the percentage disturbed should correspond to the level of impact (i.e., a high percentage of disturbance should translate into a High level of impact). The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.	%
	NATURAL_	Percentage of the Shoreline that is Natural		Numeric	Percentage of the shoreline that is natural is a measurement of the approximate length and depth of the shore zone that remains in a natural condition. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the percentage natural should correspond to the level of impact. The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.	%
	PHOTONUM	Photo Number		Alphanumeric	Photo number is a field that is used to enter in digital or still photos taken during the assessment.	
	TAPE_NUMB	Tape Number		Alphanumeric	Original Video tape number	
	VIDEO_TIME	Video Time		Alphanumeric	Delineates that start and stop time of the video segments. Assessors may also just enter in the start time of the segment, as it is generally inferred that the start time of one segment corresponds with the stop time of a previous segment.	
	CMMNT_CLAS	Class Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the class data fields above.	
Shore Type	CLIFF_BLUF	Cliff and/or Bluff Shore Type		Numeric	The Cliff / Bluff field contains the percentage of the segment, based upon the shore segment length that is a cliff or bluff shore type. A cliff shore type is typically very steep with substantial vertical elements. A bluff shore type is typically steep or very steep, and then flat for a substantial distance, typically formed by the fast recession of water levels during glacial periods.	%
	ROCKY	Rocky Shore Type	Low Rocky Shoreline and/or Vegetated Shoreline	Numeric	The Rocky Shoreline field contains the percentage of the segment, based upon the shore segment length that is rocky. Rocky shores consist mostly or boulders and bedrock, with components of large cobble and some gravels. These shores tend to occur on steeper shorelines. Previous versions of the data dictionary called these shorelines low rocky shorelines or possible (but less so) vegetated shorelines.	%

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Shore Type	GRAVEL2	Gravel Shore Type	Gravel Beach Shore Type	Numeric	The Gravel shore type field contains the percentage of the segment, based upon the shore segment length that is a gravel beach. Gravel beach shorelines tend to occur on Low or Moderate slopes, and substrates are predominantly gravels and cobbles. These shore types may also contain small percentages of gravels and or bedrock. Often times, gravels beaches and rocky shores occur along one segment, with gravel shore types occurring in depositional areas (i.e., in bays) and rocky shores (i.e., at points) occurring in erosion areas.	%
	SAND2	Sand Shore Type	Sand Beach Shore Type	Numeric	The Sand shore type field contains the percentage of the shoreline, based upon the shore segment length that is a sand beach. Sand beach shorelines tend to occur in low gradient shorelines and are predominated by sands and small gravels. These shore types may also contain some gravel shoreline areas in places that are more exposed to wind and wave action (e.g., points).	%
	STREAM_MOU	Stream Mouth Shore Type	Alluv_Fan or Alluvial Fan	Numeric	The Stream Mouth shore type field contains the percentage of the shoreline, based upon the shore segment length that is a stream mouth. A stream mouth is defined as the space where there is a confluence between a lake and a stream or a river and the stream has direct influence on sediment movements and deposition or is part of the active floodplain. Typically, the stream mouth segment is larger for rivers and smaller for creeks. A separate segment should be created for significant fisheries streams, such as those known to contain spawning populations of anadramous salmon.	%
	WETLAND	Wetland Shore Type		Numeric	The Wetland shore type field contains the percentage of the shoreline, based upon the shore segment length that is a shore marsh wetland. A wetland segment typically occurs on low gradient sites, the littoral zones is wide and shallow, substrates are predominantly silts, organics, or clays, and there is emergent vegetation present. The Wetlands of British Columbia defines a shore marsh as a seasonally or permanently flooded non tidal mineral wetland that is dominated by emergent grass like vegetation. The BC Wetland book contains descriptions of some of the wetland shore types that may be observed along lake shorelines	%
	OTHER	Other Shore Type		Numeric	The Other shore type field allows assessors to enter in shore types that do not fit into one of the general categories above. If the other shore type field is used, assessors should add comments to describe the shore type and provide justification for use of the other field. Examples of other shore types may include constructed boat access canals.	%
	STYPE_COMM	Shore Type Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the shore type data fields above.	
Land Use	AGRICULTUR	Agriculture Land Use		Numeric	The agriculture land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for crop based agricultural or as active livestock range lands (i.e., extensive holding areas, large numbers of cattle). Livestock pastures that are not active rangelands (i.e., a few cows or horses) are not considered an agriculture land use (see rural).	%
	COMMERCIAL	Commercial Land Use		Numeric	The Commercial Land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for commercial purposes. Commercial purposes include retail, hotels, food establishments, marinas with fuel, stores, etc. Commercial areas tend to occur along highly impacted shorelines.	%
	CONSERVATION	Conservation Land Use		Numeric	The Conservation Land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for conservation of critical or important habitats. Examples of conservation shorelines include lands held by the Land Conservancy, biological reserves, etc. Conservation lands cannot occur on privately held shorelines, unless conservation covenants or other agreements are in place to protect areas in perpetuity.	%
	FORESTRY	Forestry Land Use		Numeric	The Forestry Land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for forestry. These areas are typically Crown Lands that are part of active cut blocks. Log Yards are not considered a Forestry Land use as they are Industrial.	%
	INDUSTRIAL	Industrial Land Use		Numeric	The Industrial Land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for industrial purposes. Examples of industrial purposes include log yards, processing facilities, lumber mills, etc. These shorelines are typically heavily impacted.	%

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Land Use	INSTITUTIO	Institutional Land Use		Numeric	The Institutional Land Use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for institutional purposes. Examples of institutional land uses include schools, public libraries, etc.	%
	MULTI_FAMI	Multi-Family Land Use	LU_URB_RES or Urban Residential Land Use	Numeric	The Multi-Family Land Use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for multi-family residences. Multi-family developments are typically condominiums or town homes.	%
	NATURAL_AR	Natural Areas		Numeric	The Natural Areas Land use field is the percentage of the shoreline, based upon the shore segment length that is predominantly natural crown lands. These areas do not occur in provincial parklands and cannot be privately held.	%
	PARK	LU_PARK or Park			The Park Land Use field is the percentage of the shoreline, based upon the shore segment length that is predominantly natural areas parklands. These parks areas can be provincial, federal, or municipal parks. These parks tend to be predominantly natural and are different from urban parks, which are used intensively for recreational purposes (e.g., public beaches).	%
	RECREATION	Recreation Land Use		Numeric	The Recreation Land Use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for recreational purposes. Examples include public or private campgrounds, areas of known cabin rentals, etc. In some cases recreational shoreline may also be referred to as single family land uses, depending upon how much are known about them. Generally, if a shoreline contains privately held cabins that are rented out occasionally, these should be referred to as single family land uses rather than recreational.	%
	RURAL	Rural Land Use		Numeric	The Rural Land Use field is the percentage of the shoreline, based upon the shore segment length that is predominantly used for rural purposes. These shorelines are typically large lots, private estates, or hobby farms. Differentiation between rural and single family land use can be difficult when lots are narrow but deep (i.e., appear dense on the shoreline but extend quite far back). When doubt exists between a rural designation and a single family land use, assessors should be consistent in their judgments and refer back to local government zoning or bylaws to help decide on the appropriate land use type.	%
	SINGLE_FAM	Single Family Residential	LU_URB_RES or Urban Residential Land Use	Numeric	The Single Family Residential Land Use is the percentage of the shoreline, based upon the shore segments length that is predominantly used for single family residential purposes. Typically, single family residential occurs in more densely developed areas. However, seasonal use cottages or cabins can often be considered single family residential areas if the dwellings have associated outbuildings, docks, and other features consistent with more densely developed areas.	%
	URBAN_PARK	LU_PARK or Park			The Urban Park Land Use is the percentage of the shoreline, based upon the shore segments length that is predominantly used as an urban park. Examples of this land use include public beaches, picnic areas, etc. Shorelines dominated by this land use tend to have limited riparian vegetation and contain extensive areas of turf in the under story.	%
	LANDU_COMM	Land Use Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the shore type data fields above.	%
Substrates	MARL	Marl Substrate	SUB_FINES or Fine Substrates	Numeric	The Marl substrate field allows assessors to enter the relative percentage of marl occurring along the shoreline. Marl is a substrate that is typically white in color associated with clear lakes and consists of loose clay, precipitated calcium carbonate, mollusk/invertebrate shells, and other impurities.	%
	MUD	Mud Substrates	SUB_FINES or Fine Substrates	Numeric	The Mud substrate field allows assessors to enter the relative percentage of mud occurring along the segment. Mud is a substrate that is typically dark in color and consists of a mixture of silts, clays, and finely decayed organic material that is not typically discernable.	%
	ORGANIC	Organic Substrates	SUB_FINES or Fine Substrates	Numeric	The Organic substrate field allows assessors to enter the relative percentage of organic materials that occur along the shoreline. Organic substrates are typically associated with wetland sites and consist of detritus material that is identifiable to some extent (e.g., sticks, leaves, etc.).	%
	FINES	Fine Substrates	SUB_FINES or Fine Substrates	Numeric	The Fines substrate field allows assessors to enter the relative percentage of fines that occur along the shoreline. Fines consist of silts and clays and these substrates are typically less than 1 mm in size. Fines are differentiated from mud because there is little to no organic content.	%

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Substrates	SAND	Sand Substrates	SUB_FINES or Fine Substrates	Numeric	The Sand substrates field allows assessors to enter the relative percentage of sands that occur along the shoreline. Sands are any particle that contains granular particles visible to the naked eye. These particles are typically .06 to 2 mm in size.	%
	GRAVEL	Gravel Substrates	SUB_GRAVEL or Gravel Substrates	Numeric	The Grave substrates field allows assessors to enter the relative percentage of gravels that occur along the shoreline. Gravels are particles that range from 2 mm to approximately 64 mm. Thus, they are the size of a lady bug to the size of a tennis ball or orange. This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine and course gravels.	%
	GRAVEL_FIN	Fine Gravel Substrates	SUB_GRAVEL or Gravel Substrates	Numeric	The Fine Gravel substrates field allows assessors to enter the relative percentage of fine gravels that occur along the shoreline. Fine gravels are particles that are 2 mm to approximately 16 mm or the size of a ladybug to the size of a grape. This field should only be used when assessors have good visibility and can confidently identify fine gravels. If this field is used, the generally gravel category should *not* be used.	%
	GRAVEL_COA	Coarse Gravel Substrates	SUB_GRAVEL or Gravel Substrates	Numeric	The Coarse Gravel substrates field allows assessors to enter the relative percentage of course gravels that occur along the shoreline. Coarse gravels are particles that are 16 mm to approximately 64 mm or the size of a grape to the size of a tennis ball or orange. This field should only be used when assessors have good visibility and can confidently identify coarse gravels. If this field is used, the generally gravel category should *not* be used.	%
	COBBLE	Cobble Substrates	SUB_COBBLE or Cobble Substrates	Numeric	The Cobble substrates field allows assessors to enter the relative percentage of cobbles that occur along the shoreline. Cobbles are particles that are 64 to 256 mm in size (Tennis ball to basketball).	%
	COBBLE_FIN	Fine Cobble Substrates	SUB_COBBLE or Cobble Substrates	Numeric	The Fine Cobble substrates field allows assessors to enter the relative percentage of fine cobbles that occur along the shoreline. Fine cobbles are particles that are 64 to 128 mm in size (tennis ball to coconut). This field should only be used when assessors have good visibility and can confidently identify fine cobbles. If this field is used, the general cobble category should *not* be used.	%
	COBBLE_COA	Coarse Cobble Substrates	SUB_COBBLE or Cobble Substrates	Numeric	The Coarse Cobble substrates field allows assessors to enter the relative percentage of course cobbles that occur along the shoreline. Coarse cobbles are particles that are 128 to 256 mm in size (coconut to basketball). This field should only be used when assessors have good visibility and can confidently identify coarse cobbles. If this field is used, the general cobble category should *not* be used.	%
	BOULDER	Boulder Substrates	SUB_BOULDE or Boulder Substrates	Numeric	The Boulder substrates field allows assessors to enter the relative percentage of boulders that occur along the shoreline. Boulders are particles that are greater than 256 mm in size (bigger than a basketball). These substrates can not typically be lifted by one person as they are too heavy.	%
	BEDROCK	Bedrock Substrates	SUB_BEDROC or Bedrock Substrates	Numeric	The Bedrock substrates field allows assessors to enter the relative percentage of bedrock that occurs along the shoreline. Bedrock is consider any rock where blocks are larger than 4 m or is solid, un-weathered underlying rock.	%
	EMBEDDEDNE	Embeddedness	COMPACTION or Compaction	Categorical	Embeddedness is a categorical field that allows assessors to enter the approximate embeddedness of substrates. Embeddedness is a measure of the degree to which boulders, cobbles and other large materials are covered by fine sediments. Categories for embeddedness include None (0%), Low (0 to 25%), Medium (25-75%), High (>75%), or Unknown. When assessors are unclear of the embeddedness they should either complete measurements of foreshore substrates or leave the field as unknown.	
	SHAPE_1	Shape of Substrates		Categorical	Shape is a categorical field that allows assessors to identify the shape of larger particles such as cobble or boulders. Angular shapes refer to naturally occurring angular rock material that has not been substantially weathered. Blast rock refers to angular blast rock materials, such as rip rap. Smooth materials are rocks that are generally rounded. This field should be used to describe the predominant substrates that occur along the shoreline (e.g., if 85 % of the substrates are round and smooth, and 10% are blast rock, the field should be used to describe the 85%).	
	COMMNT_SUB	Substrate Comments		Categorical	The comments field allows assessors to enter applicable information that is not included in the data field above.	

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Vegetation Band 1	B1_CLASS	Vegetation Band 1 Land Cover Class	RIP_CLASS of Riparian Class	Categorical	The Vegetation Band 1 Land Cover Class is a description of the predominant vegetation class present. Categories are largely derived from the Sensitive Habitat Inventory and Mapping Module 4. The Coniferous Class occurs where tree cover is at least 20% of the shore zone area and at least 80% of the trees are coniferous. The Broadleaf Class occurs where the tree cover is at least 20% and at least 65% of the trees are broadleaf or deciduous. The Mixed Forest Class occurs where tree cover is at least 20% and there are no more than 80% coniferous trees and no more than 65% broadleaf trees. The Shrubs Class occurs where tree coverage is less than 10% and there shrubs cover at least of 20%. Shrubs are defined as multi-stemmed woody perennial plants. The Herbs / Grasses Class occur where there is at less than 10% tree coverage and less than 20% of shrubs. The Exposes Soil Class occurs where recent disturbance, either anthropogenic or natural, has occurred and mineral soils are exposes. The Landscape Class refers to urbanized areas where most natural vegetation has been replaced by at least 30% coverage of ornamental trees, shrubs, and other vegetation. The Lawn Class occurs in urbanized areas where turf grasses cover at least 30% of the shore zone area and landscaping with ornamental shrubs or trees is less than 30% coverage. The Natural Wetland Class occurs where shore marshes dominate the shore zone area and they have not been significantly influenced by human disturbance. The Disturbed Wetland Class occurs where shore marshes predominate the shore zone area and they have experience significant disturbance (i.e., greater than 30%). The Row Crops Class occurs in agricultural areas where crops are growing. If sites are agricultural, but are not used for row crops (e.g., pasture lands), they should be described as Herbs/Grasses and comments should be used to indicate the agricultural nature of the shore segment. Un-vegetated Sites occur where there is less than 5% vegetation cover and at least 50% of the vegetation cover is mosses or lichens. Un-vegetated sites tend to occur on rocky, exposed shorelines.	
	B1_STAGE	Vegetation Band 1 Stage	RIP_STAGE or Riparian Stage	Categorical	The Vegetation Band 1 Stage is a description of the structural stage of the dominant vegetation. Categories are largely derived from the Sensitive Habitat Inventory and Mapping Module 3 and the Field Manual for Describing Terrestrial Ecosystems. The Sparse Stage describes sites that are in the primary or secondary stages of succession, with vegetation consisting mostly of lichens and mosses, and the total shrub coverage is less than 20% and tree coverage is less than 10%. The Grass Herb Stage describes sites where shore zones are dominated by grasses and herbs, as a result of persistent disturbance of natural conditions (e.g., grasslands). The Low Shrubs stage describes sites that are dominated by shrubby vegetation less than 2 m in height. The Tall Shrubs Stage is dominated by vegetation that is 2 to 10 m in height and seedlings and advance regeneration may be present. The Pole / Sapling Stage describes sites that contain trees greater than 10 m in height, typically densely stocked, and there is little evidence of self thinning or vertical structure. The Young Forest Stage describes sites that are typically less than 40 years old (but could be as great as 50 to 80 years depending upon the forest community), self thinning is evident, and the forest canopy has begun to differentiate into distinct layers. The Mature Forest Stage describes sites that are typically 40 to 80 years old (but could be as high as 140 years), and the under story is well developed with a second cycle of shade trees. The Old Forest Stage describes sites that are typically greater than 80 years old and the stands are structurally complex. Old Forests contain abundant coarse woody debris at varying stages of decay. Old Forests are at least 80 years in age, but may be as old as 250 years and should be considered relative to the forest community assessors are in.	
	B1SHRUB_CO	Vegetation Band 1 Shrub Coverage	SHOR_COVER or Shore Cover	Categorical	The Shrub Coverage categorically describes shrub coverage within the shore zone. Sparse sites have less than 10% shrub coverage. Moderate shrub coverage occurs on sites that have between 10 to 50% coverage. Abundant shrub coverage occurs on sites that have greater than 50% shrub coverage.	
	B1TREE_COV	Vegetation Band 1 Tree Coverage	SHOR_COVER or Shore Cover	Categorical	The Tree Coverage categorically describes Tree coverage within the shore zone. Sparse sites have less than 10% Tree coverage. Moderate Tree coverage occurs on sites that have between 10 to 50% coverage. Abundant Tree coverage occurs on sites that have greater than 50% Tree coverage.	

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Vegetation Band 1	B1_DISTRIB	Vegetation Band 1 Distribution		Categorical	The Distribution field is used to describe whether the vegetation band described is continuous along the entire shore segment. Categories include Continuous and Patchy (for sites where the dominant vegetation band occurs in patches along the segment). An example of a patchy distribution is a shore segment where most areas are extensively landscape, with the exception of a few shore lots which remain relatively natural. In this case, the dominant landscaped area would be described and comments would be used to identify residual natural areas.	
	B1_BANDWI	Vegetation Band 1 Bandwidth		Numeric	The Vegetation Band 1 Bandwidth field is used to provide an estimate of the approximate width of the band being described. In cases where bandwidth varies along the segment, a representative width should be used to describe the shore segment. The intent of this field is to provide a general description of the width of the vegetation band that is being described and users of the database need to consider this when assessing data within the database.	
	B1_OVERHAN	Overhanging Vegetation		Numeric	The Overhanging Vegetation field is used to describe the percentage of the shore segment length that contains significant overhanging vegetation. Overhanging vegetation should be considered as if the lake was at full pool or the mean annual high water level.	
	AQUATIC_VE	Aquatic Vegetation		Numeric	The Aquatic Vegetation field is used to describe the percentage of the shoreline that contains emergent, submergent, and floating aquatic vegetation.	
	SUBMERGENT	Submergent Vegetation Quantity		Numeric	The Submergent Vegetation field is used to describe the percentage of the shoreline segment that contains submergent vegetation. Submergent vegetation includes species such as milfoil, *Potamogeton* spp., etc.	
	SUBMERG_VE	Submergent Vegetation Presence		Categorical	The Submergent Vegetation Presence field is used to indicate whether submergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.	
	EMERGENT_V	Emergent Vegetation Quantity		Numeric	The Emergent Vegetation field is used to describe the percentage of the shoreline segment that contains emergent vegetation. Emergent vegetation includes species such as cattails, bulrushes, varies sedges, etc.	
	EMERGED_VE	Emergent Vegetation Presence		Categorical	The Emergent Vegetation Presence field is used to indicate whether emergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.	
	FLOATING_V	Floating Vegetation Quantity		Numeric	The Floating Vegetation field is used to describe the percentage of the shoreline segment that contains floating vegetation. Floating vegetation includes species such as pond lilies, etc.	
	FLOATING_1	Floating Vegetation Presence		Categorical	The Floating Vegetation Presence field is used to indicate whether floating vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.	
	AVEG_CMT	Aquatic Vegetation Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
	B1_COMMNT	Vegetation Band 1 Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
Vegetation Band 2	B2_CLASS	Vegetation Band 2 Class	UP_CLASS or Upland Class	Categorical	See Vegetation Band 1 Class for a description.	
	B2_STAGE	Vegetation Band 2 Stage	UP_STAGE or Upland Stage	Categorical	See Vegetation Band 1 Stage for a description.	
	B2SHRUB_CO	Vegetation Band 2 Shrub Cover	UP_SHORE_COVER or Upland Shore Cover	Categorical	See Vegetation Band 1 Shrub Cover for a description.	
	B2TREE_COV	Vegetation Band 2 Tree Cover	UP_SHORE_COVER or Upland Shore Cover	Categorical	See Vegetation Band 1 Tree Cover for a description.	

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Vegetation Band 2	B2_DISTRIB	Vegetation Band 2 Distribution	UP_BANDWI or Upland Bandwidth	Categorical	See Vegetation Band 1 Distribution for a description.	
	B2_BANDWID	Vegetation Band 2 Width		Categorical	See Vegetation Band 2 Width for a description.	
	B2_COMMNT	Vegetation Band 2 Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
Littoral Zone	LITTORAL_Z	Littoral Zone Width Categories		Categorical	The Littoral Zone Width Category provides a general classification of the littoral zone. Wide littoral zones are greater than 50 m. Moderate littoral zones are 10 to 50 m in width, and Narrow littoral zones are less than 10 m wide.	
	LWD	Large Woody Debris Presence		Categorical	The Large Woody debris presence field allows assessors to indicate whether LWD is present along the segment. Categories include Less than 5 Pieces, 5 to 25 Pieces, and Greater than 25 Pieces.	
	LWD_NUMBER	Large Woody Debris Count		Numeric	The Large Woody debris count field allows assessors to enter the total number of large woody debris pieces counted along the shore segment. Only significant pieces of large woody debris, which are contributing to fish habitat, should be counted.	
	WIDTH_LITT	Littoral Width	LITTORAL_W or Littoral Width	Numeric	The Littoral Width field allows assessors to enter the average littoral width of the segment. This field can be determined using air photo interpretation or field measurements. Typically, the field is rounded to the nearest 5 m as the number is intended to be representative of the segment.	
	COMMNT_LIT	Littoral Zone Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
Modifications	RETAIN_WAL	Retaining Wall Count		Numeric	The Retaining Wall Count field is the total number of retaining walls occurring along the segment. Retaining walls should only be counted if they are within 5 to 10 m of the high water level. Retaining walls must have a vertical element that is greater than 30 cm and must be retaining earth to some degree. On steep sloping sites, more than one retaining wall may be present (i.e., the property is tiered). In these cases each retaining wall is counted.	#
	PERRETAIN_	Percent Retaining Wall	RET_WAL_TY	Numeric	The Percent Retaining Wall field indicates that approximate percentage of the shore segment length where retaining walls occur.	%
	DOCKS	Docks Count		Numeric	The Docks Count field is the total number of pile supported or floating docks or swimming platforms that occur along the segment. Properties may have more than one dock present and each different structure is considered a separate dock. For instance, a property could have one swimming float and one dock.	#
	DOCKS_KM	Docks Per Kilometer		Numeric	The Docks per Kilometer field is determined during post processing. This field is calculated by dividing the total number of docks observed by the total length of the shore segment.	#
	BOAT_HOUSE	Boat House Count		Numeric	The Boat House Count field is used to count boat houses that occur along the segment. Boat Houses are structures that are specifically designed to house boats or watercraft. Boat Houses can either be located on land or as structures over the water. If only structures over the water are counted, assessors should be consistent and make note of this so end users are aware of what definition was used for a boat house. If structures on land are considered as boat houses, a rail or boat launch should be present that land owners use to launch the boat to the lake. Garages that house boats should not be counted as boat houses because there is not an associated launch structure.	#
	GROYNES	Groyne Count		Numeric	The Groyne Count field is used to count any structure that is perpendicular to the shoreline that is impacting regular sediment drift along the shoreline. Groynes can be constructed out of concrete, rock, piles, wood, or other materials. Docks or other structures that are acting as groynes, and affecting sediment movement should be included in the groyne count. Rock lines that are too small to significantly impact sediment movement should not be counted as a groyne.	#
	GROYNES_KM	Groynes per Kilometer		Numeric	The Groynes per Kilometer field is determined during post processing of data. This field is calculated by dividing the total number of groynes observed by the total length of the shore segment.	#

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Modifications	BOAT_LAUNC	Boat Launch Count		Numeric	The Boat Launch Count field is the total number of boat launches that were observed along the shoreline. Generally, only permanent boat launches are counted (e.g., made of concrete). However, on small systems assessors may choose to count gravel boat launches as these may be the only type present. Assessors should document criteria used to determine what constitutes a boat launch during the assessment.	#
	PERRAIL_MO	Percent Rail Modifier		Numeric	The Percent Rail Modifier field is used to describe the percentage of the linear shore segment length that contains railways in close proximity to the shoreline.	%
	PERROAD_MO	Percent Road Modifier		Numeric	The Percent Road Modifier field is used to describe the percentage of the linear shore segment length that contains a roadway in close proximity to the shoreline.	%
	MARIN_RAIL	Marine Rail Count		Numeric	The Marine Rail Count field is the total number of marine rails that occur along a shore segment. Marine Rails are a track system that is used to remove boats from a lake during the winter months.	#
	MARINAS	Marina Count		Numeric	The Marinas Field is the total number of large and small marinas that were documented along the shoreline. A marina is considered to be any pile supported or floating structure that has slips for 6 or more boats.	#
	SUB_MODIFI	Substrate Modification Presence	BEACH_GROO or Beach Grooming	Categorical	The Substrate Modification Presence field is used to document whether substrate modification is occurring along the shore segment. Substrate modification includes any type of importation of sands, significant movement of natural substrates (e.g., to construct groynes), or earthworks.	
	PERSUB_MOD	Percent Substrate Modification		Numeric	The Percent Substrate Modification field is the estimated percentage of the shore segment where substrate modification has occurred.	%
	COMMNT_MOD	Modifications Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data field above.	
Flora and Fauna	VETERANS	Veteran Trees		Categorical	The Veteran Tree field is a categorical field to describe the number of veteran trees that occur along the shore segment. Veteran trees are defined as a tree that is significantly older than the dominant forest cover and provides increased structural diversity. Categories include No, Less than 5 Trees, 5 to 25 Trees, and Greater than 25 trees.	
	SNAGS	Snags		Categorical	The Snags field is a categorical field to describe the number of dead standing snags that occur along the shore segment. Snags are defined as dead standing trees that provide increased structural diversity. Categories include No, Less than 5 Trees, 5 to 25 Trees, and Greater than 25 trees.	
	CMMNT_FLRA	Flora Comments		Alphanumeric	The flora comments field allows users to enter in comments regarding flora observed within the shore segment.	
	CMMNT_FAUN	Fauna Comments			The fauna comments field allows users to enter in comments regarding fauna observed within the shore segment.	

Appendix B – Data Base and Field Code Version Consolidation

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Type	Definition	Rationale for Removal
Segment Class and Shore Type	VEG_SHORE	Vegetated Shore	Numeric or Category	A vegetated shore is a shoreline that is well vegetated, to the high water level.	Vegetated shore was removed because it differs from the other shore types, which tend to be more description of physical properties of the shoreline. Because a vegetated shore typically occurs on a rocky shore or gravel shore, it is better to describe lake side vegetation elsewhere in the database and leave the shore type to describe more physical attributes of the shoreline.
Riparian or Upland Vegetation	RIP_QUALIF or UP_QUALIF	Riparian or Upland Qualifier	Category	The Riparian Qualifier field was used to qualify the Riparian Class and Stage. Categories included Agriculture, Natural, Urban/Residential, Recreation, Disturbed, Unknown. Refer to Module 4 of the Sensitive Habitat Inventory and Mapping for definitions.	This field was removed from the dictionary because additional categories were added to the Vegetation Class and Stage for Bands 1 and 2. This was done to reduce redundancy in the dictionary and improve clarity.
Littoral Zone	ALLUV_FAN	Alluvial Fan	Category	The Alluvial Fan field was used to describe whether the segment contained an alluvial fan.	The Stream Mouth shore type was added to the dictionary to replace the Alluvial Fan field. Due to the importance of stream mouths as rearing and staging areas for salmonids, the shore type was used because these extremely sensitive features can be better identified.
Modifications	BEACH_GROO	Beach Grooming	Category	The Beach Grooming field identifies whether substrate modification has occurred to enhance beach conditions.	This field was removed from the dictionary and replaced with the SUB_MODI or Substrate Modification Field because it better describes the actual acitivity. Also, a PERSUB_MODI or Percent Substrate Modification field was added to help quantify substrate modification that is occuring.
Riparian or Upland Vegetation	RIP_BANKSL or U	Upland or Riparian Bank Slope	Numeric	The Ripariand or Upland Bankslope field was use to identify the slope of the riparian (now Vegetation Band 1) or upland areas (Vegetation Band 2) described (as a percentage).	This field was added with categories to the Segment Class as SLOPE. Categories was used rather than a slope percentage because assessors do not typicallly exit the boat to measure the slope. Because the idea is to gain a broad understanding of the slope for a segment, it was determined that slope categories were more appropriate for the level of detail of the assessment.
Riparian or Upland Vegetation	RIP_VET or UP_VET	Riparian or Upland Veterans	Category	The Veteran Tree field is a categorical field to describe the number of veteran trees that occur along the shore segment.	This field was added to the Flora and Fauna section and is intended to describe both the Riparian and Upland Sections. This was done to reduce redundancy in the datebase and make interpretation easier.
Substrates	COMPACTION	Compaction of Substrates	Category	Compaction is a measure of the degree of compaction or relative looseness of bed material. See the Sensitive Habitat Inventory and Mapping Module 3 for a better description of Compaction.	In lake systems, compaction is better discussed in terms of substrate embeddedness. Generally, the two measures are correlated so some extent (i.e., a high compaction is equivalent ot a high level of embeddedness). As embeddedness of substrates is a better description and easier to measure using binoculars from a boat, the field was changed to this.

Appendix C – SHIM Lake v. 2.6 Data Dictionary

Shim Lake 2008
June 23, 2008

Lake_Shoreline Line Feature, Label 1 = Segmnt_Num, Label 2 = Aquatic_Veg
Lake shore
_____ Separator
LAKE REFERENCE Separator
Lake_Name Text, Maximum Length = 100
Normal, Normal
Lake_level Numeric, Decimal Places = 2
Minimum = 0, Maximum = 3000, Default Value = 0
Normal, Normal
Sechi_depth Numeric, Decimal Places = 1
Minimum = 0, Maximum = 50, Default Value = 0
Normal, Normal
Organization Text, Maximum Length = 50
Normal, Normal
Date Date, Auto generate Create, Year-Month-Day Format
Normal, Normal
Time Time, Auto generate Create, 24 Hour Format
Normal, Normal
Crew Text, Maximum Length = 50
Normal, Normal
Weather Menu, Normal, Normal
Light Rain [L]
Heavy Rain [H]
Snow/Sleet [N]
Over cast [OV]
Clear [S]
Partly Cloudy [PC]
Other [O]
Air_Temp Numeric, Decimal Places = 1, degrees centigrade
Minimum = -25, Maximum = 45, Default Value = 0
Normal, Normal
Water_Temp Numeric, Decimal Places = 1, degrees celsius
Minimum = -2, Maximum = 29, Default Value = 0
Normal, Normal
Jurisdiction Text, Maximum Length = 100, Jurisdiction
Normal, Normal
Comments Text, Maximum Length = 100
Normal, Normal
_____ Separator
SEGMENT CLASS Separator
Segmnt_Num Numeric, Decimal Places = 1, Unique Identification number for segment
Minimum = 0, Maximum = 99999, Default Value = 0
Required, Required
Shore_Type Menu, Required, Normal
Cliff/Bluff
Rocky Shore
Gravel
Sand
Stream Mouth
Wetland
Other
Shore_Modifier Menu, Normal, Normal
Log Yard
Marina_small (6-20)
Marina_large (20+)
Railway
Road
None Default
Other
Slope Menu, Normal, Normal, general slope of shore landward
Bench
Low (0-5)
Moderate (5-20)
Steep (20-60)
Very Steep (60+)
Land_Use Menu, Normal, Normal, observed
Agriculture
Commercial
Conservation
Forestry
Industrial
Institution
Multi Family
Natural Area
Park
Recreation

```
   Rural
   Single Family
   Urban Park
Lev_of_Imp          Menu, Normal, Normal, Level of Impact
   None   Default
   Low (<10%)
   Medium (10-40%)
   High (>40%)
Livest_Acc          Menu, Normal, Normal, Stream segmnet accessible to live-stock
   Yes
   No   Default
Disturbed           Numeric, Decimal Places = 0, Percent of segment disturbed
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Natural             Numeric, Decimal Places = 0, Percent of segment natural
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
PhotoNum            Text, Maximum Length = 100, Roll and print number of photograph
                    Normal, Normal
Tape_Numb           Text, Maximum Length = 100, Original Video Tape Number
                    Normal, Normal
Video_Time          Text, Maximum Length = 100, Time stamp on original video tape
                    Normal, Normal
Cmmnt_Clas          Text, Maximum Length = 100, Comments for Segment
                    Normal, Normal
____________________      Separator
SHORE TYPE          Separator
Cliff/Bluff         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Rocky               Numeric, Decimal Places = 0, Rocky Shore
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Gravel              Numeric, Decimal Places = 0, Gravel Shore
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Sand                Numeric, Decimal Places = 0, Sand Beach
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Stream_mouth        Numeric, Decimal Places = 0, Stream mouth
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Wetland             Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Other               Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Stype_comm          Text, Maximum Length = 100, Comments for Segment
                    Normal, Normal
____________________      Separator
LAND USE            Separator
Agriculture         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Commercial          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Conservation        Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Forestry            Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Industrial          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Institution         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Multi Family        Numeric, Decimal Places = 0, Percent mult family residential (condo)
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Natural Area        Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Park                Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
```

```
Recreation          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Rural               Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Single Family       Numeric, Decimal Places = 0, Percent single family residential
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Urban Park          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Landu_Commnt        Text, Maximum Length = 100, Comment Land use
                    Normal, Normal
____________________      Separator
SUBSTRATE           Separator
Marl                Numeric, Decimal Places = 0, Clay limestone
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Mud                 Numeric, Decimal Places = 0, Percent Mud
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Organic             Numeric, Decimal Places = 0, Percent Organic
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Fines               Numeric, Decimal Places = 0, Percent Fines
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Sand                Numeric, Decimal Places = 0, Percent Sand
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Gravel              Numeric, Decimal Places = 0, Percent Gravel
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Gravel_Fine         Numeric, Decimal Places = 0, Percent Fine Gravel
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Gravel_Coarse       Numeric, Decimal Places = 0, Percent Coarse Gravel
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Cobble              Numeric, Decimal Places = 0, Percent Cobble
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Cobble_Fine         Numeric, Decimal Places = 0, Percent Fine Cobble
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Cobble_Coarse       Numeric, Decimal Places = 0, Percent Coarse Cobble
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Boulder             Numeric, Decimal Places = 0, Percent Boulder
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Bedrock             Numeric, Decimal Places = 0, Percent Bedrock
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Embeddedness        Menu, Normal, Normal, Level of substrate embeddedness
   None
   Low (0-25%) [L]
   Medium (25-75%) [M]
   High (75%+) [H]
   Unknown   Default
Shape               Menu, Normal, Normal, man made refers to angularity
   angular
   blast rock
   smooth
Commnt_Sub          Text, Maximum Length = 100, Comment for Substrates
                    Normal, Normal
____________________      Separator
VEGETATION BAND1    Separator
B1_Class            Menu, Normal, Normal, Riparian Class
   Coniferous forest [VNF]
   Broadleaf forest [VBF]
   Mixed forest [VMF]
   Shrubs [VSH]
   Herbs/grasses [VHB]
   Exposed soil [NEL]
   Landscaped [LS]
   Lawn [L]
   Natural wetland [WN]
```

```
   Disturbed wetland [DWN]
   Row Crops [NAG]
   Unvegetated
B1_Stage            Menu, Normal, Normal, Structural Stage
   Sparse [1]
   Grass/Herb [2]
   low shrubs <2m [3a]
   tall shrubs 2-10m [3b]
   sapling >10m [4]
   young forest [5]
   mature forest [6]
   old forest [7]
   Mixed age
B1Shrub_Cover       Menu, Normal, Normal, Shrub Cover
   None [ ]
   Sparse (<10%) [ ]
   Moderate (10-50%) [ ]
   Abundant (>50%) [ ]
B1Tree_Cover        Menu, Normal, Normal, Tree Cover
   None [ ]
   Sparse (<10%) [ ]
   Moderate (10-50%) [ ]
   Abundant (>50%) [ ]
B1_Distribution     Menu, Normal, Normal, Riparian Distribution
   Patchy [ ]
   Continuous [ ]
B1_Bandwi           Numeric, Decimal Places = 0, Band 1width
                    Minimum = 0, Maximum = 9999, Default Value = 0
                    Normal, Normal
B1_Overhang         Numeric, Decimal Places = 0, %  Overhang for segment
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Aquatic_Veg         Numeric, Decimal Places = 0, Length of aquatic vegetation in segment
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Submergent veg      Numeric, Decimal Places = 0, % submergent vegetation in segment
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Submerg_Veg         Menu, Normal, Normal, Submerged Aquatic Vegetation
   Yes
   No   Default
Emergent vegetation       Numeric, Decimal Places = 0, % emergent vegetation
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Emerged_Veg         Menu, Normal, Normal, Emergent Aquatic Vegetation
   Yes
   No   Default
Floating vegetatio  Numeric, Decimal Places = 0, % floating vegetation
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Floating_Veg        Menu, Normal, Normal, Floating  Vegetation presence
   Yes
   No   Default
AVeg_Cmt            Text, Maximum Length = 100, Aquatic Vegetation Comment
                    Normal, Normal
B1_Commnt           Text, Maximum Length = 100, Comment Band 1 vegetation
                    Normal, Normal
____________________      Separator
VEGETATION BAND2    Separator
B2_Class            Menu, Normal, Normal, Vegetation Class
   Coniferous forest [VNF]
   Broadleaf forest [VBF]
   Mixed forest [VMF]
   Shrubs [VSH]
   Herbs/grasses [VHB]
   Exposed soil [NEL]
   Landscaped [LS]
   Lawn [L]
   Natural wetland [WN]
   Disturbed wetland [DWN]
   Row Crops [NAG]
   Rock [NNB]
B2_Stage            Menu, Normal, Normal, Structural Stage
   Sparse [1]
   Grass/Herb [2]
   low shrubs <2m [3a]
   tall shrubs 2-10m [3b]
   sapling >10m [4]
   young forest [5]
```

```
   mature forest [6]
   old forest [7]
   Mixed age
B2Shrub_Cover       Menu, Normal, Normal, Shrub Cover
   None [ ]
   Sparse (<10%) [ ]
   Moderate (10-50%) [ ]
   Abundant (>50%) [ ]
B2Tree_Cover        Menu, Normal, Normal, Tree Cover
   None [ ]
   Sparse (<10%) [ ]
   Moderate (10-50%) [ ]
   Abundant (>50%) [ ]
B2_Distribution     Menu, Normal, Normal, B2 Vegetation Distribution
   Patchy [ ]
   Continuous [ ]
B2_Bandwidth        Numeric, Decimal Places = 0, B2 vegetation Bandwidth
                    Minimum = 0, Maximum = 9999, Default Value = 0
                    Normal, Normal
B2_Commnt           Text, Maximum Length = 100, B2 vegetation Comment
                    Normal, Normal
_____________________      Separator
LITTORAL ZONE       Separator
Littoral_Z          Menu, Normal, Normal, Littoral Zone
   Narrow (<10m)
   Moderate (10-50m)
   Wide (>50m)
LWD                 Menu, Normal, Normal, Count of Large Woody Debris
   No   Default
   <5
   5-25
   >25
LWD_Number          Numeric, Decimal Places = 0, Number of LWD units
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Width_Littoral      Numeric, Decimal Places = 0, Width of Littoral area
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Commnt_Lit          Text, Maximum Length = 100, Comment for Littoral zone
                    Normal, Normal
_____________________      Separator
MODIFICATIONS       Separator
Retain_Wal          Numeric, Decimal Places = 0, Retaining walls per segment
                    Minimum = 0, Maximum = 99999999, Default Value = 0
                    Normal, Normal
PerRetain_Wall      Numeric, Decimal Places = 0, Percent retaining wall on segment
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Retain_Mat          Menu, Normal, Normal
   Bio_Eng
   Concrete
   Mixed
   Stonework
   Wood
   Metal
   Tires
   Rock
   Other
Docks               Numeric, Decimal Places = 0, Docks per segment
                    Minimum = 0, Maximum = 99999999, Default Value = 0
                    Normal, Normal
Docks_km            Numeric, Decimal Places = 0, Docks per km
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Boat_House          Numeric, Decimal Places = 0, Docks per segment
                    Minimum = 0, Maximum = 99999999, Default Value = 0
                    Normal, Normal
Groynes             Numeric, Decimal Places = 0, Groynes per segment
                    Minimum = 0, Maximum = 99999999, Default Value = 0
                    Normal, Normal
Groynes_km          Numeric, Decimal Places = 0, Groynes per km
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Boat_Launch         Numeric, Decimal Places = 0, Number of Boat launches
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
PerRail_mod         Numeric, Decimal Places = 0, % of segment with a railway
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
```

```
  PerRoad_mod          Numeric, Decimal Places = 0, % of segment with a road
                       Minimum = 0, Maximum = 100, Default Value = 0
                       Normal, Normal
  Marin_Rail           Numeric, Decimal Places = 0, Marine Railways per segment
                       Minimum = 0, Maximum = 99999999, Default Value = 0
                       Normal, Normal
  Marinas              Numeric, Decimal Places = 0, Marinas per segment
                       Minimum = 0, Maximum = 99999999, Default Value = 0
                       Normal, Normal
  Sub_modification     Menu, Normal, Normal, Substrate modification / grooming
     Yes
     No
  PerSub_mod           Numeric, Decimal Places = 0, % of segment with substrate alteration
                       Minimum = 0, Maximum = 100, Default Value = 0
                       Normal, Normal
  Commnt_Mod           Text, Maximum Length = 100, Comments on modification
                       Normal, Normal
  ____________________       Separator
  FLORA & FAUNA        Separator
  Veterans             Menu, Normal, Normal, Number of Veterans
     No   Default
     <5
     5-25
     >25
  Snags                Menu, Normal, Normal, Presence of Snags
     No   Default
     <5
     5-25
     >25
  Cmmnt_Flra           Text, Maximum Length = 100, Flora Comment
                       Normal, Normal
  Cmmnt_Faun           Text, Maximum Length = 100, Fauna Comment
                       Normal, Normal

Site                   Point Feature, Label 1 = HWM, Label 2 = Land_Use
                       Site Description
  Lake_Name            Text, Maximum Length = 100
                       Normal, Normal
  Crew                 Text, Maximum Length = 50
                       Normal, Normal
  Date                 Date, Auto generate Create, Year-Month-Day Format
                       Normal, Normal
  Weather              Menu, Normal, Normal
     Light Rain [L]
     Heavy Rain [H]
     Snow/Sleet [N]
     Over cast [OV]
     Clear [S]
     Partly Cloudy [PC]
     Other [O]
  Jurisdiction         Text, Maximum Length = 100, Jurisdiction
                       Normal, Normal
  PID_Folio number     Text, Maximum Length = 50, Property Identifier
                       Normal, Normal
  HWM                  Numeric, Decimal Places = 1, High water mark
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
  Lake_Level           Numeric, Decimal Places = 0
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
  Length_frontage      Numeric, Decimal Places = 1, frontage length
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
  Land_Use             Menu, Normal, Normal
     SF
     MF
     C
  Veg_removal          Menu, Normal, Normal, vegetation removal age
     historic
     recent
     NA
  Natural              Numeric, Decimal Places = 0, % natural vegetation state
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
  Landscaped           Numeric, Decimal Places = 0, % landscaped vegetation state
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
  no_vegetation        Numeric, Decimal Places = 0, % no vegetation
                       Minimum = 0, Maximum = 99999, Default Value = 0
```

```
                     Normal, Normal
  Disturbed          Numeric, Decimal Places = 0, % site state disturbed
                     Minimum = 0, Maximum = 99999, Default Value = 0
                     Normal, Normal
  PhotoNum           Text, Maximum Length = 100, Roll and print number of photograph
                     Normal, Normal
  Comments           Text, Maximum Length = 100
                     Normal, Normal

Modification         Point Feature, Label 1 = Point_number, Label 2 = Type_Modification
  Point_number       Numeric, Decimal Places = 1, unique point identification number
                     Minimum = 0, Maximum = 99999, Default Value = 0
                     Normal, Normal
  PID_Folio number   Text, Maximum Length = 50, Property Identifier
                     Normal, Normal
  Lot_number         Text, Maximum Length = 50, Property Identifier
                     Normal, Normal
  Type_Modification  Menu, Normal, Normal, Code for feature
    Boat House
    Boat_Launch
    Buoy
    Catchbasin [CB]
    Dam [HOD]
    Detention Pond [DP]
    Dock [DK]
    Dredging [HBDD]
    Effluent [E]
    Fences [HOF]
    Fill_Pile [FP]
    FloodGate [FG]
    Garbage/Pollution [WP]
    Gravel Pit [GP]
    Groyne [Gy]
    Hydro_thermal
    Infill
    Livestock access [LC]
    Log_Dump [LD]
    Logging [LG]
    Marina
    Outbuilding [OB]
    PipeCrossing [PL]
    Pump Station [PS]
    Retain Wall/Bank Stb [EHB]
    Rip_Rap [RR]
    Road [R]
    Trail [TR]
    Utility_Crossing [UC]
    Water Withdrawal [FUP]
    Other [O]
  Type_Material      Menu, Normal, Normal
    Asphalt [AS]
    Bark_Mulch [BM]
    Bio-engineered [BI]
    Concrete [C]
    Dyke [DY]
    Gabions [GB]
    Gravel [G]
    Metal [Mt]
    Mixed [Mx]
    Pilings [P]
    Rip_rap [RR]
    Sandbags [SB]
    Stonework [S]
    Synthetic [Sy]
    Treated_Wood [TW]
    Wood [W]
    Other [O]
  High_Water         Menu, Normal, Normal, Above or below high water level
    Above
    Below
    At
    Unknown   Default
  Sed_Movement       Menu, Normal, Normal, Sediment movement
    Erosion
    Accretion
    Unknown
    NA
  Conditions         Menu, Normal, Normal, Did it meet conditions
    Yes
```

```
   No
   Unknown   Default
Age_Modification    Menu, Normal, Normal, Age of modification
   Historic
   Recent
   Unknown   Default
Construction        Menu, Normal, Normal, state of modification
   complete
   ongoing
Length              Numeric, Decimal Places = 2, Feature length
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Width               Numeric, Decimal Places = 2, Width of Feature
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
Height              Numeric, Decimal Places = 2, Height of feature
                    Minimum = 0, Maximum = 1000, Default Value = 0
                    Normal, Normal
_____________________      Separator
WATER ACT           Separator
WA_approval         Menu, Normal, Normal, Received Water Act approval
   Yes
   No
   Unknown
   NA   Default
WA_Notification     Menu, Normal, Normal, Received Water Act Notification
   Yes
   No
   Unknown
   NA   Default
Size_Compliant      Menu, Normal, Normal
   Yes
   No
   Unknown   Default
Mat_Compliant       Menu, Normal, Normal, Material Compliant
   Yes
   No
   Unknown   Default
SM_Compliant        Menu, Normal, Normal, Sediment movement compliant
   Yes
   No
   Unknown   Default
Roof_Compliant      Menu, Normal, Normal
   Yes
   No
   Unknown   Default
BMP                 Menu, Normal, Normal, Conforms with  Best Management Practices
   Yes
   No
   Unknown   Default
EIA                 Menu, Normal, Normal
   Yes
   No
   Unknown   Default
WAComments          Text, Maximum Length = 100, Water Act Comments
                    Normal, Normal
_____________________      Separator
LAND ACT            Separator
Land_Act            Menu, Normal, Normal
   Yes
   No
   Unknown
   NA   Default
LASize_Compliant    Menu, Normal, Normal, Land Act Size Compliant
   Yes
   No
   NA   Default
LAMat_Compliant     Menu, Normal, Normal, Material Compliant
   Yes
   No
   NA   Default
LASM_Compliant      Menu, Normal, Normal, Land Act Sediment movement compliant
   Yes
   No
   NA   Default
LARoof_Compliant    Menu, Normal, Normal
   Yes
   No
   NA   Default
```

```
   Slip_Compliant      Menu, Normal, Normal
      Yes
      No
      NA   Default
   PVT_MCompliant      Menu, Normal, Normal, pvt moorage compliant
      Yes
      No
      NA   Default
   LA_EIA              Menu, Normal, Normal, Land Act EIA
      Yes
      No
      NA   Default
   _____________________      Separator
   DEVELOPMENT PERMIT  Separator
   DP_Area             Menu, Normal, Normal, Development Permit compliant
      Yes
      No
   Dev_Permit          Menu, Normal, Normal, Development Permit
      Yes
      No
      Unknown   Default
   DP_Compliant        Menu, Normal, Normal, Development Permit compliant
      Yes
      No
      Unknown   Default
   DP_EIA              Menu, Normal, Normal, Development Permit EIA
      Yes
      No
      Unknown   Default
   RAR                 Menu, Normal, Normal
      Accepted
      Submitted
      Not_Submitted
      Unknown   Default
   PhotoNum            Text, Maximum Length = 100, Roll and print number of photograph
                       Normal, Normal
   Comments            Text, Maximum Length = 100
                       Normal, Normal

Discharge              Point Feature
   Point_number        Numeric, Decimal Places = 1, unique point identification number
                       Minimum = 0, Maximum = 99999, Default Value = 0
                       Normal, Normal
   Lot_Number          Text, Maximum Length = 30, Parcel lot number
                       Normal, Normal
   Type_Discharge      Menu, Normal, Normal, Code for feature
      Agricultural Runoff [WPA]
      HouseEffluent [WE]
      Landfill Leachates [WPML]
      Pollutant [WP]
      Pulp Mill/Effluent [WPP]
      Storm Drain [WPD]
      Septic Effluent [WPMP]
      Sewer [S]
      Tile Drain [WPI]
      Trench [WPE]
      Other [O]
   Culvert             Menu, Normal, Normal, Culvert material
      Concrete [C]
      Steel [S]
      Wood [W]
      Iron [I]
      PVC [P]
      Asphalt coded [AD]
      Corrugated Steel [CS]
      Other [O]
   Headwall            Menu, Normal, Normal, Does a headwall exist
      Concrete [C]
      Concrete Block [CB]
      Gabion [G]
      Sand bag [SB]
      Wood [W]
   Length              Numeric, Decimal Places = 2, Feature length
                       Minimum = 0, Maximum = 1000, Default Value = 0
                       Normal, Normal
   Width               Numeric, Decimal Places = 2, Width of Feature
                       Minimum = 0, Maximum = 1000, Default Value = 0
                       Normal, Normal
   Diameter            Numeric, Decimal Places = 2, Diameter of feature
```

```
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Height            Numeric, Decimal Places = 2, Height of feature
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Temperature       Numeric, Decimal Places = 2, Water temperature
                     Minimum = 0, Maximum = 100, Default Value = 0
                     Normal, Normal
   PhotoNum          Text, Maximum Length = 100, Roll and print number of photograph
                     Normal, Normal
   Comments          Text, Maximum Length = 100
                     Normal, Normal

Waterbody            Point Feature, Label 1 = Point_number, Label 2 = Type_Water
                     location of an adjacent waterbody
   Point_number      Numeric, Decimal Places = 1, unique point identification number
                     Minimum = 0, Maximum = 99999, Default Value = 0, Step Value = 1
                     Normal, Normal
   Water_Name        Text, Maximum Length = 100, Waterbody Name
                     Normal, Normal
   Type_Water        Menu, Normal, Normal, Code for feature
      Tributary [HMT]
      Groundwater Seep
      Natural Springs [HMS]
      Beaver Pond [BP]
      Other  [HM]
   Inlet/Outl        Menu, Normal, Normal
      Inlet
      Outlet
   Length            Numeric, Decimal Places = 2, Waterbody length
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Width             Numeric, Decimal Places = 2, Bankfull Width
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Depth             Numeric, Decimal Places = 2, Bankfull Depth
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Temperatur        Numeric, Decimal Places = 2, Water temperature
                     Minimum = 0, Maximum = 100, Default Value = 0
                     Normal, Normal
   PhotoNum          Text, Maximum Length = 100, Roll and print number of photograph
                     Normal, Normal
   Comments          Text, Maximum Length = 100
                     Normal, Normal

Erosion              Point Feature, Label 1 = Point_number, Label 2 = Source_Erosion
   Point_number      Numeric, Decimal Places = 1, unique point identification number
                     Minimum = 0, Maximum = 99999, Default Value = 0
                     Normal, Normal
   Source_Erosion    Menu, Normal, Normal, Code for feature
      Bank Erosion [HCEB]
      Culvert [CV]
      Headwall [H]
      Lack of Riparian Veg [WDL]
      Livestock Access [WDC]
      Lakeside Grazing [WDG]
      Landslide
      Sloughing
      Other [O]
   Severity          Menu, Normal, Normal
      Low (<5m sq) [L]
      Moderate (5-10m sq) [M]
      High (>10m sq) [H]
   Exposure          Menu, Normal, Normal
      Clay [C]
      Till [T]
      Bedrock [B]
      Roots [R]
      Soil [S]
      Other [O]
   Length            Numeric, Decimal Places = 2, Feature length
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Width             Numeric, Decimal Places = 2, Width of Feature
                     Minimum = 0, Maximum = 1000, Default Value = 0
                     Normal, Normal
   Height            Numeric, Decimal Places = 2, Height of feature
                     Minimum = 0, Maximum = 1000, Default Value = 0
```

```
                        Normal, Normal
   Slope                Numeric, Decimal Places = 0
                        Minimum = 0, Maximum = 90, Default Value = 0
                        Normal, Normal
   PhotoNum             Text, Maximum Length = 100, Roll and print number of photograph
                        Normal, Normal
   Comments             Text, Maximum Length = 100
                        Normal, Normal

Flood plain             Point Feature, Label 1 = Point_number, Label 2 = Flood_plain
                        location of flood plain
   Point_number         Numeric, Decimal Places = 1, unique point identification number
                        Minimum = 0, Maximum = 99999, Default Value = 0, Step Value = 1
                        Normal, Normal
   PID_number           Text, Maximum Length = 50, Property Identifier
                        Normal, Normal
   Flood_plain          Menu, Normal, Normal, Elevation level
      200_yr
      MeanAH
      other
   Elevation            Numeric, Decimal Places = 2, Height above sea level
                        Minimum = 0, Maximum = 1000, Default Value = 0
                        Normal, Normal
   Distance             Numeric, Decimal Places = 2, Distance from building
                        Minimum = 0, Maximum = 1000, Default Value = 0
                        Normal, Normal
   Slope                Numeric, Decimal Places = 1, slope to flood plain from lake
                        Minimum = 0, Maximum = 100, Default Value = 0
                        Normal, Normal
   Bearing              Numeric, Decimal Places = 1, Bearing to building
                        Minimum = 0, Maximum = 360, Default Value = 0
                        Normal, Normal
   PhotoNum             Text, Maximum Length = 100, Roll and print number of photograph
                        Normal, Normal
   Comments             Text, Maximum Length = 100, Description of point location
                        Normal, Normal

Photo                   Point Feature, photo point location
   PhotoNum             Text, Maximum Length = 100, Photo number
                        Normal, Normal
   Comments             Text, Maximum Length = 100, Description of photo
                        Normal, Normal

Line_Modification       Line Feature, Modification Line feature
   Type_Modification    Menu, Normal, Normal, Code for feature
      Dredging [HBDD]
      Fences [HOF]
      Livestock crossing [LC]
      Log_Dump [LD]
      Logging [LG]
      Marina
      Railway
      Retain Wall/Bank Stb [EHB]
      Rip_Rap [RR]
      Road [R]
      Trail [TR]
      Other [O]
   Retain_Wal           Numeric, Decimal Places = 0, Retaining walls per segment
                        Minimum = 0, Maximum = 99999999, Default Value = 0
                        Normal, Normal
   Docks                Numeric, Decimal Places = 0, Docks per segment
                        Minimum = 0, Maximum = 99999999, Default Value = 0
                        Normal, Normal
   Groynes              Numeric, Decimal Places = 0, Groynes per segment
                        Minimum = 0, Maximum = 99999999, Default Value = 0
                        Normal, Normal
   Impact               Menu, Normal, Normal, Level of Impact
      Low
      Medium
      High
   High_Water           Menu, Normal, Normal, Above or below high water
      Above
      Below
   PhotoNum             Text, Maximum Length = 100, Roll and print number of photograph
                        Normal, Normal
   Commnt_Mod           Text, Maximum Length = 100, Comments on modification
                        Normal, Normal

1_Riparian              Line Feature
```

```
  Rip_Class           Menu, Normal, Normal, Riparian Class
     Coniferous forest [VNF]
     Broadleaf forest [VBF]
     Mixed forest [VMF]
     Shrubs [VSH]
     Herbs/grasses [VHB]
     Exposed soil [NEL]
     Landscaped [LS]
     Lawn [L]
     Natural wetland [WN]
     Disturbed wetland [DWN]
     Row Crops [NAG]
     Rock [NNB]
  Rip_Stage           Menu, Normal, Normal, Structural Stage
     low shrubs <2m [3a]
     tall shrubs 2-10m [3b]
     sapling >10m [4]
     young forest [5]
     mature forest [6]
     old forest [7]
  Shor_Cover          Menu, Normal, Normal, Shoreline Cover
     None [ ]
     Sparse (<5%) [ ]
     Moderate (5-20%) [ ]
     Abundant (>20%) [ ]
  Rip_Snag            Menu, Normal, Normal, Presence of Snags
     No   Default
     <5
     >=5
  Rip_Commnt          Text, Maximum Length = 100, Comment Riparian
                      Normal, Normal

2_Riparian            Line Feature
  Rip_Class           Menu, Normal, Normal, Riparian Class
     Coniferous forest [VNF]
     Broadleaf forest [VBF]
     Mixed forest [VMF]
     Shrubs [VSH]
     Herbs/grasses [VHB]
     Exposed soil [NEL]
     Landscaped [LS]
     Lawn [L]
     Natural wetland [WN]
     Disturbed wetland [DWN]
     Row Crops [NAG]
     Rock [NNB]
  Rip_Stage           Menu, Normal, Normal, Structural Stage
     low shrubs <2m [3a]
     tall shrubs 2-10m [3b]
     sapling >10m [4]
     young forest [5]
     mature forest [6]
     old forest [7]
  Shor_Cover          Menu, Normal, Normal, Shoreline Cover
     None [ ]
     Sparse (<5%) [ ]
     Moderate (5-20%) [ ]
     Abundant (>20%) [ ]
  Rip_Snag            Menu, Normal, Normal, Presence of Snags
     No   Default
     <5
     >=5
  Rip_Commnt          Text, Maximum Length = 100, Comment Riparian
                      Normal, Normal

1_Substrate           Line Feature, Label 1 = Substrate
  Substrate           Menu, Normal, Normal
     Mud
     Fines
     Gravel
     Gravel_Fine
     Gravel_Coarse
     Cobble
     Cobble_Fine
     Cobble_Coarse
     Boulder
     Bedrock
  Shape               Menu, Normal, Normal, man made refers to angularity
     angular
```

```
      blast rock
      smooth   Default
   Commnt_Sub          Text, Maximum Length = 100, Comment for Substrates
                       Normal, Normal

2_Substrate            Line Feature
   Substrate           Menu, Normal, Normal
      Mud
      Fines
      Gravel
      Gravel_Fine
      Gravel_Coarse
      Cobble
      Cobble_Fine
      Cobble_Coarse
      Boulder
      Bedrock
   Shape               Menu, Normal, Normal, man made refers to angularity
      angular
      blast rock
      smooth   Default
   Commnt_Sub          Text, Maximum Length = 100, Comment for Substrates
                       Normal, Normal

Sub_Veg                Line Feature, Label 1 = Comment
   Comment             Text, Maximum Length = 30
                       Normal, Normal

Emerg_veg              Line Feature, Label 1 = Comment
   Comment             Text, Maximum Length = 30
                       Normal, Normal
```

Appendix D – Brief GPS Overview

Global Positioning System (GPS)

Theory

What is GPS?

The Global Positioning System (GPS) is a satellite-based navigation system, providing position information, accurate to approximately 15m, anywhere on earth. Special methods can achieve position accuracy better than 1 mm. Satellites transmit radio signals, used by GPS receivers to compute positional information.

GPS System Configuration

24 Satellites orbit around the earth with a period of 12 hours. Because the orbits are inclined at 55 degrees to the equator, satellites are not seen to the North in Canada. Reception is difficult where the southern sky is obstructed (e.g., steep north-facing slopes, gullies, buildings in cities). Satellites operate on "sidereal time", based on the earth's rotation, so configurations repeat every 23h 56m ("solar time"). Certain times of the day are better or worse for GPS surveying; these times advance 4 minutes per day (~30 minutes per week).

Position Computation

How is it done?
GPS satellites broadcast a coded time signal;
GPS receiver computes a distance to the satellite, using the send-time, receive time, and the signal speed (speed of light):
GPS receivers calculate their position by intersecting ranges from four or more satellites ("triangulation").

Sources of Error

Clock Errors
Receiver clocks have limited accuracy;
The observed "range" to the satellite (pseudorange) is biased by an unknown clock offset, translating to range errors of hundreds of kilometers.
Satellites have accurate atomic clocks (to a few trillionths of a second) but small errors cause range errors of a few meters.

Atmospheric
The signal is slowed down due to a magnetic effect as it travels through the atmosphere.
Common mode
Signal propagation and satellite errors are the same for receivers within the same general area.
Can be corrected using a reference receiver at a known location

Multipath
Signals reflects off nearby objects before reaching receiver antenna due to local site conditions

Increasing Accuracy of Position

Dilution of Precision (DOP) Mask

DOP measures the geometry of the satellites relative to each other and to the receiver.
Low DOP = good geometry = more accurate (satellites are well spread in sky)
High DOP = poor geometry = less accurate (satellites are close together)
Obstructions (tree cover, buildings, etc.) cause higher DOPs.
GPS can be set to reject positions with DOPs too high **(PDOP limit=8 for SHIM)** to help ensure accuracy

Position Correction: Differential GPS

Position accuracy is increased by comparing the rover receiver (yours) with a reference receiver at a known location.
Without differential correction, the expected accuracy of GPS positions is about 20 metres.
Differential correction can be done either via post-processing or real-time (in the field).

Post-Processing Reference Data

After the survey is done, data from the field receiver and a reference receiver is downloaded to a computer and the positions are differentially corrected.

Real-Time GPS Surveying

Positions stored in the GPS receiver are corrected in the field, before downloading to the computer
Corrections are broadcast as soon as possible to users in a local area
Equipped GPS receivers can correct positions in real-time and store corrected positions in the field
GPS receivers can be configured to store uncorrected GPS data (for later post-processing) when real-time data is not available
Real-time corrections are slightly less accurate than post-corrected GPS, but the difference is not important for most mapping surveys (<1m).

Sound to Noise Ratio (SNR) Mask

Interference from gases, forest canopy, multipathing, and even GPS cable connections can cause signal attenuation. If the interfering components overwhelm the signal tracing can become difficult. The SNR is a comparison between the signal strength to the noise. **The SNR mask should be set to 3 for SHIM mapping however lowering the SNR mask to 0 allows for faster data collection with little difference to the accuracy of the collected data.**

From: RIC Standards Training using GPS Technology, September 1998.

Elevation Mask

Traveling through the atmosphere causes a great deal of noise to the GPS signal. The elevation mask allows GPS users to limit the length the signal travels through the atmosphere. **The elevation mask should be set to 15^{o} according to RIC standards.**

From: RIC Standards Training using GPS Technology, September 1998.

Accuracy Requirements for SHIM

GPS-derived stream features must be within five metres of the true location, 95 percent of the time (to be compatible with 1:5000 scale municipal maps). Under typical conditions with local obstructions, forest cover, and other factors, five-metre accuracy is achievable only with the best GPS equipment and careful methods.

General Field Methods for Poor GPS Reception

Moving the antenna around within a meter can help re-acquire satellite signals, without affecting position accuracy.
Waiting for ten or twenty minutes (sometimes hours in extreme cases) can usually enable surveying.
Conventional methods can be used to supplement GPS methods during these reception "down" periods.
Adjusting the Receiver Configurations
Under forest canopy, configuring the receiver to accept weaker satellite signals will make GPS surveying possible in most situations.
Weaker signals (such as signals passing through foliage) may be less accurate than strong signals.
Using the manufacturer's default configuration (e.g. SNR mask 6), the best GPS receivers are capable of accuracy better than 1 m in ideal conditions, but usually they work poorly in forest cover – if at all.
Reducing SNR to 0 allows collection of more data under forest canopy and does not degrade accuracy beyond acceptable limits (5 m, 95% confidence).

Using the Trimble Pathfinder

Upload the Data Dictionary from Pathfinder Office
Configure GPS

Field Mapping

Press on the power.
Select TerraSync Program
Select Data Collection from the main menu.

Select Create new file to create a new rover file. *Never re-open a rover file to add more information. You may lose your data or the file may become corrupted.*
Enter the file name. Decide on a file naming system and use it consistently (for example, Stream name / date: "FERG0601" for Fergus Creek, June 1st).
Select the Data Dictionary you will be using, which is generally the most recent Data Dictionary.
This opens the Start feature menu, from which you can choose to map point or line features.

Entering Shoreline Information

Note: *Remember to pause logging before stopping to enter information into the data logger, and resume when you continue walking the stream centreline.*

Reference Information applies to the entire shoreline feature you are mapping. It is usually entered while standing at the start point, but the timing depends on crew preference. For example you may prefer to do it at the same time as entering characteristics for the first segment. In any case, the data logger will not let you end the stream feature until you have entered all the required information.

APPENDIX B
Moyie Lake Data Tables

Table 1: Natural versus Disturbed shoreline lengths and percentages in Moyie Lake.

	Moyie Lake	
	% of Shoreline	Shore Length (m)
Natural	50.40%	18944
Disturbed	49.60%	18641
	Total	37585.1

Table 2: The total length of natural and disturbed shorelines and their associated land uses around Moyie Lake.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	2.1%	784	784	0	0.0%	0.0%
Commercial	0.0%	0	0	0	0.0%	0.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	17.5%	6574	4477	2097	68.1%	31.9%
Park	1.7%	636	636	0	100.0%	0.0%
Recreation	0.8%	294	88	206	0.0%	0.0%
Rural	30.5%	11472	8117	3355	70.8%	29.2%
Single Family	17.8%	6679	3125	3554	46.8%	53.2%
Urban Park	1.4%	527	61	466	11.6%	88.4%
Transportation	28.3%	10619	5557	5061	52.3%	47.7%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	37585.1				

Table 3: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Moyie Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	8.1%	3039	2626	413	86.4%	13.6%
Rocky Shore	38.8%	14591	8522	6069	58.4%	41.6%
Gravel Beach	29.7%	11152	5830	5322	52.3%	47.7%
Sand Beach	2.8%	1036	715	321	69.0%	31.0%
Stream Mouth	5.1%	1905	1095	809	57.5%	42.5%
Wetland	15.6%	5864	4057	1806	69.2%	30.8%
Other	0.0%	0	0	0	0.0%	0.0%
Total	100.00%	37585.1				

Table 4: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Moyie Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	24.7%	9282
Submergent Vegetation	1.2%	437
Emergent Vegetation	24.7%	9282
Floating Vegetation	2.3%	850

Table 5: The total number and density (# per km) of different shoreline modifications occurring around Moyie Lake.

Type	Total #	# Per km
Docks	108	2.87
Groynes	2	0.05
Boat Launch	10	0.27
Retaining Walls	105	2.79
Marinas	5	0.13
Marine Rails	3	0.08

Table 6: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Moyie Lake.

Category	% of Shoreline	Shore Length (m)
Roadway	11%	4106
Retaining Wall	12%	4685
Railway	12%	4452
Substrate Modification	35%	13263
Total Shoreline Length		37585

Table 7: The Level of Impact around Moyie Lake.

Category	Level of Impact (% of Shoreline)	Shore Length
High	47.23%	17750
Moderate	7.89%	2964
Low	44.89%	16871
Total		37585

APPENDIX C

Moyie Lake Aquatic Habitat Index

ECOSCAPE
Environmental Consultants Ltd.

Lowest Score Break for Habitat Categories (i.e., Current Value Score must be greater than this number)			
Very High	64	Moderate	40
High	52	Low	28

Summary						
Max	76.6	82.8	Max	76.6	82.8	
Min	20.0	21.6	Min	24.2	26.1	

	Biophysical						Fisheries			Riparian		Modifications				
Seg - ment	Shore Type	Sub - strate	% Natural	Aquatic Vege - tation	Over - hanging Vegetation	Large Woody Debris	Burbot Con - firmed Spawn	Stage	Rear	Band 1 (Riparian)	Band 2 (Upland)	Retain - ing Wall	Docks	Groyne	Boat Launch	Marina
1	15	8.4	3	0	0.6	0	0	0	5	0.4	0.24	-0.25	-1.10	0.00	-1	-1
2	20	7.6	13.5	8	1.8	0	0	0	5	4	4.8	0	0.00	0.00	0	0
3	15	8	9	1.6	0.6	0	0	0	5	4	4.8	0	0.00	0.00	0	0
4	12.75	5.9	14.25	0	0.3	0	8	0	5	8	0	-0.1	-0.20	0.00	-1	0
5	20	5.7	15	8	3.6	0	0	5	5	10	2.4	0	0.00	0.00	0	0
6	15	8.1	14.55	1.2	2.7	0	0	5	0	2	6	0	-0.10	0.00	0	0
7	15	8.2	0.15	0	0.3	0	0	0	0	3	0	-2	-0.40	-0.25	-3	-1
8	15	9.2	14.25	0	2.7	0	0	0	0	2	6	0	0.00	0.00	0	0
9	14.5	7	10.5	2.4	1.2	0	0	0	5	4	6	-3.5	-0.20	0.00	-1	0
10	13.5	7.6	6	0.8	0.6	0	0	0	0	8	0	-3.5	-2.20	0.00	0	-2
11	15	8.4	15	0	0.3	0	0	0	0	8	0	0	0.00	0.00	0	0
12	19	8.1	3	0.8	0.3	0	0	5	5	8	0	-3	-3.80	0.00	-2	0
13	20	7.7	1.5	0.16	0.12	0	0	5	5	8	0	-2.5	-0.40	0.00	-1	-1
14	15	7.4	0.75	0.4	0.12	0	0	0	0	0.2	0.3	0	0.00	0.00	0	0
15	16	7.6	3	1.2	2.4	0	0	0	0	8	3.6	-0.25	-1.40	0.00	0	0
16	15	7.3	10.5	0.8	1.8	0	0	0	0	6	1.2	0	0.00	0.00	0	0
17	20	5.4	14.25	8	6	0	0	0	5	10	6	0	0.00	0.00	0	0
18	15	9.5	3.75	0.8	0.9	0	0	5	0	8	0	-2	-0.70	0.00	0	0
19	10.5	3.6	14.85	0	0	0	0	5	0	8	0	0	0.00	0.00	0	0
20	20	8	14.25	2.4	4.8	0	0	5	0	2	6	0	-0.10	0.00	0	0
21	20	7.4	14.25	6.4	3.6	0	0	5	5	4	3.6	0	0.00	0.00	0	0
22	20	7.4	14.25	7.2	3.6	0	0	5	5	4	6	0	-0.10	0.00	0	0
23	15.5	8.4	1.5	0	0.3	0	8	5	5	4	6	-0.1	0.00	0.00	0	0
24	15.5	8.2	9	4.8	3.6	0	8	5	5	4	6	0	-0.20	-0.25	0	0
25	10	2.8	14.25	0	0	0	8	0	0	8	0	0	0.00	0.00	0	0
26	15	8.4	1.5	0.4	0.3	0	8	5	5	2	6	0	0.00	0.00	0	0
27	20	5.6	15	8	6	0	0	5	5	6	6	0	0.00	0.00	0	0
28	20	7	3	0	0	0	0	5	5	3	0	-0.75	0.00	0.00	0	0
29	14	7	3	1.2	0.9	0	0	5	0	10	0	0	0.00	0.00	0	0
30	15	7	6	1.6	1.2	0	0	0	5	2	6	-0.5	0.00	0.00	-1	0
31	15	8.8	15	3.2	0.6	0	0	0	5	8	0	0	0.00	0.00	0	0

Total Score	Maximum Score Possible			
	59	5	16	12.6

Seg - ment	Bio - physical	Fish	Rip - arian	Modifi - cations (All)
1	27	5	0.64	-3.35
2	50.9	5	8.8	0
3	34.2	5	8.8	0
4	33.2	13	8	-1.3
5	52.3	10	12.4	0
6	41.55	5	8	-0.1
7	23.65	0	3	-6.65
8	41.15	0	8	0
9	35.6	5	10	-4.7
10	28.5	0	8	-7.7
11	38.7	0	8	0
12	31.2	10	8	-8.8
13	29.48	10	8	-4.9
14	23.67	0	0.5	0
15	30.2	0	11.6	-1.65
16	35.4	0	7.2	0
17	53.65	5	16	0
18	29.95	5	8	-2.7
19	28.95	5	8	0
20	49.45	5	8	-0.1
21	51.65	10	7.6	0
22	52.45	10	10	-0.1
23	25.7	18	10	-0.1
24	41.1	18	10	-0.45
25	27.05	8	8	0
26	25.6	18	8	0
27	54.6	10	12	0
28	30	10	3	-0.75
29	26.1	5	10	0
30	30.8	5	8	-1.5
31	42.6	5	8	0

Seg - ment	Shore Length	Current Value	Current Value Total Percent	AHI Ranking	Potential Value	Potential Value Percent	AHI Ranking
1	348.3	29.3	31.6	Low	32.6	35.3	Low
2	244.0	64.7	69.9	Very High	64.7	69.9	Very High
3	430.9	48.0	51.9	Moderate	48.0	51.9	Moderate
4	4873.7	52.9	57.2	High	54.2	58.6	High
5	3917.7	74.7	80.7	Very High	74.7	80.7	Very High
6	1157.9	54.5	58.8	High	54.6	58.9	High
7	539.1	20.0	21.6	Very Low	26.7	28.8	Very Low
8	1035.8	49.2	53.1	Moderate	49.2	53.1	Moderate
9	490.2	45.9	49.6	Moderate	50.6	54.7	Moderate
10	2119.0	28.8	31.1	Low	36.5	39.4	Low
11	816.1	46.7	50.5	Moderate	46.7	50.5	Moderate
12	2521.9	40.4	43.7	Moderate	49.2	53.2	Moderate
13	986.0	42.6	46.0	Moderate	47.5	51.3	Moderate
14	2600.6	24.2	26.1	Very Low	24.2	26.1	Very Low
15	961.4	40.2	43.4	Moderate	41.8	45.2	Moderate
16	1254.2	42.6	46.0	Moderate	42.6	46.0	Moderate
17	874.3	74.7	80.7	Very High	74.7	80.7	Very High
18	669.5	40.3	43.5	Moderate	43.0	46.4	Moderate
19	206.9	42.0	45.3	Moderate	42.0	45.3	Moderate
20	475.5	62.4	67.4	High	62.5	67.5	High
21	695.9	69.3	74.8	Very High	69.3	74.8	Very High
22	1029.7	72.4	78.2	Very High	72.5	78.3	Very High
23	5403.7	53.6	57.9	High	53.7	58.0	High
24	583.1	68.7	74.2	Very High	69.1	74.7	Very High
25	231.3	43.1	46.5	Moderate	43.1	46.5	Moderate
26	603.5	51.6	55.8	Moderate	51.6	55.8	Moderate
27	1143.2	76.6	82.8	Very High	76.6	82.8	Very High
28	231.0	42.3	45.7	Moderate	43.0	46.5	Moderate
29	275.8	41.1	44.4	Moderate	41.1	44.4	Moderate
30	636.3	42.3	45.7	Moderate	43.8	47.3	Moderate
31	228.5	55.6	60.1	High	55.6	60.1	High

APPENDIX D
Summary of Fisheries Data

Table 1: Summary of the total number of fish surveyed during spring and fall sampling seasons in Moyie Lake using beach seines and snorkel surveys.

Species	Common Family Name	Total Number Surveyed	Relative Abundance (%)
Redside Shiner	Cyprinid (Minnows)	106	82
Cyprinid (unidentified)	Cyprinid (Minnows)	1642	
Lake Chubb	Cyprinid (Minnows)	25	
Long Nose Dace	Cyprinid (Minnows)	23	
Largescale sucker	Sucker	173	8
Kokanee	Salmonid	5	1
Rainbow Trout	Salmonid	2	
Mountain Whitefish	Salmonid	18	
Pumpkinseed Sunfish	Non Native	204	9
	Total	2198	100

APPENDIX E

Summary of Wildlife and Vegetation Surveys

#102 – 450 Neave Ct. Kelowna BC. V1V 2M2 ph: 250.491.7337 fax: 250.491.7337 ecoscape@ecoscapeltd.com

Habitat Attributes		Shore Segment and Site Sample Identifier (First Row is Shore Segment and Second Row is Site Identifier)					
		3	4	4	5	5	6
		1.1	2.1	2.2	3.1	3.2	4.1
Forest Cover	**Age / Canopy**	mature with understory, open	mature, open	old, open		mature, open	mature, closed
	Species	Pl, Ct	Lw, Ct	Fd		Ct, Sp	Sp, Pl, Lw, Fd, Bp
Wildlife Trees		few	few	moderate	few		moderate
CWD/LOD		very little	abundant	abundant	very little	very little	abundant
Shrub Cover	**Amount**	sparse	moderate	moderate	sparse	abundant	abundant
	Species	cinquefoil, willow	willow, red-osier dogwood, rose, mountain alder	juniper, maple, alder, saskatoon, choke cherry, red-osier dogwood,	grasses	willow, red-osier dogwood, rose, mountain alder	red-osier dogwood, rose, mountain alder
Clay Bank/Cliff			yes	cliff			cliff and steep
Adjacent Wetland					yes		yes
Littoral Zone	**Gradient**	shallow	steep	steep	shallow	shallow	steep
	Piece Size	cobble	boulder, cobble	boulder	mud, sand	sand	pebble to cobble
Emergent/Submergent					yes	little submergent	very little
Wildlife		cedar waxwing	red-breasted nuthatch, dark-eyed junko, black-capped chickadee	peregrine falcon, black capped chickadee, red-breasted nuthatch	Canada geese, common merganser, song sparrow, northern rough-winged swallow, bank swallow, tree swallowbald eagle, red-winged blackbird, yellow-rumped warbler, cedar waxwing, osprey, mule deer, rocky mountain elk, painted turtle, mallard, American robin, belted kingfisher, northern flicker, lesser scaup, Cooper's hawk, grebe, great blue heron	song sparrow, American crow, northern rough-winged swallow, cedar waxwing, Canada geese, spotted sandpiper, turkey vulture, yellow warbler, grebe, belted kingfisher, elk, beaver, deer, western toad	common merganser, Canada geese, nuthatch
Notes		ice influence	scree slope		channel piers used by cavity nesters, beaver house	quad activity, wapato	extensive browse, unique wetland

Habitat Attributes		Shore Segment and Site Sample Identifier (First Row is Shore Segment and Second Row is Site Identifier)								
		8	9	10	12	12	13	14	15	17
		6.1	7.1	7.2	9.1	9.2	10.1	11.1	12.1	14.1
Forest Cover	**Age / Canopy**	mature	mixed young and mature	moderate	mature, moderate	mature, moderate	modified	sparse	sparce	
	Species	Ct, Pl, Lw, Py, Fd	Ct, Lw, Fd, Bp, Sp	Pl, Lw, Cw	Py, Pl, Lw	Fd, Lw, Pl	Ct		Ct, Fd	
Wildlife Trees		few	few		low	few				
CWD/LOD		moderate	little		little					
Shrub Cover	**Amount**	moderate to abundant	moderate	sparse	sparse	sparse		abundant to none	moderate	abundant
	Species	mountain alder, rose	red-osier dogwood, willow, mountain alder, saskatoon		mountain alder			maple, willow, mountain alder, red-osier dogwood, cinquefoil, ocean spray, saskatoon	mountain alder	willow
Clay Bank/Cliff										
Adjacent Wetland										yes
Littoral Zone	**Gradient**	steep	shallow	moderate	steep, drop off	stream bank	shallow	steep	steep	shallow
	Piece Size	cobble	sand, pebble	cobble, gravel			mud		cobble	silt
Emergent/Submergent			submerged				emergent - equisetum			yes, yes
Wildlife			black-capped chickadee, American robin, dark-eyed junko, grosbeak, yellow warbler, northern flicker, spotted sandpiper, garter snake, squirrel, sharp-shinned hawk, American crow	northern rough-winged swallow, sparrow	violet green swallow, spotted sandpiper, hummingbird	belted kingfisher, song sparrow, American robin, swallow *spp.*	northern flicker, violet green swallow, rough-winged swallow, Stellar's jay, pine siskin	common merganser (family unit), cedar waxwing, yellow warbler	osprey	osprey, yell warbler, Ame robin, swall Canada geese, (scat/track
Notes		old mine tailings				beaver house	filled in wetland		Moyie townsite	

Habitat Attributes		Shore Segment and Site Sample Identifier (First Row is Shore Segment and Second Row is Site Identifier)						
		18	23	23	24	26	27	27
		15.1	17.1	17.2	18.1	19.1	20.1	21.1
Forest Cover	**Age / Canopy**	modified		mid, open	mature, closed		mature, open	mature, moderate to closed
	Species	Willow, Pl, Py, Fd		Pl, Fd, Ct	Pl, Fd, Ct		Ct	At, Ct, Pl
Wildlife Trees					few		few - Ct	
CWD/LOD				very little	abundant, receiving	little	abundant	moderate
Shrub Cover	**Amount**		moderate to abundant	sparse	abundant	abundant	abundant	abundant to moderate
	Species		red-osier dogwood, rose, saskatoon, snowberry	saskatoon, maple, willow, rose	cinquefoil, mountain alder, red-osier dogwood, rose	red-osier dogwood, mountain alder	willow	willow, red-osier dogwood
Clay Bank/Cliff								
Adjacent Wetland							yes	
Littoral Zone	**Gradient**	moderate	steep	steep	moderate then steep	steep	shallow	shallow
	Piece Size	cobble	boulder, cobble	boulder, cobble	cobble, boulder	cobble, boulder	sand	sand?
Emergent/Submergent		submerge			very little		yes	submergent
Wildlife		American robin, osprey	dark-eyed junko, rough-winged swallow	northern rough-winged swallow	cedar waxwing, swallow, pine siskin, common merganser, great blue heron, American crow	Amercian crow, swallow, sandpiper, sparrow	common loon	sandpiper, Barrow's goldeneye
Notes			St. John's Wort		kokanee spawning		windy	increased sightings of crayfish

APPENDIX F
Additional Legal Requirements

This Appendix was reproduced from the Windermere Lake Shoreline Management Guidelines entirely. All credit should be given to the original authors of that document.

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, and Regional District. 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.

APPENDIX G

Best Management Practices and Regional Operating Statements

This Appendix was reproduced from the Windermere Lake Shoreline Management Guidelines entirely. All credit should be given to the original authors of that document.

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
- Best Management Practices for Recreational Activities on Grasslands in the Thompson and Okanagan Basins

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