Foreshore Inventory and Mapping

KOOTENAY LAKE MAIN ARM

Prepared For:
Regional District of Central Kootenay

Prepared By:
Ecoscape Environmental Consultants Ltd.

January, 2011
File No.: 09-513

ECOSCAPE
Environmental Consultants Ltd.

FORESHORE INVENTORY AND MAPPING

Regional District of Central Kootenay

Kootenay Lake
Main Arm

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ACKNOWLEDGEMENTS

This project was made possible through collaboration between the Regional District of Central Kootenay and Fisheries and Oceans Canada.

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Recommended Citation:
Schleppe, J., 2009. Kootenay Lake Foreshore Inventory and Mapping. Ecoscape Environmental Consultants Ltd.. Project File: 09-513. January, 2011. Prepared for: Regional District Central Kootenay.
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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 pertinent environmental information to facilitate future land use planning along the Kootenay Lake Main Arm foreshore. This project is Step 1 of a general process of inventory and planning exercises that are happening around the province:

1. Step 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 are carried out. Inventories were conducted using a variety of methods and data was utilized from numerous different sources;

2. Step 2 - An Aquatic Habitat Index (AHI) is generated using the FIM data to determine the relative habitat value of the shoreline. The relative habitat value was determined for each shoreline segment and ranged from Very High to Very Low (5 class ranking). This index follows similar methods that were developed for Shuswap Lake, Okanagan, Mabel, Mara, Columbia, Wasa, Rosen, and Windermere Lakes. This step has not yet been completed for Kootenay Lake and has been identified as an important next step in shoreline management for the lake.

3. Step 3 - Shoreline Management Guidelines are prepared for the shorelines surveyed to allow governments to make informed land use decisions for our watersheds that are based upon the risks of potential land use change. 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. This step has not yet been completed for Kootenay Lake.

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.

Kootenay Lake is integral to the communities that surround it. The lake provides drinking water, is critical habitat for numerous fish and wildlife species, and is a focus point of nearly all lakeshore communities that surround it.

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

- Approximately 80% or 232 km of the shoreline of Kootenay Lake Main Arm remains in natural condition.

- The lake is generally surrounded by Moderate to Very Steep slopes, which account for 86% or 246.6 km of the total shoreline.

- Natural Areas or Crown Lands occur along 17% or 51 km of shoreline. The remaining lands are privately held, with the majority occurring in larger, rural holdings. Rural holdings account for 48% or 138 km of shoreline. Transportation land uses, such as road or railways were the next most prevalent land use, occurring along approximately 15% or 43 km of shoreline.

- Cliff / Bluff shorelines were the most prevalent shore type observed, with approximately 45% or 130 km of shoreline being this type. Rocky shores and gravel beaches were the next most prevalent shore types, occurring along 30% (86 km) and 13% (38 km) respectively. Steam confluences and wetlands were not common and only occurred around 6% (18 k) and 2% (7 km) of the shoreline respectively. The most important stream confluences identified (and those encompassing the largest shore length) were the Duncan River and Kootenay River floodplains.

- Aquatic vegetation was not very common along Kootenay Lake, with approximately 7% or 21 km of shoreline containing foreshore vegetation. This is likely the result of the steep nature of the shoreline in combination with the more prevalent rocky type shorelines (e.g., Cliff / Bluff) that occur. It is possible that smaller patches of emergent vegetation may be present that were not mapped as part of this assessment.

The following summarizes habitat modifications observed:

- Groynes and boat basins were the most prevalent shore modification observed. There were a total of 381 groynes and 41 boat basins observed along the shoreline. Many of the boat basins were also groynes because of their impacts on longshore sediment movement. Some of the groynes and boat basins observed were substantial and likely required large equipment to construct.

- There were a total of 21 marinas were more than 6 slips observed along the shorelines of Kootenay Lake Main Arm.

- Mooring buoys, retaining walls, and docks were also commonly observed. There were a total of 172 mooring buoys, 138 retaining walls, and 136 docks observed.

- Substrate modification was prevalent along the shoreline, with approximately 15% or 43 km of shoreline experiencing modification of lakebed substrates. A portion of this substrate modification is the result of construction of groynes mentioned above. Other substrate modification impacts are the result of road and railway impacts, which occur along 2% (7 km) and 8% (21 km) of the shoreline respectively.

A brief analysis of developed areas was completed to assess impacts within regions that have experienced higher development intensity. The following summarizes this analysis:

- Disturbances within developed areas doubles from approximately 20% to 39%. Within these areas, Single Family development was typically 40% disturbed and these levels of disturbance are lower than those observed on Shuswap or Okanagan Lake.

The findings of the FIM indicate that the foreshore areas of Kootenay Lake has been impacted by our current land use practices. The surveys indicate that in more densely developed areas, impacts are greatest. It was readily apparent that where intense development was present most habitat features had been impacted or impaired in some way. Transportation has also played a role in disturbances along the shorelines. Despite these impacts, many areas around the shoreline remain in a relatively natural condition. The lake shore still supports diverse communities in rural areas. Also, there are many natural park land areas around Kootenay Lake that support a diverse community that is in good condition. Maintenance of the rural nature of the shore line in areas will help reduce cumulative impacts along the shoreline. Further, by limiting intense development areas along the shoreline, habitat impacts will be reduced.

REPORT DISCLAIMER

The results contained in this report are based upon data collected during a brief one year inventory completed by others. Data was provided to Ecoscape and we have assumed that the data provided is accurate. Ecoscape has reviewed and corrected data based upon the information provided from multiple sources to the best of our ability. 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. Numerous different agencies and people contributed comments to this report to ensure inferences or data referenced or stated is accurate. Not all agencies or people were able to respond to the requests and the authors have attempted to ensure accuracy. However, some assumptions with the text about past governance or other issues may not entirely reflect historic conditions and the appropriate agencies or people should be contacted to confirm the truth of these inferences. 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.

TABLE OF CONTENTS

FIGURES

SEGMENT PHOTO PLATE SUMMARY

FORESHORE INVENTORY AND MAPPING FIGURE BINDER

APPENDICES

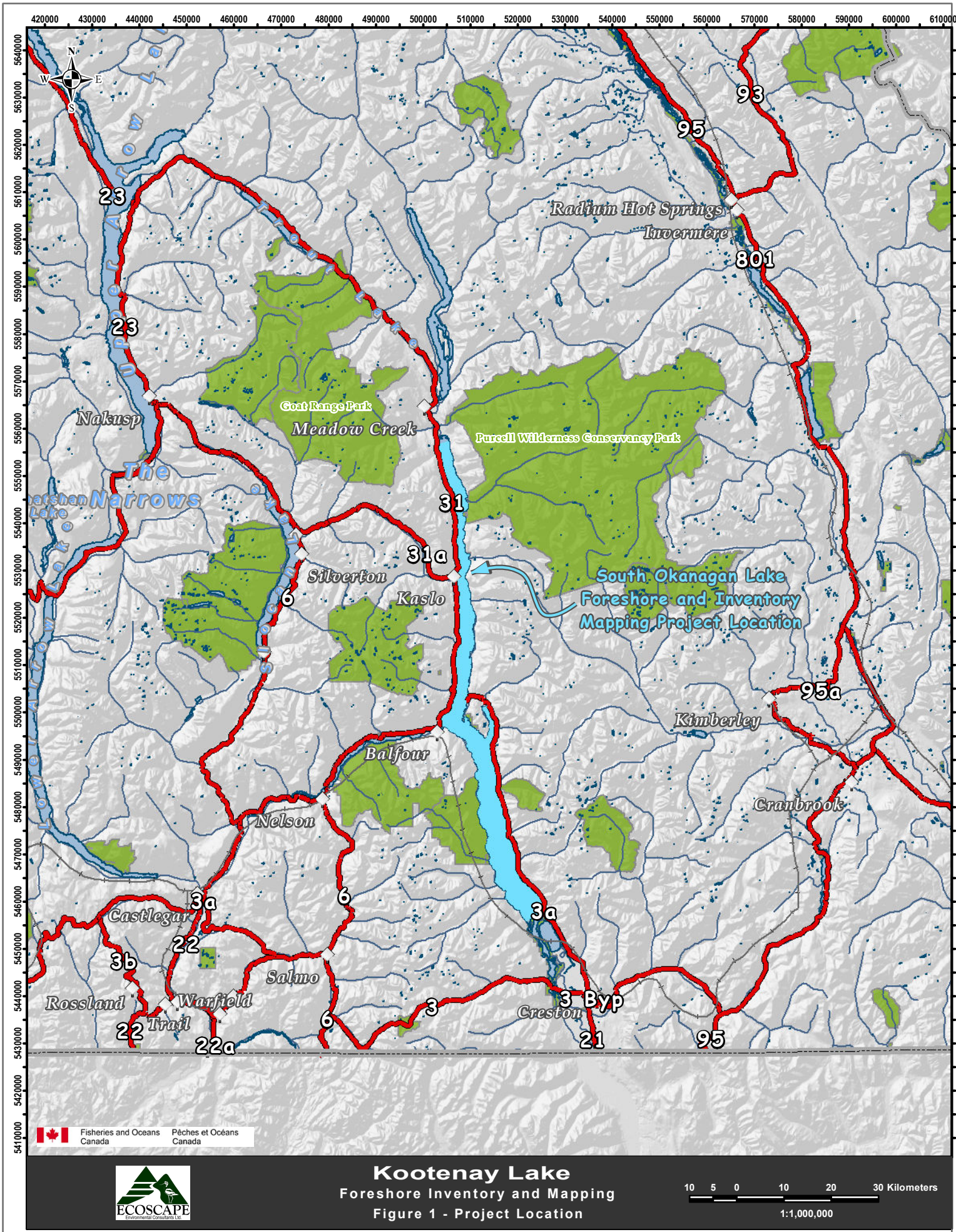
1.0 INTRODUCTION

The North and South Arms of Kootenay Lake are critical resources to the communities occurring along the shoreline. The lake offers scenic beauty, year-round recreational opportunities such as fishing, is a source of drinking water, and provides key habitat for numerous fish and wildlife species. Due to the desire to live and recreate in the Kootenay's, development pressure is increasing along all of the large lakes in the area. As a result of development, the shorelines are being impacted and habitat function is often being impaired. 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 at the provincial and federal levels. It is widely acknowledged that development pressure has the potential to or has already impacted fish, wildlife, and/or water quality. As a result of this, the Regional District of Central Kootenay (RDCK) and Fisheries and Oceans Canada (DFO) gathered and presented data to document the baseline conditions of Kootenay Lake. This project is intended to help in the development of shoreline planning policies that can be considered for inclusion in the Kootenay Lake Stewardship Plan.

It is a complex relationship between development pressure, the natural environment, and social, economic and cultural values. To balance these various community values, a baseline 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 shorelines of Kootenay 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

Kootenay Lake is a narrow lake with a U shaped bottom. The primary tributaries to the lake are the Kootenay River (entering in the South Arm) and the Duncan and Lardeau Rivers (entering in the North Arm). The shorelines of the North and South Arm's of Kootenay Lake are within the Regional District of Central Kootenay and Village of Kaslo. The intent of this project was to inventory the shoreline of the main arm of Kootenay Lake to understand the current condition of the shoreline and facilitate better long term management. In 2008, the West Arm of Kootenay Lake was inventoried using the same methodology (Lawrence and Porto, 2008). 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 should be incorporated into the Kootenay Lake Stewardship Plan.



Kootenay Lake

Foreshore Inventory and Mapping

Figure 1 - Project Location

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 seven (7) years and have become a standardized approach to shoreline inventory. The first Foreshore Mapping effort was conducted in 2004 on Okanagan Lake. Numerous local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol since in conception. 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. Regional District Central Kootenay; and,
2. Fisheries and Oceans Canada;

2.2 Objectives

The project objectives were as follows:

1. Compile existing map base resource information for the Kootenay Lake;

2. Foster collaboration between the Regional District of Central Kootenay, Fisheries and Oceans Canada, and other relevant stakeholders;

3. Provide an overview of foreshore habitat condition on the lakes;

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

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

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

7. 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 adapted from 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 Kootenay Lake FIM of the main arm.

3.1 Field Surveys

FIM field surveys were conducted July 25 to 28 and September 24, 2009. Field crews for the data collection are identified above in the acknowledgements.

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.

Parties using the data should ensure that they have the most recent versions of the FIM dataset for Kootenay Lake, as this project is continually evolving as new data is collected.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for *select areas* of the shoreline along Kootenay Lake. Areas selected for mapping were easily identifiable on the air photos provided for the project. Generally, these areas occurred in important floodplain areas around the lake. Due to airphoto resolution, mapping is considered to be moderately accurate and should not be relied upon exclusively for any detailed assessment. 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 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 shallow, flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating watertable is typical in marshes, with early-season high water tables dropping throughout the growing season. Exposure of the substrates in late season or during dry years is common. The substrate is usually mineral, but may have a well-decomposed organic veneer derived primarily from marsh emergents. Nutrient availability is high (eutrophic to hyper-eutrophic) due to circum-neutral pH, water movement, and aeration of the substrate.

Swamp (Ws)

A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs on sites with a flowing or fluctuating, semipermanent, near-surface watertable. Swamps occur on slope breaks, peatland margins, inactive floodplain back-channels, back-levee depressions, lake margins, and gullies. Tall-shrub swamps are dense thickets, while forested swamps have large trees occurring on elevated microsites and lower cover of tall deciduous shrubs.

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 understory 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.

Other Vegetation Areas

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 needs 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.

The reader should note that none of the vegetation polygons have been field confirmed and detailed assessment of the polygons is required to more accurately assess the communities present.

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 moderate resolution air photos that were available. Airphoto's used during this assessment were of moderate quality and therefore, some mapping boundaries are not as accurate as desired.
- 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 did not complete shoreline mapping (i.e., digitization of the shoreline to more accurately determine the HWL) for this project due to budgetary constraints.

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. This field is currently blank.

4.0 DATA ANALYSIS

4.1 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.

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

5.0 RESULTS

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

5.1 Biophysical Characteristics of the Lakes

Foreshore Inventory and Mapping was completed on 285,245 m (~288 km) of shoreline on Kootenay Lake. The total length of disturbed shoreline on Kootenay Lake was 58,667 m (58 km) and the total length of natural shoreline was 226,579 m (226 km). This level of disturbance represents nearly 20% of the total shoreline length (Figure 2). In Okanagan Lake and Shuswap Lakes, the shorelines were 56% and 42% disturbed respectively.

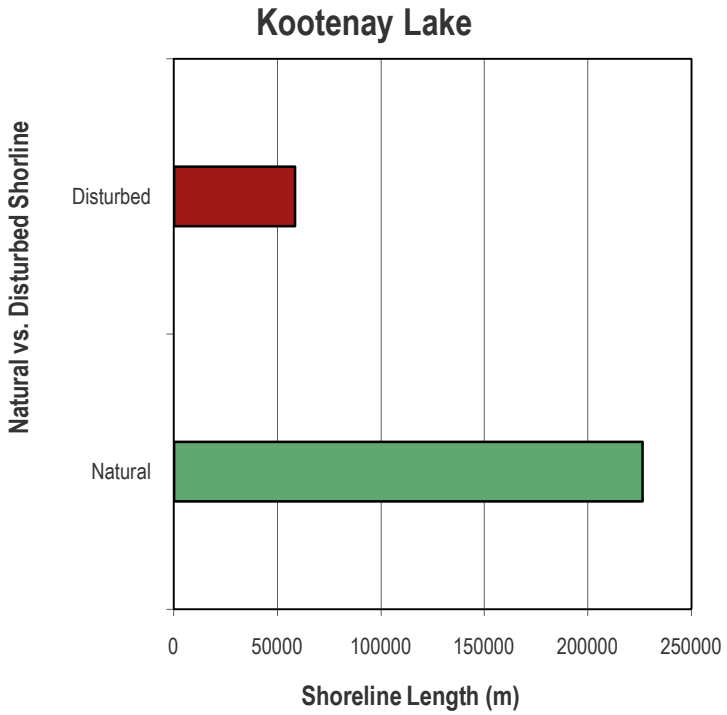


Figure 2 The total shoreline length that is either natural or disturbed on Kootenay Lake.

Different gradient slopes tended to have similar disturbance levels associated with them. Areas of Moderate Slope tended to have the highest level of disturbance, with over 32% or for 30 km of their length disturbed. Low gradient areas on Kootenay Lake were disturbed along 27% (10 km). Along steeper shorelines in Kootenay Lake, disturbance only occurred along 12% (16.5 km) and 8% (1.5 km) of the Steep and Very Steep shore lengths respectively.

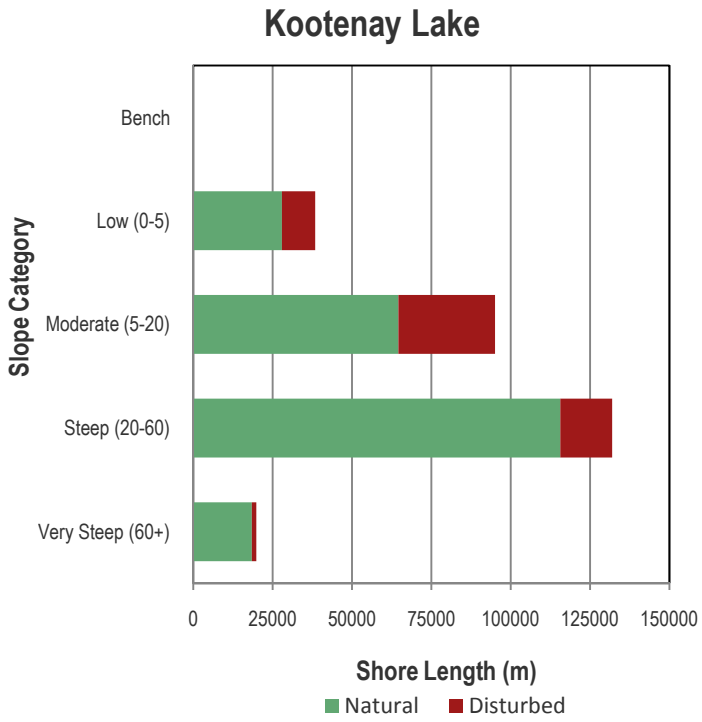


Figure 3 The total shoreline length that is either natural or disturbed within the different slope categories of Kootenay Lake.

Rural land use was the most prevalent along the shoreline of Kootenay Lake, with 48% or 137 km of shoreline generally having this land use type. Within rural areas, shorelines tended to be mostly natural in character with approximately 84% of the length still natural. Natural Areas or Crown Lands were the second most common land use observed, occurring along approximately 18% or 51 km of shoreline. Natural areas were approximately 90% natural, with very little disturbance observed. The next prevalent land use type was Transportation, which occurred along 15% or 43 km of shoreline. Within shoreline areas identified as a Transportation land use, disturbance was still quite low with only 30% of the shoreline area disturbed. Single family development occurred along 11% or approximately 32 km of shoreline and within these areas 60% still remained in relatively natural condition.

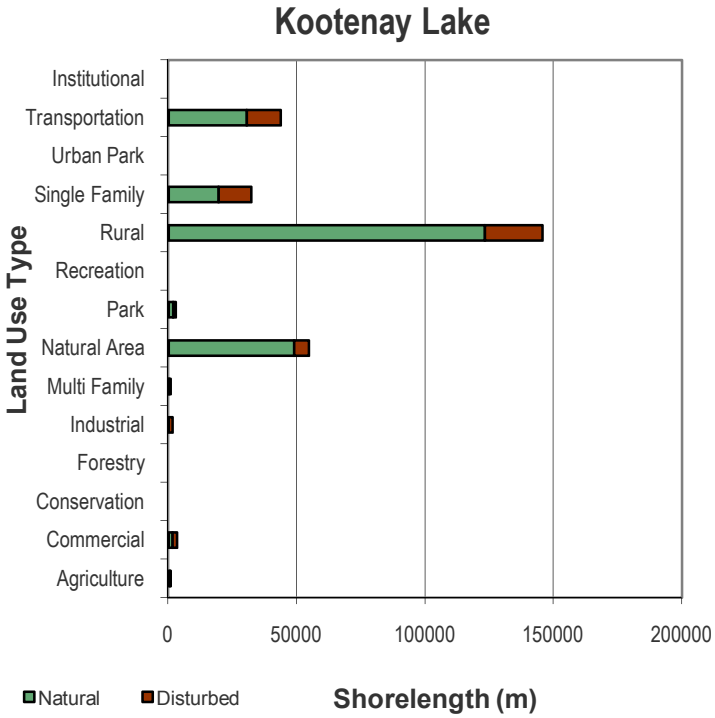


Figure 4 presents the natural and disturbed shore length by the different types of land use types occurring around Kootenay Lake.

The most predominant shore type observed along Kootenay Lake was Cliff / Bluff, which accounted for 45% (~130 km) of the shore length. Cliff / Bluff shorelines were disturbed along 13% of the length, or for approximately 16 km. Rocky shores were the second most predominant shore type observed, and occurred along 87 km or 30% of the total shore length. Rocky shores were disturbed along approximately 28% or 24 km of the shore length. Gravel beaches were third most prevalent shore type, accounting for about 13% of the shoreline, or approximately 38 km. Gravel beaches were disturbed along 33% of the shore length or 13 km. Sandy shores, wetlands, and stream confluences were not very common and represented only 1.6%, 2.4% and 6.5% of the total shoreline length, respectively. The condition of these shore types varied, with Sandy beaches being 38% (1.7 km), Wetlands being 6% (0.5 km) disturbed, and Stream confluences being 16% (2.9 km) disturbed. Sand beaches, rocky and gravel shores were the most disturbed because these shorelines occur on lower gradient slopes (Low to Moderate) and the analysis above corroborates this assessment.

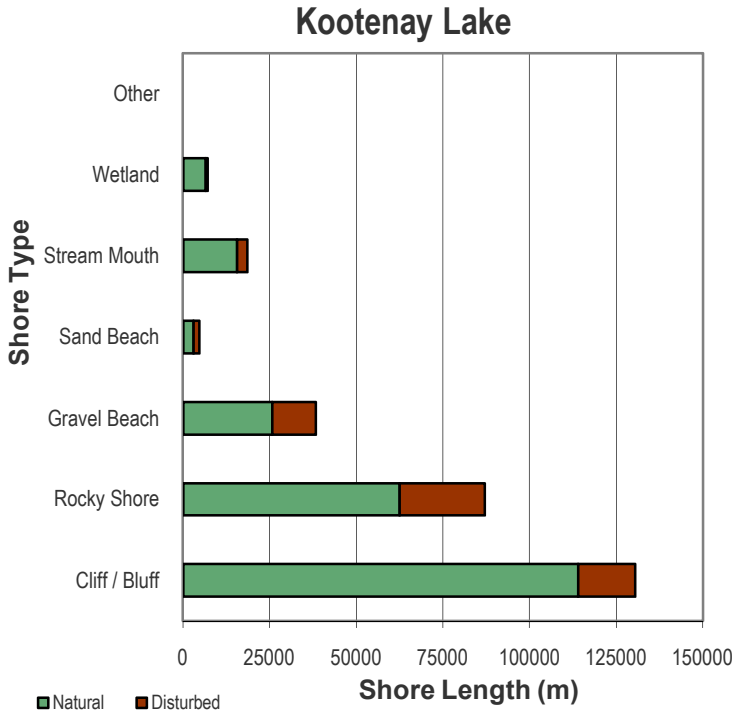


Figure 5 presents the length of natural and disturbed shoreline along each of the different shore types on Kootenay Lake.

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 and sedge 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 21 km of the shoreline of Kootenay Lake that has aquatic vegetation, which represents approximately 7.5% of the total shoreline length in the lake. The most common vegetation type observed was emergent vegetation, which occurred along 6.2% (18 km) of the Kootenay Lake shore length. Floating and submergent vegetation accounted for 1.3 % (3.5 km) and 1% (2.8 km) of the shorelines respectively. Detailed mapping of submergent vegetation was difficult due to the length of shoreline surveyed and time allotted for inventory, and due to the resolution of air photos available. . It is highly probable that there are additional submergent vegetation areas that have not been inventoried as part of this assessment. Crawford Bay (Segments 30-31), the Duncan River floodplain (Segment 10), Fry Creek floodplain (Segment 13-15), and the Kootenay River floodplain (Segment 42) were shoreline areas with significant aquatic vegetation.

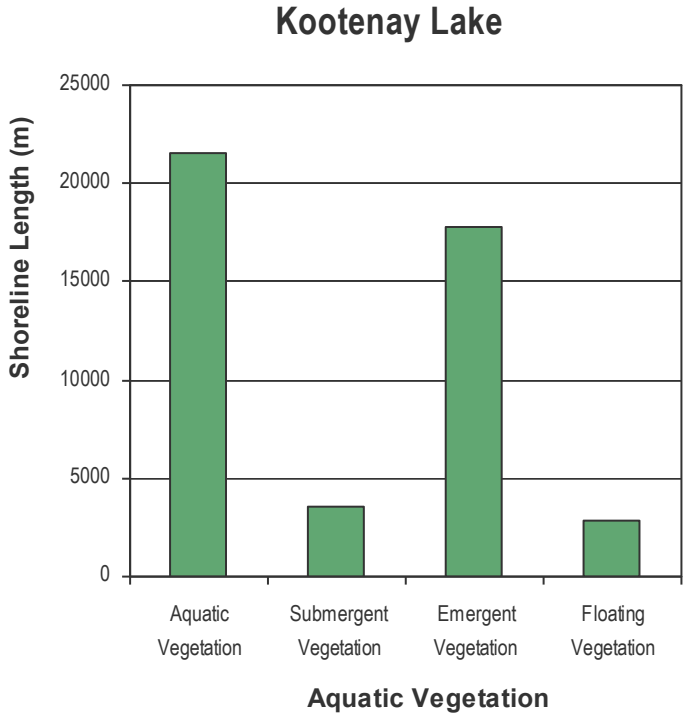


Figure 6 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

On Kootenay Lake groynes were the most commonly observed type of shoreline modification, with a total of 381 observed around the lake. Boat basins were also a significant shoreline modification, with 41 observed along the shoreline. Boat basins were often also acting as groynes because of the impacts on shoreline sediment movement. Mooring buoys, docks, and retaining walls were the next most prevalent modification observed, with a total of 172, 136, and 138 observed along the shore length respectively. There are a total of 21 marinas with greater than 6 boat slips and 55 boat launches. There were a total of 69 marine rails observed on Kootenay Lake. The above summarizes the current structures that occur on, over, and around Kootenay Lake.

Boat basins were documented in numerous locations along the shoreline of the lake. The basins were constructed out of varying materials including concrete lock blocks, rip rap, timber logs, and poured concrete. These large features, sometimes up to 30 m in length affect numerous shoreline processes and subsequently fish habitat. Documented impacts include alterations to shoreline wave patterns, energy transfer to adjacent areas and potentially subsequent erosion issues, infill of basins with fine sediment resulting in the creation of habitat more suitable to introduced invasive fish species (i.e., fine sediments promote growth of dense aquatic vegetation that favors species like bass), and impacts to longshore sediment drift.

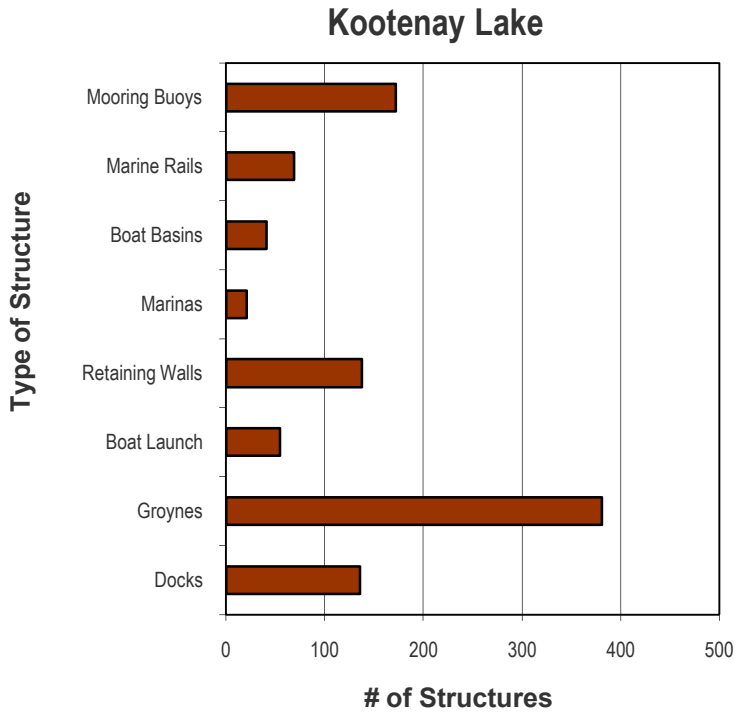


Figure 7 presents the total number of different shoreline modifications that occur around Kootenay Lake.

The percentage of the shoreline that was impacted by transportation (roads, railways), and substrate modification was recorded along Kootenay Lake 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 15% or 44 km of shoreline has experienced some form of substrate modification in the form of beach grooming, highway or railway fills, and construction of groynes. Transportation impacts from railways were the next most prevalent modification and were present along 7% or 20km of shore line. Roadways having a direct impact on the foreshore of Kootenay Lake occurred along approximately 3% or 10 km of the shore length.

Groynes were most prevalent (i.e., > 7 groynes / km) in near Riondel (Segment 24), around Gray Creek (Segment 33), Sirdar areas (Segment 39), and Ainsworth areas (Segment 54)

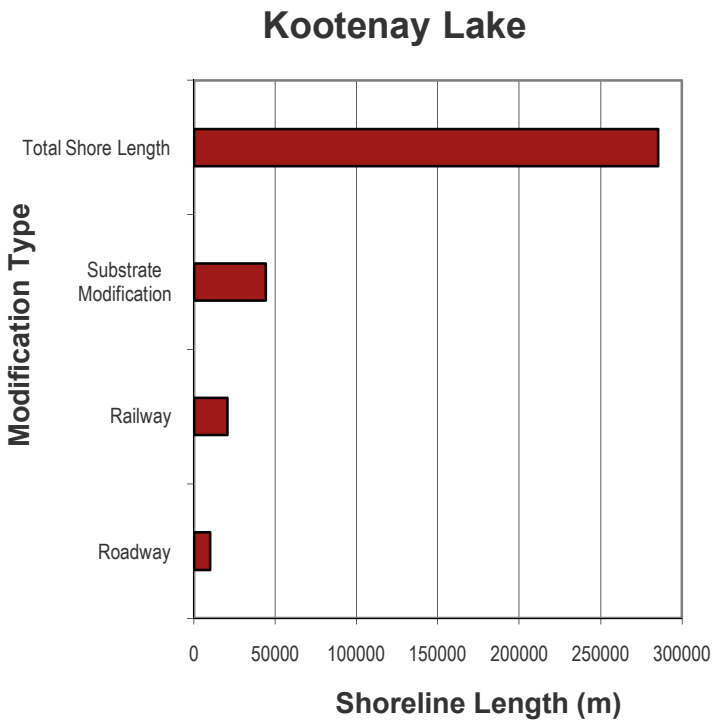


Figure 8 presents the total shoreline length that has been impacted by substrate modification, road and railways along Kootenay Lake.

The foreshore modifications by the different mechanisms described above for Kootenay Lake have resulted in a high level of impact around approximately 11% or 30 km of the shoreline. Areas of moderate and low impact account for about 26% (75 km) and 56% (161 km) of the shoreline respectively. Kootenay Lake had approximately 6% (17 km) of the shoreline that remained 100% natural in condition. High levels of impacts due to land development were observed in the Kootenay Bay / Riondel areas (26), Gray Creek (Segment 32), and Sirdar (Segment 39) areas. Segment 63 was another highly disturbed segment from Transportation land uses, and occurred around Balfour.

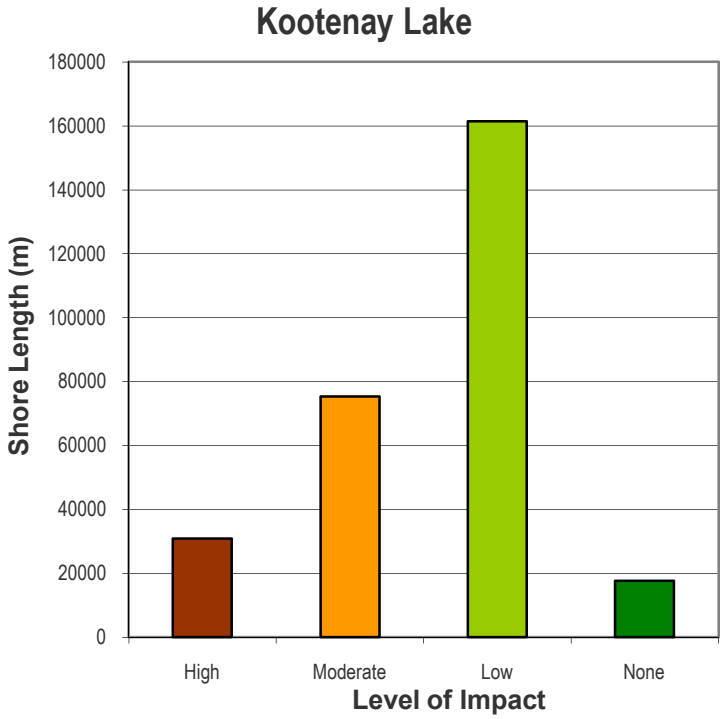


Figure 9 presents the level of impact (High, Moderate, Low, or None) observed along Kootenay Lake.

5.2 Summary of Foreshore Modifications

The foreshore of Kootenay Lake has experienced varying degrees of impacts.

- Substrate modification was a prevalent disturbance along the shoreline of Kootenay Lake. Substrate modification was observed on private lands due to retaining construction, lake infills, and construction of groynes. On public lands, substrate modification was mostly observed due to the construction of highways or railways. The construction of these features has resulted in the loss of aquatic vegetation (actual loss has not been determined), and a losses in productivity. This impact is similar to other interior lakes that have been surveyed including Okanagan, Wood, Kalamalka, Mabel, Moyie, Monroe, Mara, and Shuswap.

- Floodplain areas within Kootenay Lake have been modified since construction of the dam at the outflow for power generation. A result of this water level regulation is an increase in establishment of shrubby vegetation along the shoreline in areas that were historically more prone to flooding. In developed areas, it is apparent that emergent shrubby vegetation below the high water level (e.g., willows and cottonwoods), including 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 groyne construction, substrate modification, or from road/rail fills. All aquatic vegetation, including establishing shrubby vegetation resulting from lake level regulation is important and continued impacts will affect juvenile fishes 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 in more densely developed areas. The noticeable losses of riparian vegetation have not been quantified as part of this assessment, but are considered significant. There are numerous opportunities for riparian habitat enhancements along the shoreline of the lakes. Currently, an effort is underway in the Shuswap system to digitize and map all riparian vegetation to better track changes over time. This approach would provide a very accurate description of the shoreline, but may be costly to conduct.

- Private boat launches have been constructed on Kootenay 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 all boat launches on Kootenay Lake have resulted in the loss of at least 990 m^2 of lost foreshore habitat (i.e., below high water level) and 1,650 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. These construction practices are currently being required in many shore guidance documents including the Okanagan Large Lakes Protocol. Retaining walls constructed at or adjacent to the high water level should generally only occur to help reduce losses of land from

shoreline erosion and even in these circumstances softer engineering approaches should be used.

- Roadway and railway impacts were prevalent in some areas. In these areas, there was little evidence of bioengineering to soften constructed edges along the shoreline. However, in cases where the roadway or railway 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.

- A significant impact observed below the high water level along the shorelines was due to the construction of groynes and boat basins. The construction of these features has resulted in the loss of aquatic vegetation (actual loss has not been determined), a loss of productivity along the shoreline, the alteration of shore type from a rocky shore to gravel or sand beaches, has covered valuable fish habitat, has resulted in the erosion of shoreline and lake bed substrates, and has potentially resulted in reduced shore spawning success due to sedimentation impacts. In many cases, the construction of groynes required the use of heavy equipment. All groynes observed were constructed on crown lands below the high water level, and it is likely that many, if not all, were not permitted under the BC Water Act or Federal Fisheries Act. Boat basins also impact fish habitat. These features act as groynes (resulting in impacts discussed above), and also provide a calm water zone allowing sediment deposition of fine susbtrates. Within these basins, the fine substrates that settle promote the establishment of dense aquatic vegetation that creates habitat for invasive fish such as bass (which potentially exist in the lake) and cyprinids (minnows).

- Docks were a common shoreline modification observed. These overwater structures varied in size and were built using a variety of materials. Docks pose a significant challenge to fisheries and land use managers because the demands for moorage are extensive. Covered boat lifts were also observed. Although boat houses (covered with walls) were not as prevalent, the impact of covered boat lifts is similar to a boat house and is considered significant. The cumulative footprint of docks on Kootenay Lake is conservatively estimated to be 612 m^2 (assuming dock is 1.5 m (5 ft) wide and 3 m long (10 ft)). In Kootenay Lake, littoral areas are a potentially limiting factor and the shading and habitat modifications due to docks could be significant if not manage effectively.

5.3 Analysis of Developed Areas

A detailed analysis was conducted for areas that have a higher level of development. This analysis used the same analyses presented above for the whole lake, but focused on key areas where more development pressure has already occurred. The intent of this analysis was to assess the effects of development intensity on Kootenay Lake, given that many areas are either large, undeveloped rural holdings or are areas of undeveloped Crown Lands.

This analysis focused on a cumulative assessment of the following general areas (i.e., they were all lumped into one analysis):

1. Gray Creek;
2. Boswell;
3. Ainsworth; and,
4. Kaslo

This analysis was conducted on the following segments: 32-33,35-37, 40, 54-56, and 60-63.

Within these areas, development intensity resulted in increased disturbance along the shoreline. Disturbance levels within these areas nearly doubled from 20% on the lake as a whole to 39% of the total shoreline length.

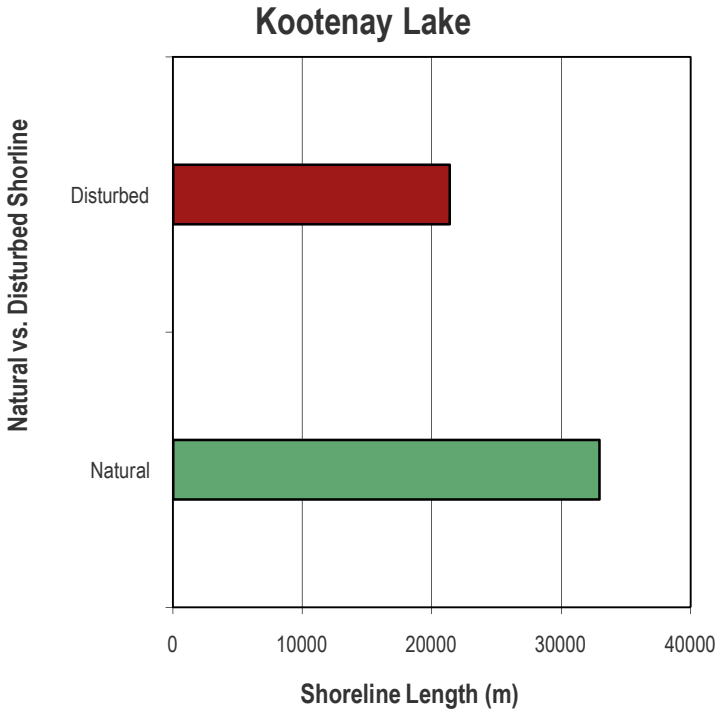


Figure 10 presents the level of disturbance in developed areas along Kootenay Lake.

When looking at the influence of land use, disturbance levels were similar. Disturbances within Single Family areas were 40%, which was of similar magnitude to the 39% observed for the lake as a whole. As previously mentioned, these disturbance levels are less than those observed along Shuswap or Okanagan Lake, which were 77% and 85% respectively (Data available from CSRD for Shuswap and Draft Data from the Okanagan Lake FIM project currently being completed by Ecoscape).

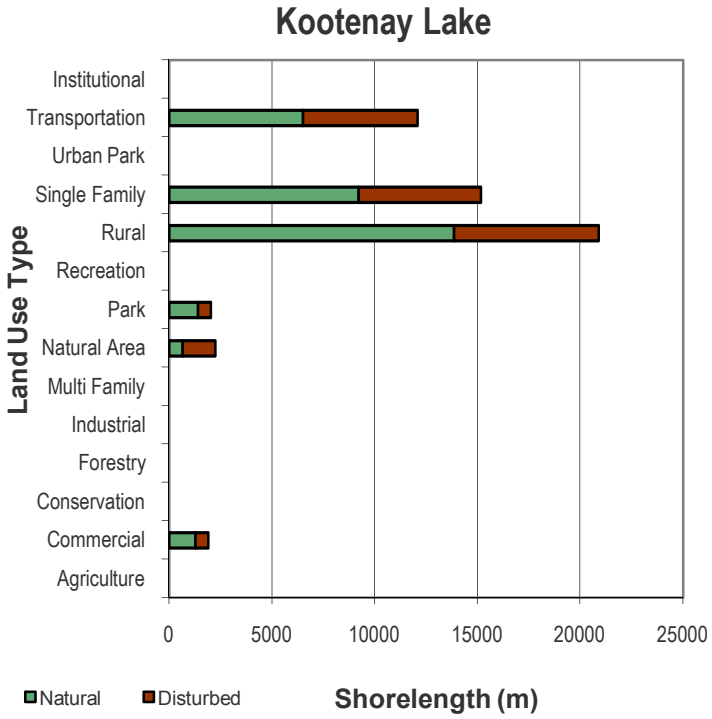


Figure 11 presents the level of disturbance within different land use areas along Kootenay Lake.

This small sub analysis points, with references to Shuswap and Okanagan Lake highlights the role that development intensity plays on lakeshore disturbance. Further, the analysis (including references to Shuswap and Okanagan) allows land use managers to infer that disturbance is correlated with land use and that areas developed as Single Family for instance have a substantially higher level of disturbance.

6.0 KEY MANAGEMENT CONSIDERATIONS

6.1 Fisheries Overview and Considerations

Kootenay Lake has very important fisheries values because it has some of the best recreational fishing for rainbow trout, kokanee, and bull troutin British Columbia (Andrusak, 2006; Thorley and Andrusak, 2010). The lake supports a variety of strains of rainbow trout, including the large Gerrard rainbows (Andrusak, 2006). In 1992 an experimental fertilization programs was initiated by the Ministry of Environment (now the Ministry of Natural Resource Operations) to help improve fisheries within the North Arm of Kootenay lake (Wright *et al.*, 2002). The fertilization program is now considered a requirement for maintenance of the fishery in Kootenay Lake and is run by the Columbia Basin Trust in the North Arm and the Kootenai Tribe of Idaho for the South Arm, which was initiated in 2004 (Schindler *et al*, 2010). The focus of the fertilization programs has been to improve kokanee stocks, which are a key food source for the large Gerrard

Rainbows and Bull trout. Other key food sources for smaller Gerrard rainbows include terrestrial insects, which can account for as much as 30% of their diet during spring and summer months (Andrusak and Parkinson, 1984). The terrestrial insects rainbows forage on rely upon riparian vegetation, highlighting the importance of this lakeside vegetation. Given the dependence that the Gerrard trout stocks have on terrestrial insects, which are directly dependent upon riparian vegetation, highlights the importance of protecting of existing riparian areas.

Burbot are another species of management concern within Kootenay Lake (Spence, 1999). In the 1960s, burbot populations were very high, with large angler efforts and catch rates (e.g., in 1969, 25,920 burbot were harvested) (Andrusak, 1997). The cause of the decline is not fully understood, but it is believed that habitat alterations such as stream channelization may be a contributing factor (Andrusak, 1997). The significant decline in the burbot stock has resulted in the closing of the burbot fishery that began in 1997 and still remains in place. The lack of a detailed understanding of burbot biology within Kootenay Lake and the potential impacts that land use has on them requires a conservative approach to ensure the long term sustainability of this species.

Each native fish species within the lake relies upon key habitat features, including spawning areas for adults, juvenile rearing areas, general living and foraging areas, and key migration corridors between general living areas and spawning zones. At this time, there is a growing knowledge base regarding the key life history requirements of different species of greater economic concern (e.g., spawning locations of Gerrard rainbows, Bull Trout, and kokanee, lake exploitation rates, etc.). For other species, knowledge is much more limited (e.g., burbot knowledge is much more limited since populations are at all time lows). Coupled with this, there is only a rudimentary understanding of how land development impacts (e.g., How important is riparian vegetation to the different life stages of Gerrard rainbows? etc.) each of the different fish species and life stages within the lake. The combined lack of knowledge, makes predicting how development affects populations and their habitats difficult (i.e., you can't manage for a species or population if you do not know where they have key habitat characteristics such as spawning grounds).

White sturgeon, listed as Endangered under the Species at Risk Act (SARA), are another fish known to have critical habitats within Kootenay Lake. Sturgeon may be found throughout the lake, but three main areas of the lake have been identified as necessary for survival or recovery: 1) Kootenay River Delta (referred to as the Creston Delta); 2) Crawfor Bay; 3) Duncan Delta (referred to as the Lardeau Delta) (National Recovery Team for White Sturgeon, 2009). These areas provide critical habitat for various life stages including early juveniles to important staging and migration areas. At this time, these three areas are in the process of being identified formally as Critical Habitat under SARA and the draft areas have been identified on the maps for this project. For specific information regarding this species, readers should refer to the detailed assessments that have been completed, the National Recovery Team for White Sturgeon works or the SARA Public Registry.

Another management concern is bass, which are managed as a sport fishery in Duck Lake. This is of concern because there is potential for emigration of this non native species from Duck Lake to Kootenay Lake. Bass have the potential to alter the community structure within Kootenay Lake, provided they can emigrate from and establish viable populations within the lake. The extent of this concern is unknown to the author because the dynamics of the floodplain were not investigated.

Due to the lack of knowledge surrounding specific species habitat areas and requirements around Kootenay Lake, a conservative approach must be taken. The rapid rate of development will continue to threaten each of these key fish stocks, if important habitat areas aren't identified and maintained. Current strategies at all levels of government are to help manage these resources using a risk based framework where there is a general acceptance of the risk that different activities pose to life stages of various key fish species. Given the extent of disturbance observed on this lakes and the risk this disturbances poses to fish species, retention of remaining natural areas should be a priority.

6.2 Land Development Considerations

Land development activities are largely governed by the Ministry of Transportation (through subdivision), local governments (through zoning and bylaws) and through the Ministry of Natural Resource Operations (Resident fish and wildlife responsibilities) and Fisheries and Oceans Canada (Fish Habitat responsibilities). Environmental land use planning is difficult because of the inherent stochastic nature of biological systems and their interactions (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). Adjacent terrestrial areas also play a key role in a sustainable land development and maintenance of our fish and wildlife habitats. Many of these terrestrial areas rely upon the shore line areas of Kootenay Lake and visa versa.

Precautionary principles to adjust for the inherent variability of living systems as part of a sustainable approach to land use planning and management is required if we intend to ensure the long term viability of the lake system. The data set that has been developed for this project 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.

Key considerations to incorporate into land use plans include understanding and developing strategies to mitigate impacts to key fisheries and wildlife areas. Mitigation within these areas must rely upon accurate data surrounding species critical habitats. Current trends in many areas are to identity key areas and utilize a risk based approach in land use planning exercises. However, without key data on these critical habitats it will be difficult to manage these resources effectively. Effective management will not be successful unless biological (i.e., critical habitats) data and the risks that land development activities pose to these resources are integrated in a planning process at all levels of government (i.e., local, provincial and federal).

6.3 Cumulative Impacts Considerations

To completely understand cumulative impacts, you must have a baseline condition to compare with. Ongoing FIM projects in the Okanagan, Shuswap, and Kootenay region lakes have given government useful information regarding the baseline condition of their respective shore line areas. This facilitates a better understanding of future change because there is now a basis upon which trends in land use development types can be measured. A detailed cumulative review of FIM projects completed to date will also play a key role in understanding how different land use activities impact lake shore lines and should occur at some point. Different reviews and analyses that should be considered include an assessment of the overall impacts of land use types on shoreline areas.

A review such as this would help summarize how current land development trends and land uses typically affect shorelines and allow managers to better gage cumulative effects.

7.0 RECOMMENDATIONS FOR FUTURE CONSIDERATION

7.1 General

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

1. **Environmentally Sensitive Areas should be mapped and identified because they are extremely important**. Environmental development permit areas (EDP's) (or other types of mechanisms) are a primary tool for municipalities. At this time, most municipalities require a development permit prior to the onset of construction for lakeside residences. It will be important for local governments to integrate the FIM collected during this assessment with other important datasets that may be collected such as the Sensitive Ecosystem and Inventory (SEI), Sensitive Habitat and Inventory (SHIM), etc. *All lakeside areas identified in this report should be designated as development permit areas if this has not already been accomplished.*

2. **Habitat restoration opportunities should be achieved wherever possible by identifying them during the development review processes.** In more urbanized areas, examples include removal of retaining walls, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, etc. 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. Habitat restoration projects should focus on key goals, such as riparian restoration, fisheries enhancements, etc. Any new shoreline developments, including single family dwellings or additions, should incorporate some aspect of restoration via the development permit process mentioned above.

3. **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. Integration of lakeside sensitive areas with terrestrial areas, identified though inventory such as Sensitive Ecosystem Inventory, is required through a development permit process. Numerous different possibilities exist to preserve areas identified as sensitive, including Section 219 No Build / No Disturb Covenants registered with the Land Titles office, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), creation of Map Reserves by the Integrated Land Management Bureau, or by other mechanisms (donation to trust, etc.).

4. **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.

5. **Development and use of best practices for construction of bioengineered retaining walls, marinas, boat ramps, and boat basins is required.** Concise guidelines and functional requirements for construction of the above modifications should be developed and incorporated into BMPs specific to Kootenay Lake. Development of these BMPs should considered design, construction, and monitoring requirements to ensure a consistent standard practice is achieved. A lake specific approach is required because of unique aspects of Kootenay Lake including draw down, lake level regulation by BC Hydro, and exposure.

6. **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.

7. **Compliance and enforcement monitoring of approved works is required, with consequences for failure to construct following standard best practices.** There were numerous examples of poor practice observed during this survey. An increase in compliance and enforcement monitoring is required because current practice does not appear to be working effectively (i.e., there were numerous, recent examples of construction inconsistent wtih BMPs).

   Compliance Monitoring Example

   The Ministry of Environment in the Okanagan recently assessed a 30 km segment of Okanagan Lake shoreline for compliance with the Water Act and Best

Management Practices. Within that segment assessed, there were 35 properties randomly selected for assessment. Compliance assessments were completed in 3 days (May 12-14). In total 638 *Water Act* files were found for Okanagan Lake and none of those files matched the properties. All 638 files were reviewed to confirm if they matched the randomly selected properties. There was 100% non-compliance with the modifications documented on the randomly selected properties on Okanagan Lake. This highlights the necessity and requirement of better compliance and enforcement at all levels.

8. **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.

9. **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. Coupled with this, storm water management of small tributary streams (even non fish bearing ones) is also important. In recent works on Okanagan Lake, Ecoscape has documented extensive impacts to water quality in Okanagan Lake as a result of poor upstream storm water management a kilometer or more away. It is recommended that storm water management plans be required as part of development processes for all developments proposing discharge to a water course. Standard best practices have been developed and current regulations do not allow development of storm water treatment systems within setback areas.

10. **Rural areas accounted for 48% of the shoreline, indicating that there are substantial risks to fish and wildlife habitats if development proceeds without appropriate Best Management Practices and appropriate shoreline planning policies.** The Kootenay Lake Stewardship Plan should incorporate analyses to determine the sensitivity of shoreline features on rural lands. Rural lands are the most prone to subdivision, and therefore are more likely to experience greater

impacts as development occurs. In previous FIM projects, Single Family development areas typically had some of the highest levels of disturbance (e..g, 77% on Shuswap and 85% on Okanagan), indicating that as rural properties develop into Single Family areas, there will be an inevitable increase in shoreline disturbance. Identifying critical habitat areas for fish and wildlife on these rural lands must be completed and subsequently incorporated into the Kootenay Lake Stewardship Plan in order to protect important biological resoureces.

7.2 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. The Community Mapping Network is currently publishing many of the data sets that have been collected. Sufficient funding must be allocated to CMN to keep up with management of the data because as there becomes more datasets costs of management will increase.

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.**

4. **Review and update of FIM and mapping should occur on a 5 to 10 ten year cycle.** Review and update of the FIM will be required to determine if shore line goals and objectives are being achieved. In a perferct world, changes to the FIM data set would be done as projects are approved. However, at this time, it is unlikely that the multiple government agencies responsible have the capability to establish such a system.

7.3 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 recommended segment breaks identified within this report should be incorporated into the Kootenay Lake FIM as soon as possible.** Several new segment breaks were identified during the completion of this document. These new segment breaks should be incorporated as soon as possible in the future. These segment breaks, plus others, will be required prior to the development of an Aquatic Habitat Index (Step 2) for the lake. As an example, Okanagan Lake has a shoreline length of approximately 289 km, with a total of 312 segments. This compares to Kootenay Lake, which has a similar shoreline length but only 62 segments. Although development is substantially greater on Okanagan Lake, a similar level of inventory detail is probably required prior to development of an Aquatic Habitat Index.

2. **Critical habitat areas for key fish and wildlife species should be inventoried and mapped using GIS.** In order to manage biological resources, a baseline understanding of critical habitats for different species is required. Some of this information is currently available, while much of it is still unknown. Identification and spatial mapping of this information for key species will facilitate preparation of an Aquatic Habitat Index (Step 2).

3. **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 the 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. An inventory of streams that have been mapped within the Okanagan should be undertaken to prepare on concise SHIM GIS dataset. This will allow managers to determine which streams have been completed and which ones haven`t.

4. **Wetland habitats were quite rare on Kootenay Lake and great care should be taken to maintain the wetland habitats that remain.** Although, wetlands were rare on this lake, many were observed to be in good condition and land use plans should be prepared to ensure these key habitat features remain in functioning condition.

5. **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 and SHIM GIS datasets. At this time, some TEM datasets may exist. There are however, many areas that have not been completed and continued efforts to find funding to complete these works should be

undertaken. Integrations of the SEI and TEM with Step 2 - Aquatic Habitat Index, would help determine key shoreline areas to consider as part of an inclusive management plan.

6. **A GPS shoreline video should be completed.** A GPS shoreline video is recommended to help provide detailed documentation of the current condition of the Kootenay Lake shoreline for long term monitoring. This information should be incorporated into the Kootenay Lake Stewardship Plan.

7. **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. This could form part of a riparian mapping exercise. Riparian mapping exercises are currently being completed on the Shuswap Lake system and could be used as a template for the Okanagan.

8. **A carrying capacity analysis of Kootenay 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 but many key risks have already been identified (e.g., low fish populations, etc.) and some populations are at risk (e.g., burbot). Determining the threshold upon which cumulative effects of land development 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 ability of a lake to accommodate recreational use (e.g., boating) and residential occupation without compromising adjacent upland areas, biological resources, aesthetic values, safety, fish and wildlife populations, etc.. Determining carrying capacities on our large, interior lake systems is currently one of the most significant challenges to lakeshore management because it impacts the many cultural, social, and environmental values of residents.

9. **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.

10. **Native beds of aquatic vegetation should be mapped in detail and should be protected from further impacts.** Aquatic vegetation was rare on Kootenay Lake. More detailed mapping, maybe as part of a Wetland Inventory and Mapping project, would help better classify and described these rare, sensitive features. All areas of aquatic vegetation should be protected in the Kootenay Lake Stewardship Plan because of their importance to fish and wildlife.

11. **High resolution airphotos of the shoreline area should be obtained.** The airphotos of the lakeshore were only of moderate quality. The quality of the photos limited the ability to provide accurate spatial mapping of aquatic vegetation areas, the spatial extents of the HWL, and other aspects important to the project. Airphotos of the lakeshore should be obtained on a 3 to 5 year cycle, depending upon land use changes as part of a long term monitoring program.

12. **Future fisheries work is required.** The knowledge gaps for the different species and their habitat areas at different life stages should be addressed. Although speculations can be made, studies aimed at identifying the important areas and life stage will facilitate more informed planning.

13. **A GIS stamped still photography photo records should be completed.** A GPS stamped still photo record is considered very important for shoreline management. The still photos allow consultants, agencies, and the generally public access to information regarding the current condition of the shoreline. Within the Okanagan, the use of shoreline video and still photography has been extremely useful for compliance monitoring.

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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.

SEGMENT PHOTO PLATE SUMMARY

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Kootenay Lake

FORESHORE INVENTORY AND MAPPING
FIGURE BINDER

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APPENDIX A

Foreshore Inventory and Mapping Methodology

FORESHORE INVENTORY AND MAPPING

Standard Methods for Completion of Foreshore Inventory And Mapping Projects

Prepared By:

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Acknowledgements

The following parties have contributed to the ongoing development of Foreshore Inventory and Mapping by funding, partnering, and working together for improved large lake management:

Department of Fisheries and Oceans and Community Mapping Network
Ministry of Environment
Regional District of Central Okanagan
Regional District of East Kootenay
Regional District of Okanagan Similkameen
City of Kelowna
District of Lake Country
District of Invermere
Okanagan Conservation Collaborative Program
East Kootenay Integrated Lake Management Partnership
Ducks Unlimited
Fraser Salmon and Watersheds Program
BC Conservation Foundation
BC Real Estate Foundation
Okanagan Basin Water Board
Various different private companies and sponsors

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.

This report should be cited as:

Schleppe, J. and B. Mason. 2009. Standard Methods for Completion of Foreshore Inventory and Mapping Projects. Prepared by: Ecoscape Environmental Consultants Ltd. and The Community Mapping Network.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Foreshore Inventory and Mapping is a methodology currently being employed to map the larger lakes of British Columbia experiencing land use and recreational pressures. The protocol for Foreshore Inventory and Mapping (FIM) was first developed by the Regional District of Central Okanagan (RDCO), in conjunction with the Department of Fisheries and Oceans (DFO), Ministry of Environment (MOE), City of Kelowna, District of Lake Country, BC Conservation Foundation, and the Real Estate Foundation of British Columbia (Magnan and Cashin, 2004). The intent of the project was to characterize shoreline areas around the central regions of Okanagan Lake so that sensitive ecosystems could be better managed.

Since 2005, numerous other lakes have been mapped using this methodology. During 2008, the MOE, DFO (Community Mapping Network) and other stakeholders worked to update information collected during FIM to better reflect how this information is being used. With the numerous ongoing works on FIM projects, it was in the best interest of land use managers to ensure a standardization of the FIM methodology.

2.0 FORESHORE INVENTORY AND MAPPING OVERVIEW

Foreshore Inventory and Mapping (FIM) is a GPS/GIS assessment of lake shorelines. The methodology closely resembles that of Sensitive Habitat Inventory and Mapping (SHIM) (Mason and Knight, 2001), a GPS/GIS methodology developed for mapping streams and watercourses. The concepts are similar to other land based spatial mapping initiatives (e.g., Terrestrial Ecosystem Mapping (TEM), Sensitive Ecosystem Inventories (SEI)). However, for lake shorelines, the primary feature under review is the shore zone area. For the purposes of this methodology, the shore zone is the area from the pelagic regions of the lake (deepwater) to 30 to 50 m past the high water level in the upland/riparian zone. In FIM, spatial data describing the shore zone area is attributed to shoreline using a line feature.

The methodology developed incorporates standard practices developed by the Resource Inventory Committee for mapping of fish and fish habitat features. It also adapts standards developed for stream SHIM mapping (Mason and Knight, 2001). The methodology is typically completed in a three step process as follows:

1. Video Documentation of the Lake Shoreline;
2. Data Collection of biophysical and habitat attributes along the lake shoreline;
3. Reporting and Data Analysis;

The intent of FIM projects is to catalogue and describe land uses (e.g., Residential Development), shoreline modifications (e.g., docks), and biophysical attributes (e.g., substrates) along lake shoreline. Information collected allows resource managers at all levels of government to incorporate the information into a variety of land use planning documents including but not limited to:

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.

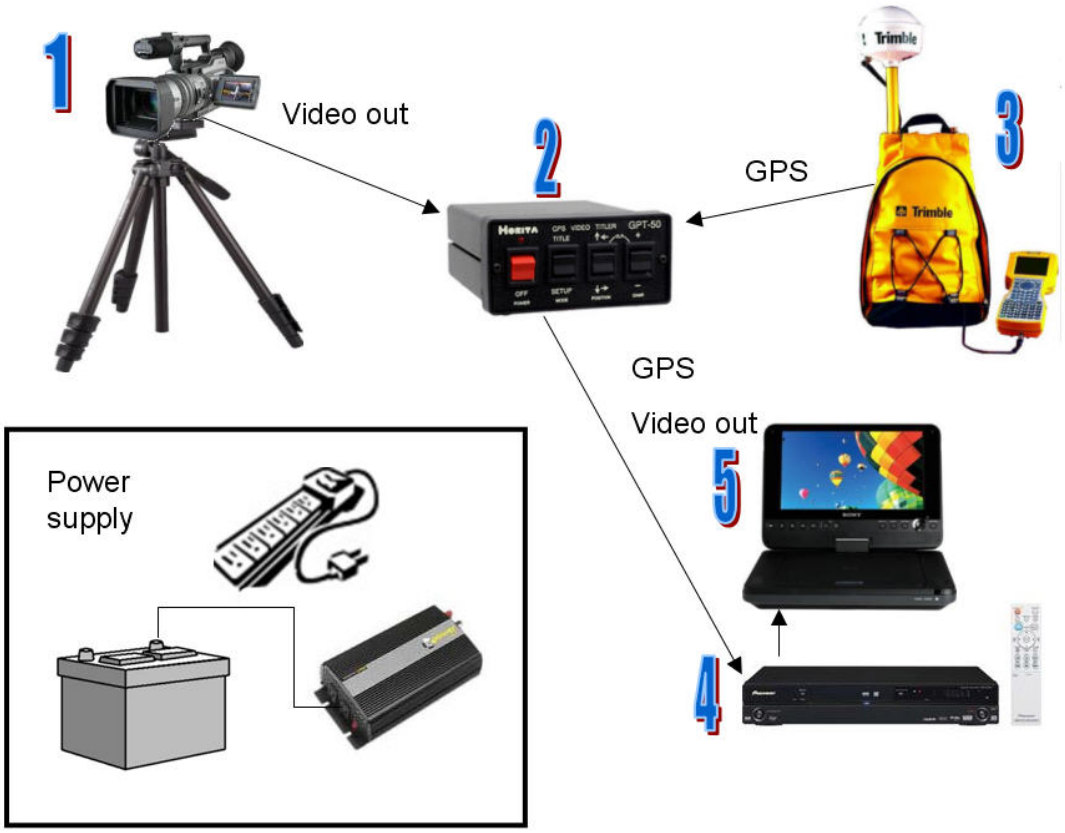


Figure 1: Shoreline video setup. 1) Digital video camera, 2) GPS stamper unit, 3) GPS data logger and receiver, 4) Digital video recorder, 5) Digital video player

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.

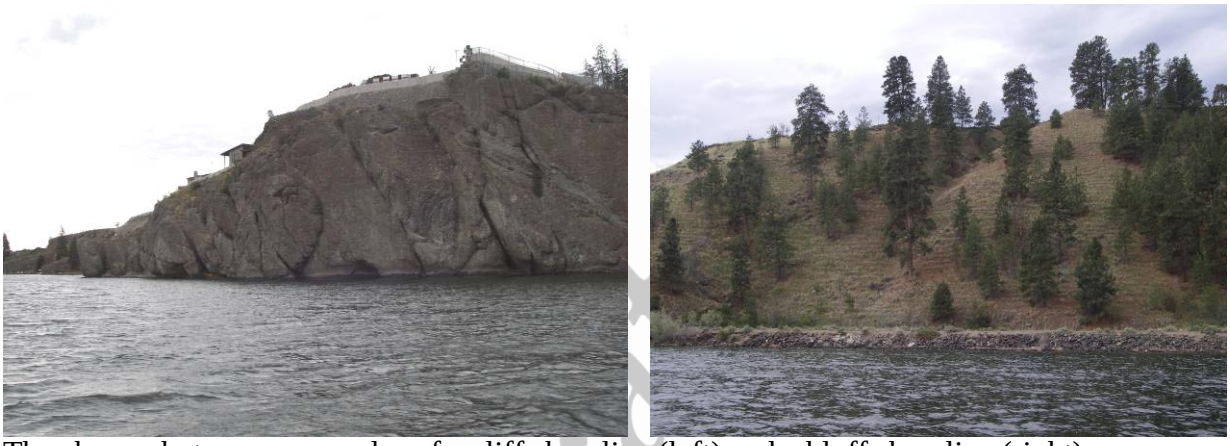
4.3.3 Shore Type

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
```

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                        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
Kootenay Lake Data Tables

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	79.43%	226579
Disturbed	20.57%	58667
	Total	285245.9

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	7.0	19971	18379	1592	92.0	8.0
Steep (20-60)	46.2	131825	115634	16191	87.7	12.3
Moderate (5-20)	33.3	94968	64585	30383	68.0	32.0
Low (0-5)	13.5	38482	27981	10501	72.7	27.3
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	285246	226579	58667	79.4	20.6

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.2%	539	512	27	95.0%	5.0%
Commercial	1.1%	3262	1579	1683	48.4%	51.6%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.5%	1528	0	1528	0.0%	100.0%
Multi Family	0.3%	916	131	785	14.3%	85.7%
Natural Area	17.8%	50715	45340	5375	89.4%	10.6%
Park	5.2%	14819	13384	1434	90.3%	9.7%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	48.2%	137534	115249	22285	83.8%	16.2%
Single Family	11.3%	32329	19542	12788	60.4%	39.6%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	15.3%	43603	30390	13213	69.7%	30.3%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	285245.9				

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	45.7%	130241	113825	16415.6	87.4%	12.6%
Rocky Shore	30.5%	86954	62385	24568.9	71.7%	28.3%
Gravel Beach	13.4%	38185	25566	12618.7	67.0%	33.0%
Sand Beach	1.6%	4578	2849	1728.9	62.2%	37.8%
Stream Mouth	6.5%	18412	15505	2906.2	84.2%	15.8%
Wetland	2.4%	6877	6449	428.7	93.8%	6.2%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	285246				

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	7.5%	21496
Submergent Vegetation	1.3%	3578
Emergent Vegetation	6.2%	17816
Floating Vegetation	1.0%	2860

Table 6: The total number and density (# per km) of different shoreline modifications occurring around Kootenay Lake.

Type	Total #	# Per km
Docks	136	0.48
Groynes	381	1.34
Boat Launch	55	0.19
Retaining Walls	138	0.48
Marinas	21	0.07
Marine Rails	69	0.24
Mooring Buoys	172	0.60

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

Category	% of Shoreline	Shorelength (m)
Roadway	3%	9817
Railway	7%	20750
Substrate Modification	15%	44115
Total Shore Length		285246

Table 8: The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	10.83%	30887
Moderate	26.39%	75278
Low	56.62%	161500
None	6.16%	17581
Total Shore Length		285245.9

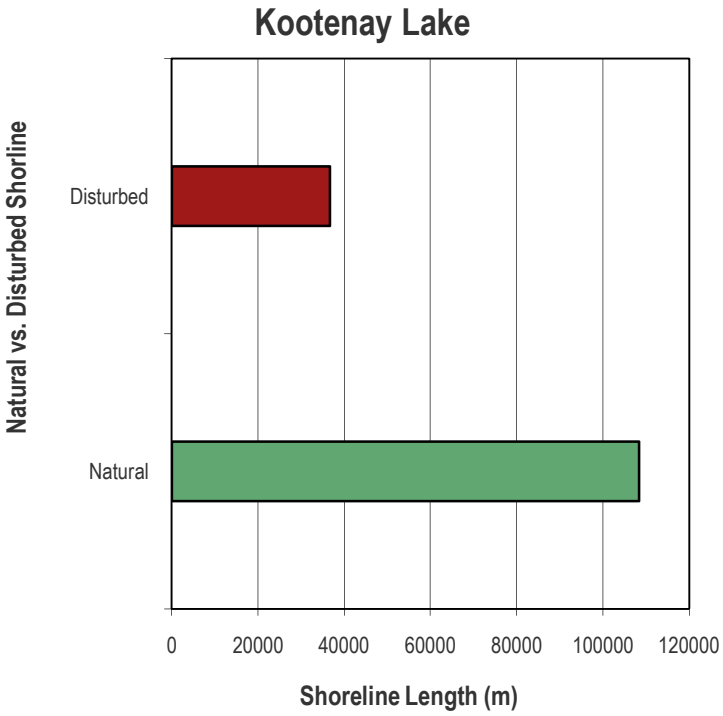

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	74.74%	108399
Disturbed	25.26%	36638
	Total	145036.8

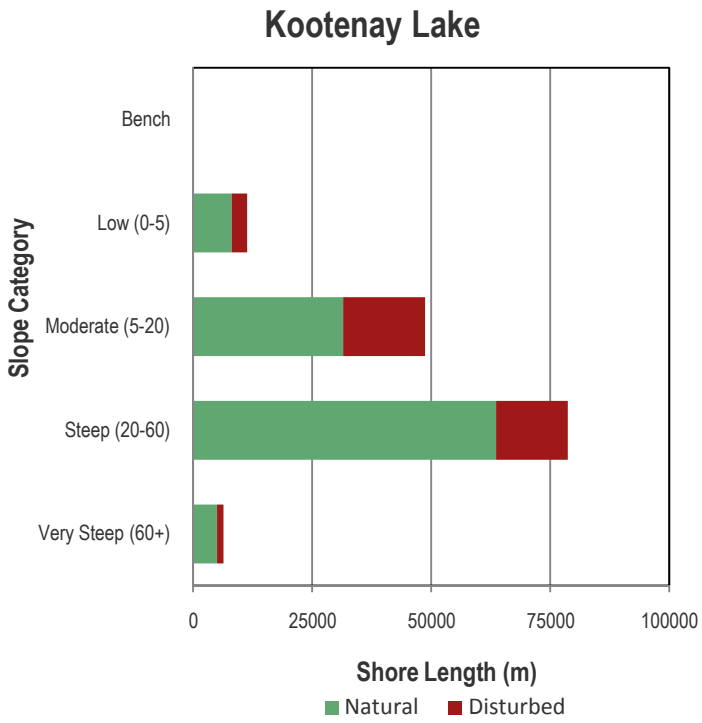

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	4.4	6383	5075	1309	79.5	20.5
Steep (20-60)	54.2	78632	63637	14995	80.9	19.1
Moderate (5-20)	33.6	48665	31550	17115	64.8	35.2
Low (0-5)	7.8	11356	8137	3219	71.7	28.3
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	145037	108399	36638	74.7	25.3

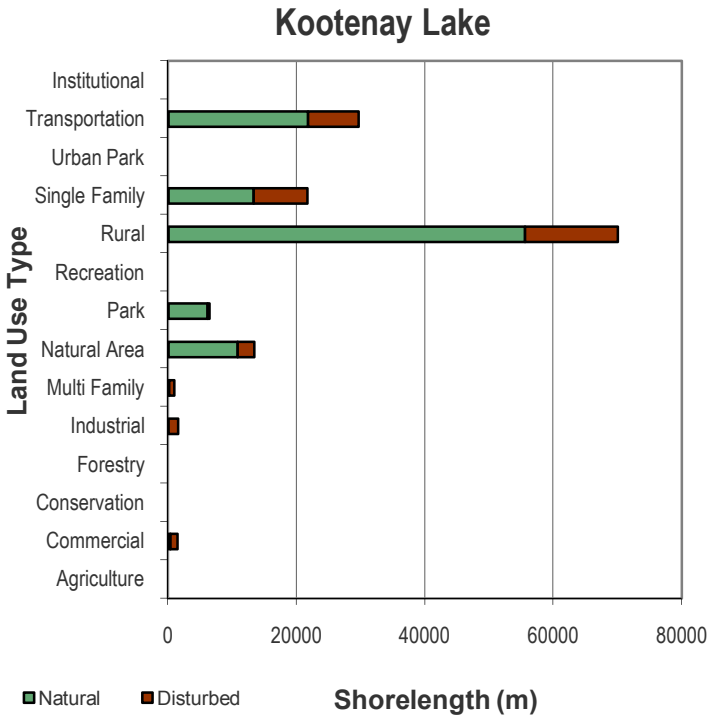

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	1.0%	1404	330	1074	23.5%	76.5%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	1.1%	1528	0	1528	0.0%	100.0%
Multi Family	0.6%	916	131	785	14.3%	85.7%
Natural Area	9.3%	13434	10747	2687	80.0%	20.0%
Park	4.4%	6421	6136	285	95.6%	4.4%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	48.3%	69992	55562	14430	79.4%	20.6%
Single Family	14.9%	21675	13312	8363	61.4%	38.6%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	20.5%	29667	21730	7936	73.2%	26.8%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	145036.8				

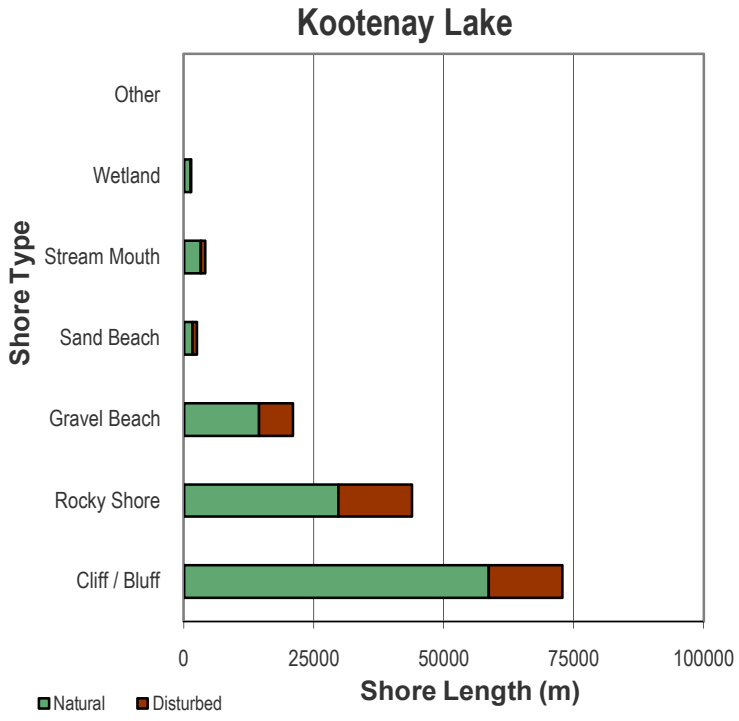

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	50.1%	72686	58579	14107.1	80.6%	19.4%
Rocky Shore	30.2%	43758	29601	14157.2	67.6%	32.4%
Gravel Beach	14.4%	20845	14395	6450.2	69.1%	30.9%
Sand Beach	1.7%	2452	1522	930.0	62.1%	37.9%
Stream Mouth	2.8%	4040	3109	930.5	77.0%	23.0%
Wetland	0.9%	1256	1193	62.8	95.0%	5.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	145037				

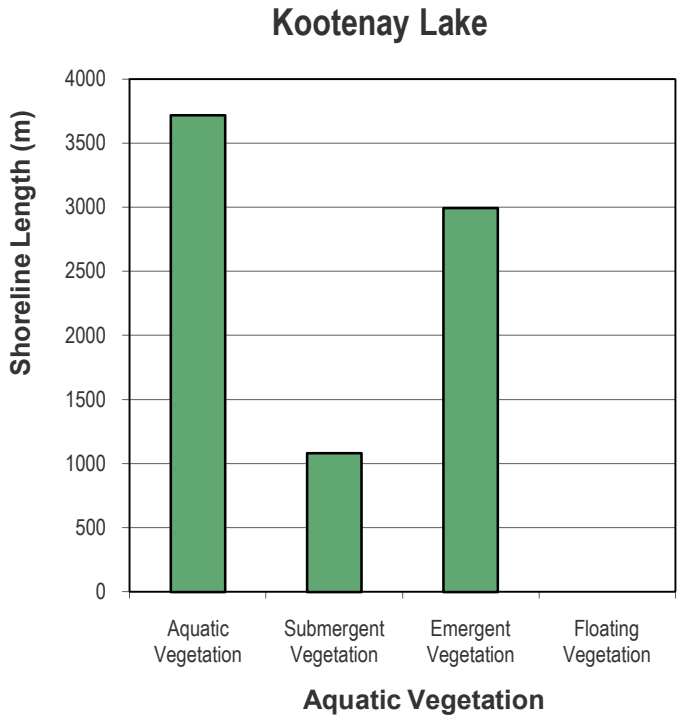

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	2.6%	3714
Submergent Vegetation	0.7%	1080
Emergent Vegetation	2.1%	2992
Floating Vegetation	0.0%	0

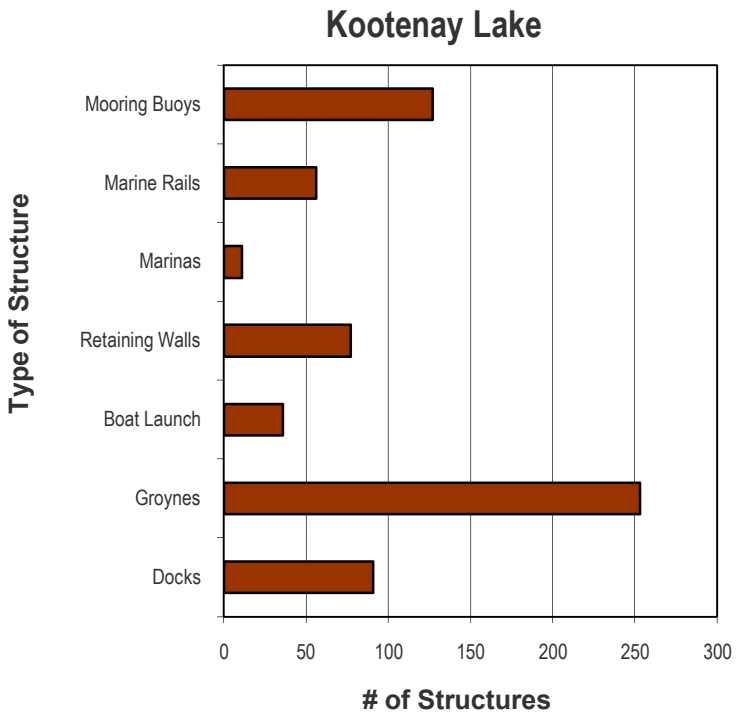

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

Type	Total #	# Per km
Docks	91	0.63
Groynes	253	1.74
Boat Launch	36	0.25
Retaining Walls	77	0.53
Marinas	11	0.08
Marine Rails	56	0.39
Mooring Buoys	127	0.88

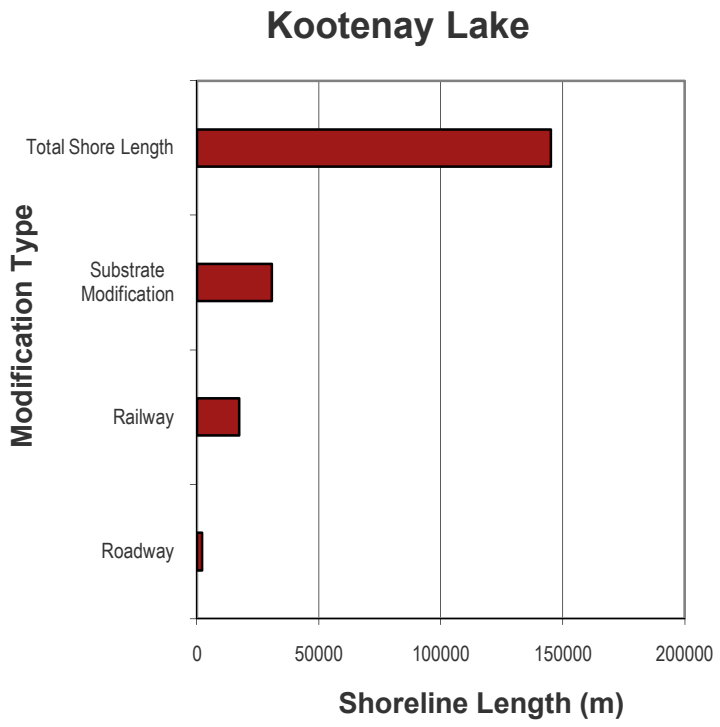

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

Category	% of Shoreline	Shorelength (m)
Roadway	2%	2248
Railway	12%	17306
Substrate Modification	21%	30665
Total Shore Length		145037

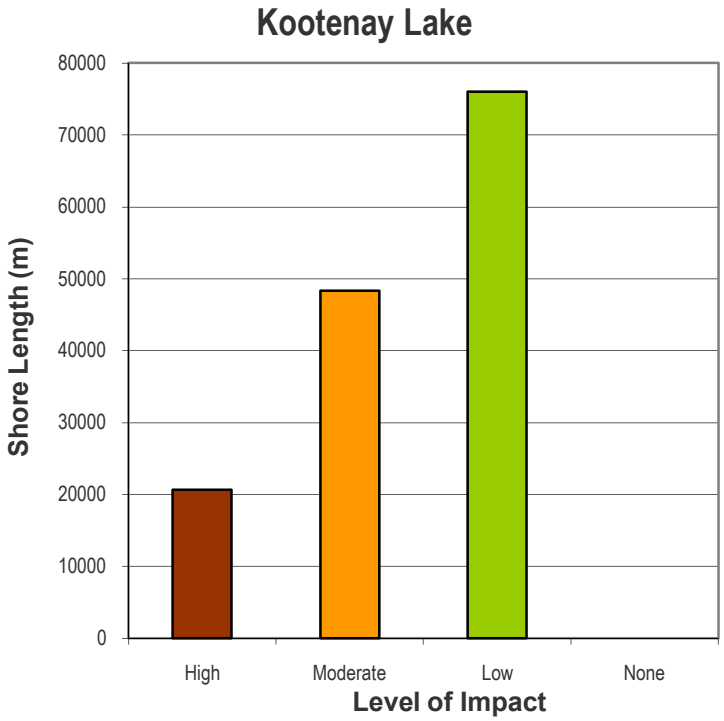

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	14.25%	20672
Moderate	33.31%	48310
Low	52.44%	76055
None	0.00%	0
	Total Shore Length	145036.8

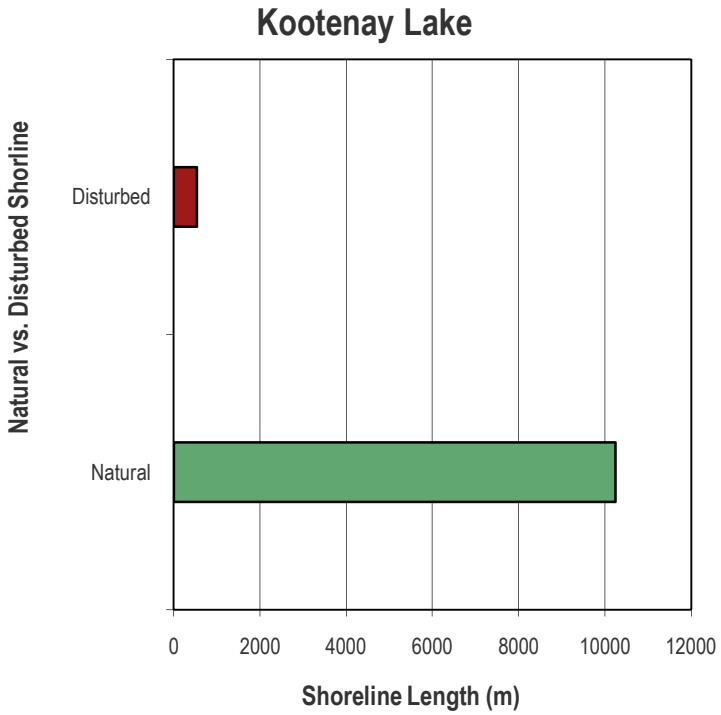

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	95.00%	10241
Disturbed	5.00%	539
	Total	10780.5

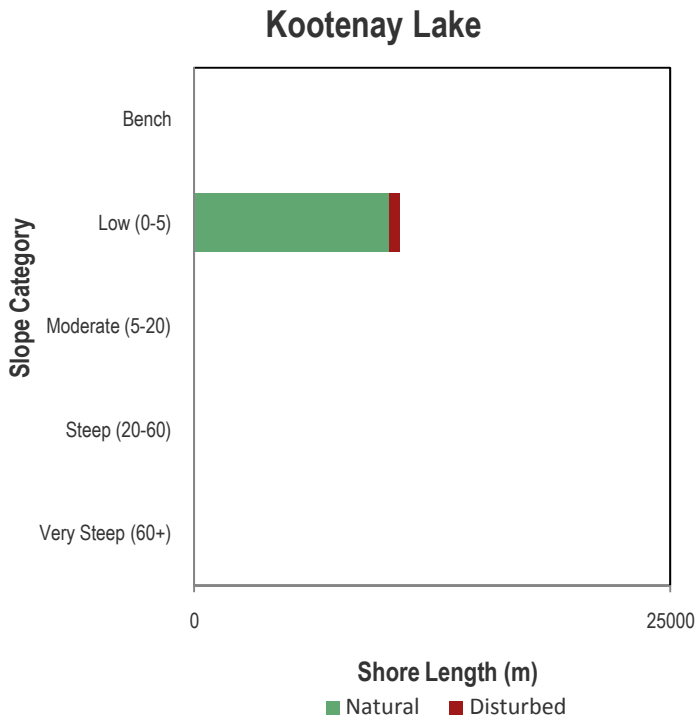

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	0.0	0	0	0	0	0
Steep (20-60)	0.0	0	0	0	0	0
Moderate (5-20)	0.0	0	0	0	0	0
Low (0-5)	100.0	10780	10241	539	95.0	5.0
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	10780	10241	539	95.0	5.0

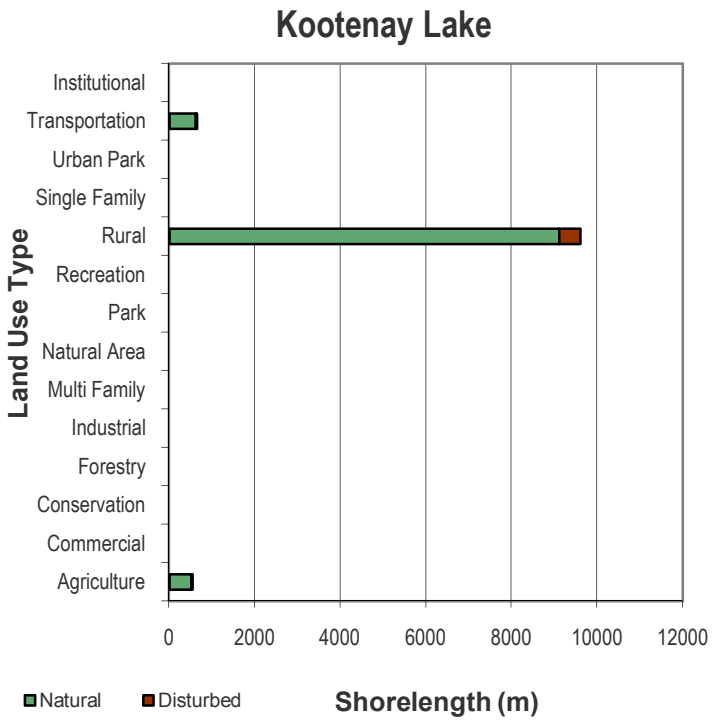

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	5.0%	539	512	27	95.0%	5.0%
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	0.0%	0	0	0	0.0%	0.0%
Park	0.0%	0	0	0	0.0%	0.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	89.0%	9595	9115	480	95.0%	5.0%
Single Family	0.0%	0	0	0	0.0%	0.0%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	6.0%	647	614	32	95.0%	5.0%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	10780.5				

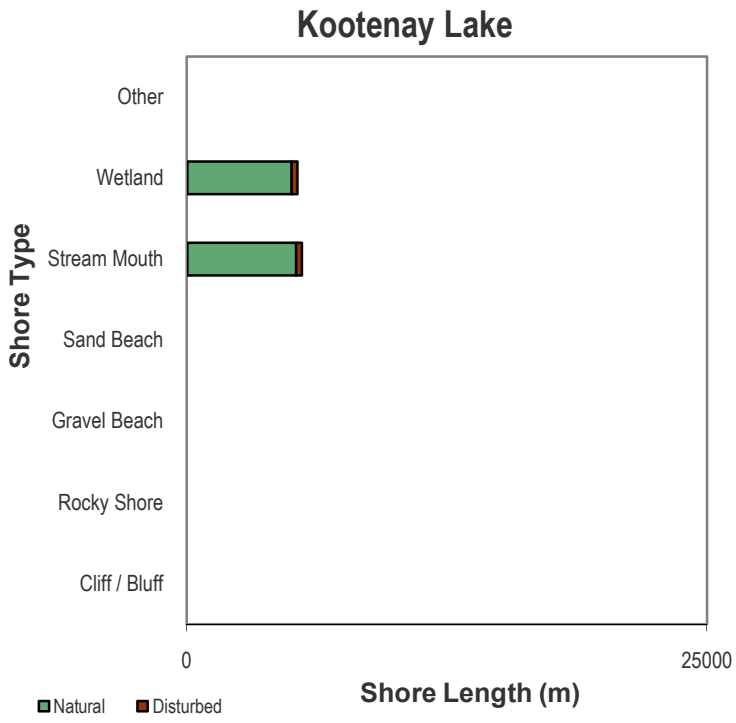

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.0%	0	0	0.0	0!	0
Rocky Shore	0.0%	0	0	0.0	0	0
Gravel Beach	0.0%	0	0	0.0	0	0
Sand Beach	0.0%	0	0	0.0	0	0
Stream Mouth	51.0%	5498	5223	274.9	95.0%	5.0%
Wetland	49.0%	5282	5018	264.1	95.0%	5.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	10780				

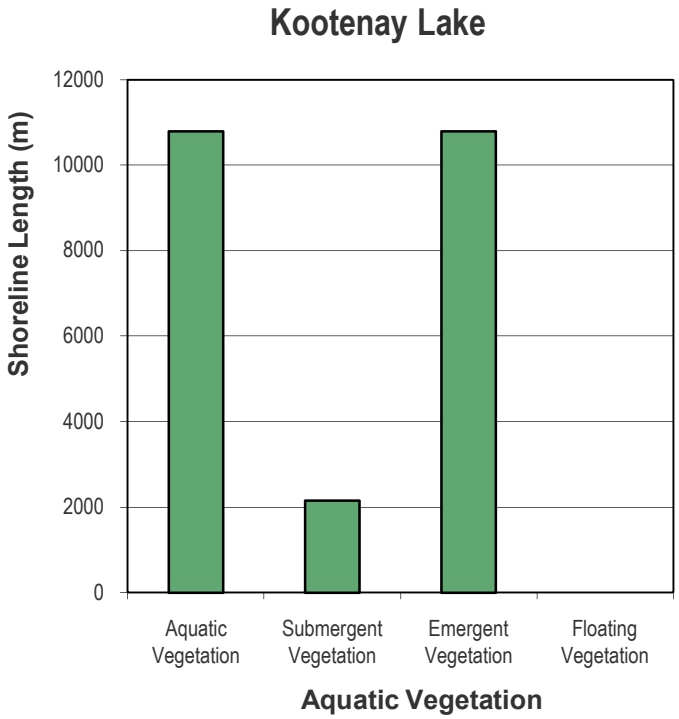

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	100.0%	10780
Submergent Vegetation	20.0%	2156
Emergent Vegetation	100.0%	10780
Floating Vegetation	0.0%	0

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

Type	Total #	# Per km
Docks	0	0.00
Groynes	0	0.00
Boat Launch	0	0.00
Retaining Walls	0	0.00
Marinas	0	0.00
Marine Rails	0	0.00
Mooring Buoys	0	0.00

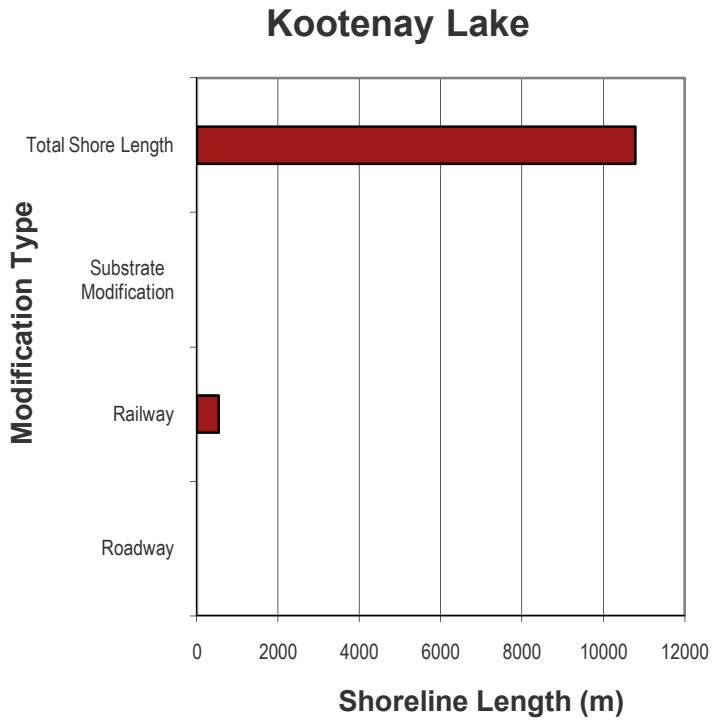

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

Category	% of Shoreline	Shorelength (m)
Roadway	0%	0
Railway	5%	539
Substrate Modification	0%	0
Total Shore Length		10780

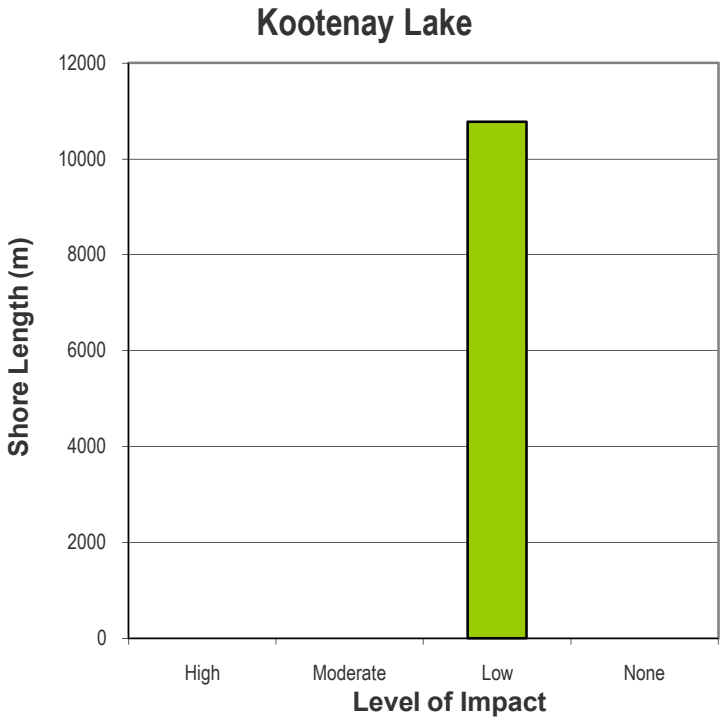

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	0.00%	0
Moderate	0.00%	0
Low	100.00%	10780
None	0.00%	0
	Total Shore Length	10780.5

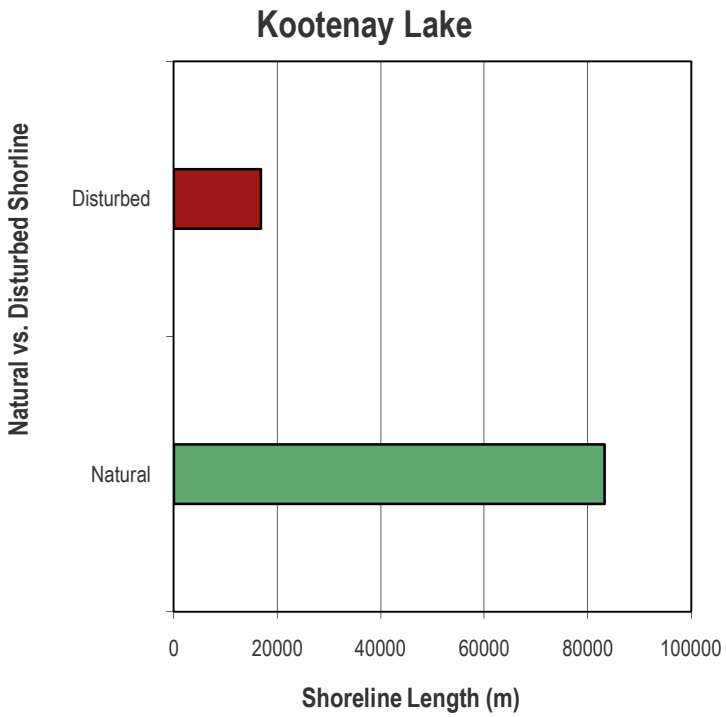

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	83.18%	83286
Disturbed	16.82%	16845
	Total	100131.4

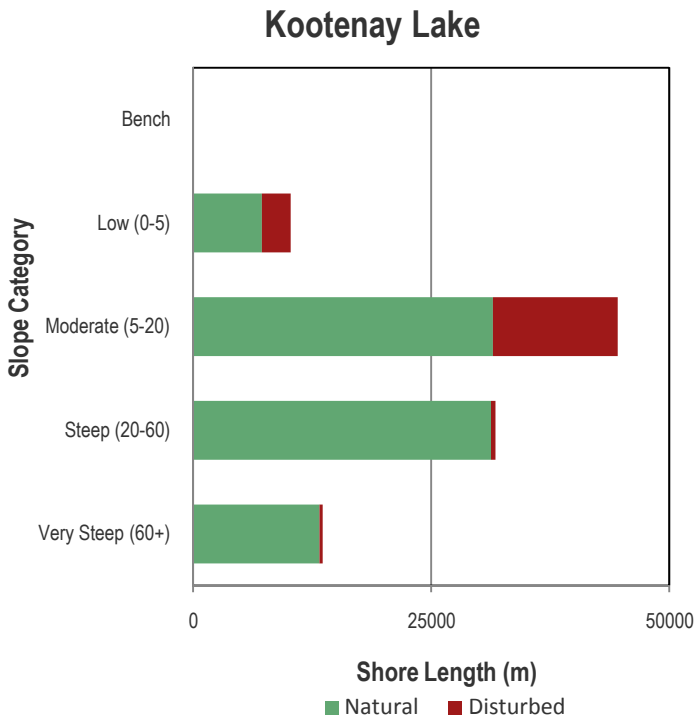

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	13.6	13587	13304	283	97.9	2.1
Steep (20-60)	31.7	31729	31294	435	98.6	1.4
Moderate (5-20)	44.5	44553	31460	13093	70.6	29.4
Low (0-5)	10.2	10262	7228	3034	70.4	29.6
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	100131	83286	16845	83.2	16.8

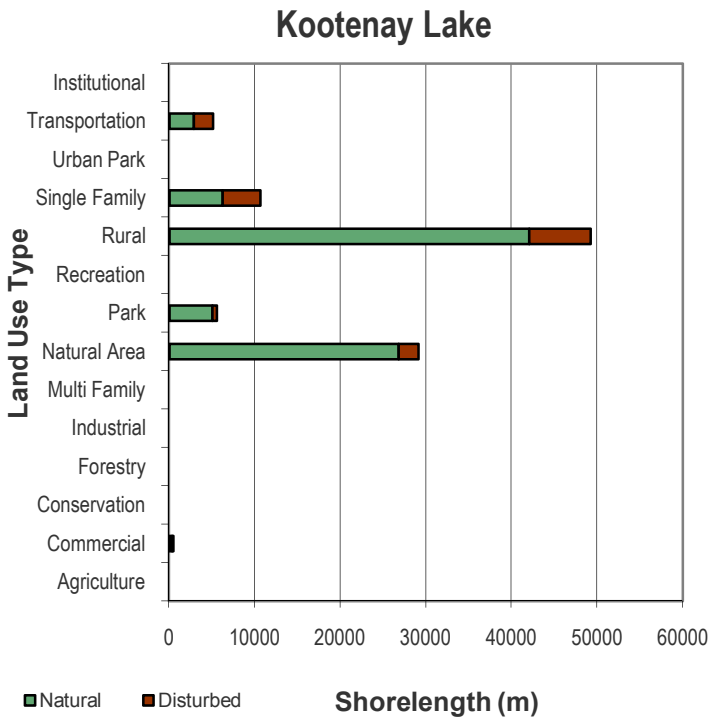

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	0.5%	500	299	201	59.8%	40.2%
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	29.1%	29091	26812	2279	92.2%	7.8%
Park	5.6%	5581	5050	531	90.5%	9.5%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	49.1%	49184	42019	7166	85.4%	14.6%
Single Family	10.6%	10655	6230	4425	58.5%	41.5%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	5.1%	5120	2877	2244	56.2%	43.8%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	100131.4				

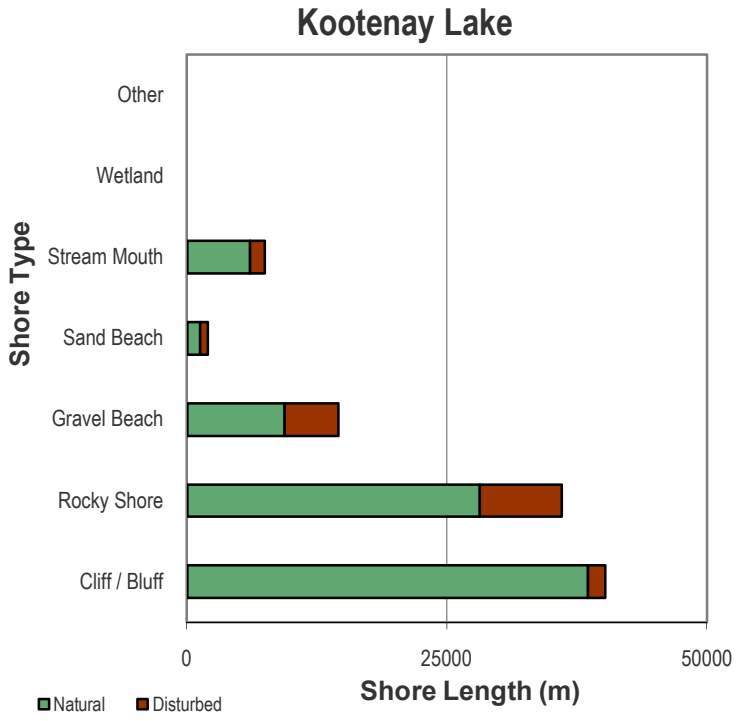

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	40.2%	40209	38526	1682.5	95.8%	4.2%
Rocky Shore	36.0%	36014	28119	7895.6	78.1%	21.9%
Gravel Beach	14.5%	14505	9376	5129.3	64.6%	35.4%
Sand Beach	2.0%	1955	1207	748.1	61.7%	38.3%
Stream Mouth	7.4%	7448	6058	1389.9	81.3%	18.7%
Wetland	0.0%	0	0	0.0	0	0
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	100131				

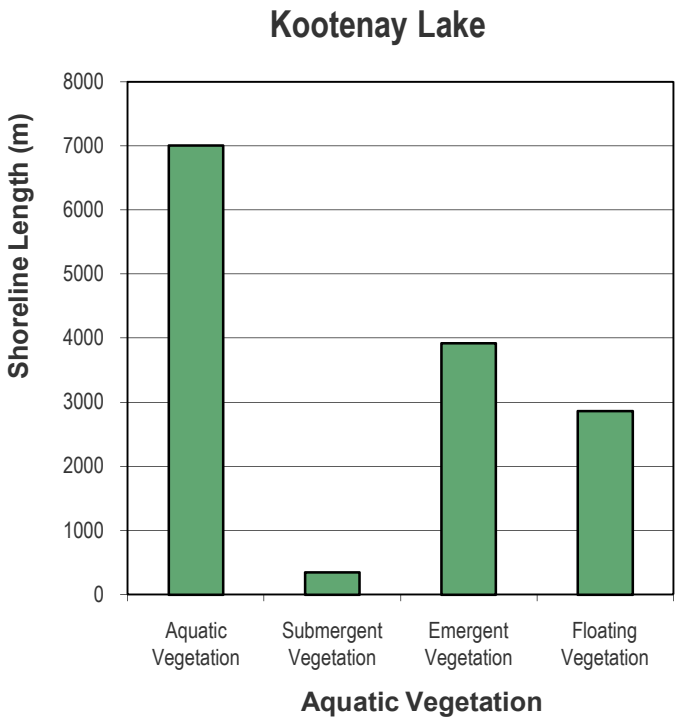

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	7.0%	7002
Submergent Vegetation	0.3%	342
Emergent Vegetation	3.9%	3921
Floating Vegetation	2.9%	2860

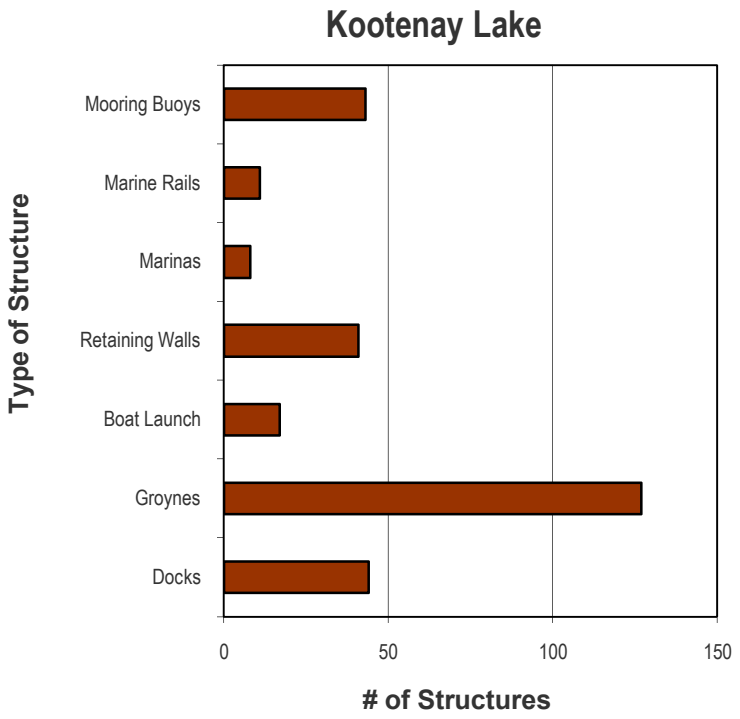

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

Type	Total #	# Per km
Docks	44	0.44
Groynes	127	1.27
Boat Launch	17	0.17
Retaining Walls	41	0.41
Marinas	8	0.08
Marine Rails	11	0.11
Mooring Buoys	43	0.43

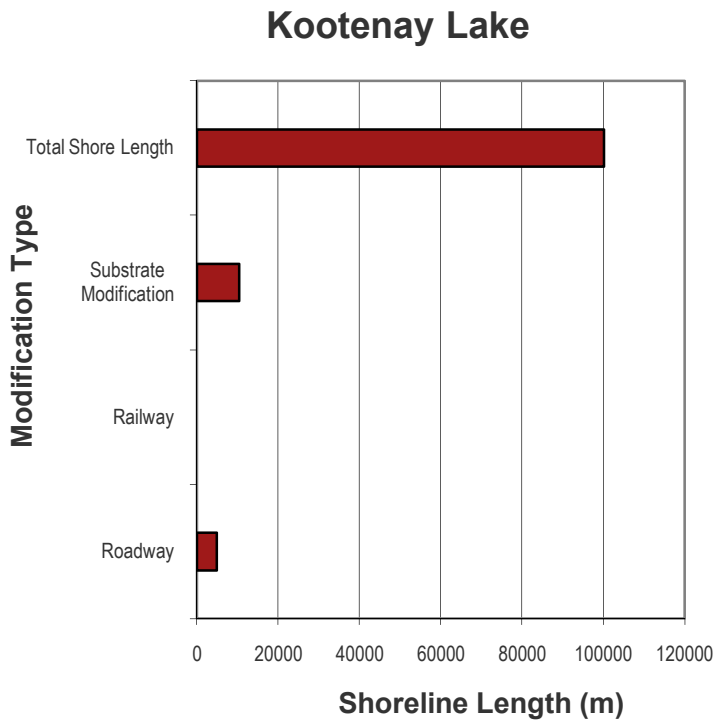

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

Category	% of Shoreline	Shorelength (m)
Roadway	5%	4877
Railway	0%	0
Substrate Modification	10%	10470
Total Shore Length		100131

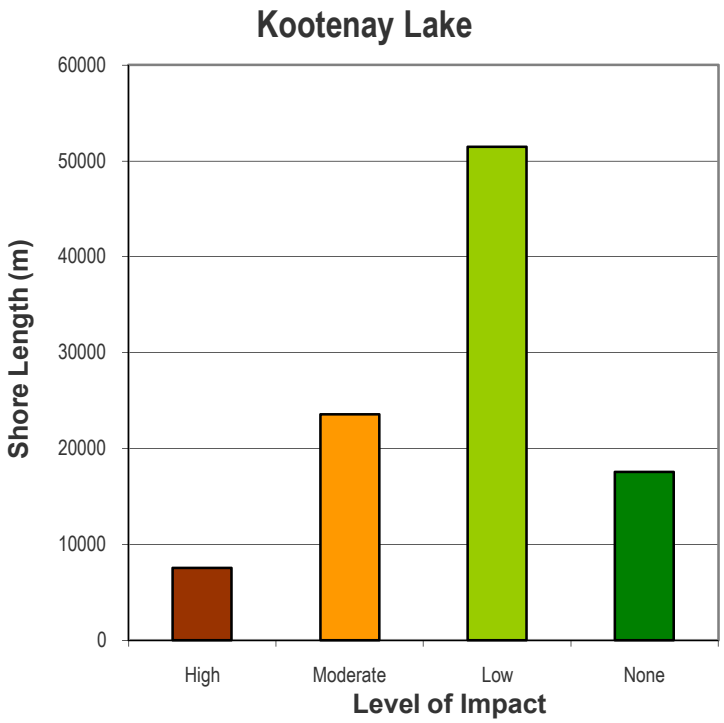

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	7.51%	7524
Moderate	23.54%	23576
Low	51.38%	51452
None	17.56%	17581
	Total Shore Length	100131.4

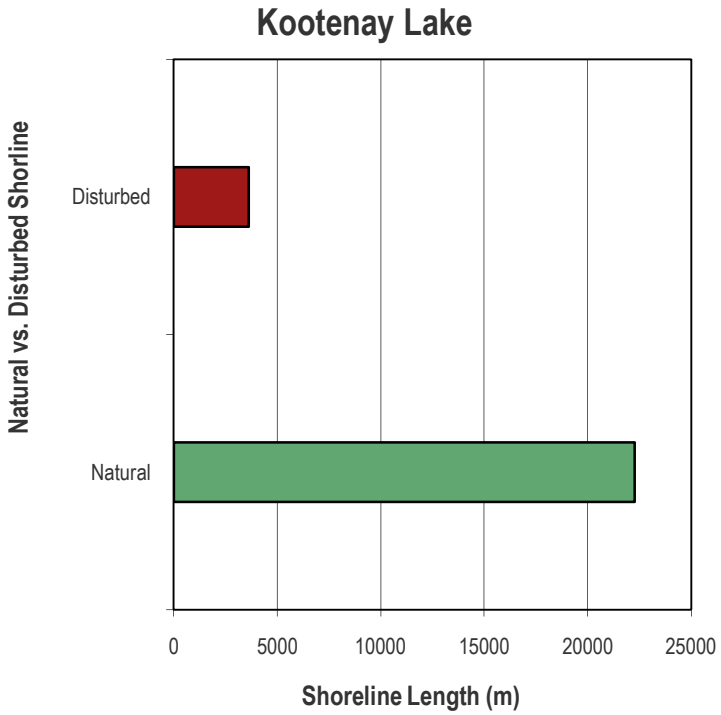

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	86.00%	22277
Disturbed	14.00%	3627
	Total	25904.5

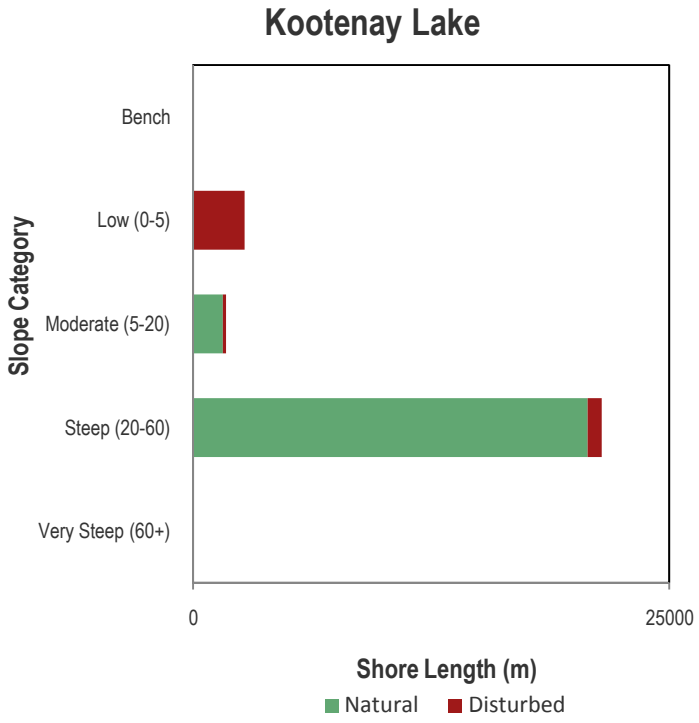

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	0.0	0	0	0	0	0
Steep (20-60)	82.9	21464	20703	761	96.5	3.5
Moderate (5-20)	6.8	1749	1574	175	90.0	10.0
Low (0-5)	10.4	2692	0	2692	0.0	100.0
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	25904	22277	3627	86.0	14.0

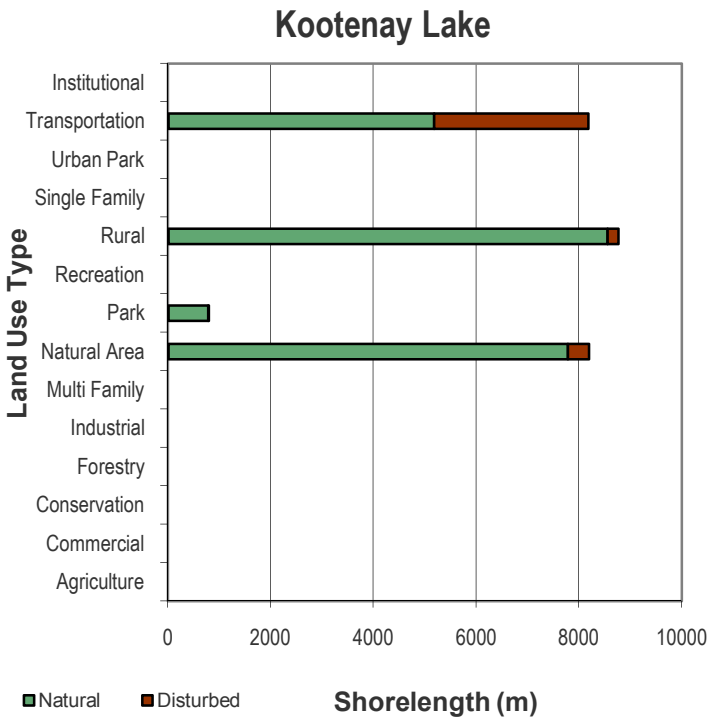

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	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	31.6%	8191	7781	410	95.0%	5.0%
Park	3.0%	781	773	8	99.0%	1.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	33.8%	8763	8554	209	97.6%	2.4%
Single Family	0.0%	0	0	0	0.0%	0.0%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	31.5%	8169	5169	3000	63.3%	36.7%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	25904.5				

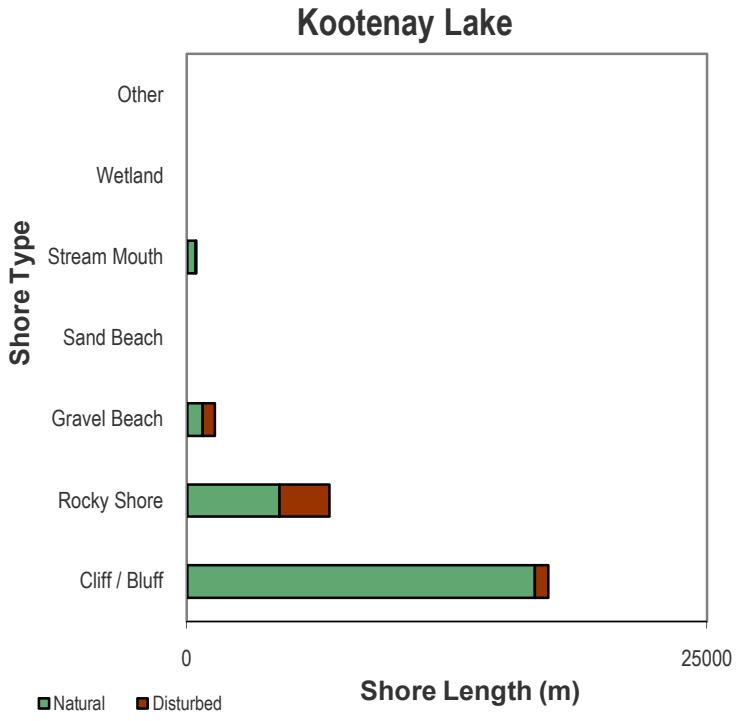

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	67.0%	17346	16720	626.0	96.4%	3.6%
Rocky Shore	26.4%	6842	4428	2414.3	64.7%	35.3%
Gravel Beach	5.1%	1308	727	581.2	55.6%	44.4%
Sand Beach	0.0%	0	0	0.0	0	0
Stream Mouth	1.6%	408	402	5.7	98.6%	1.4%
Wetland	0.0%	0	0	0.0	0	0
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	25904				

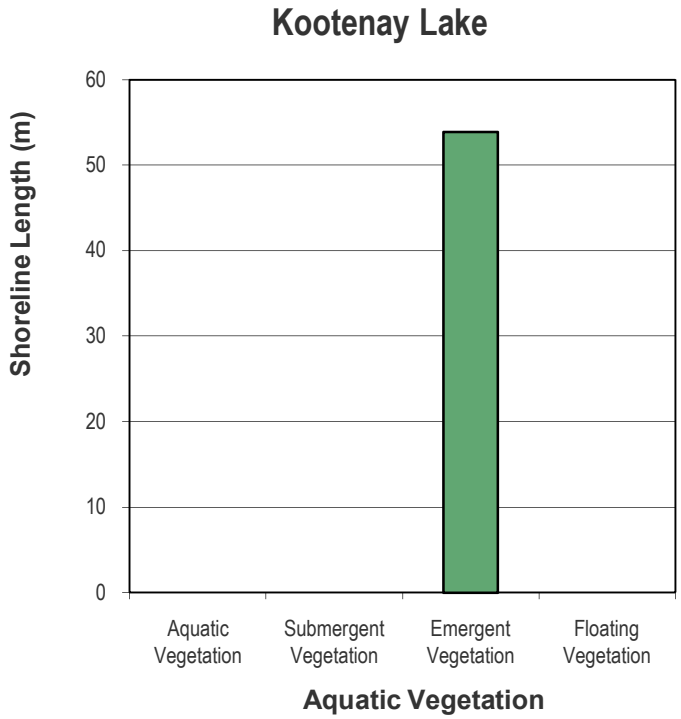

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	0.0%	0
Submergent Vegetation	0.0%	0
Emergent Vegetation	0.2%	54
Floating Vegetation	0.0%	0

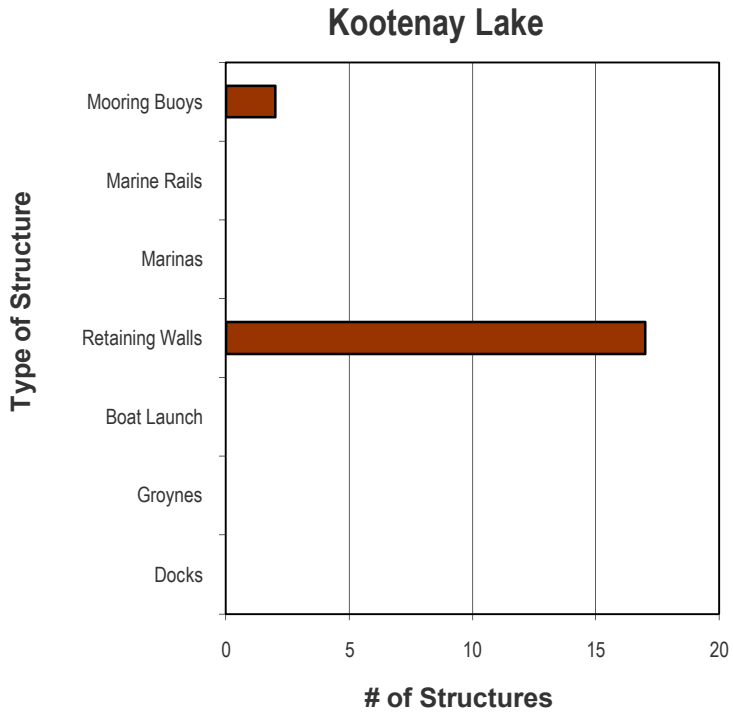

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

Type	Total #	# Per km
Docks	0	0.00
Groynes	0	0.00
Boat Launch	0	0.00
Retaining Walls	17	0.66
Marinas	0	0.00
Marine Rails	0	0.00
Mooring Buoys	2	0.08

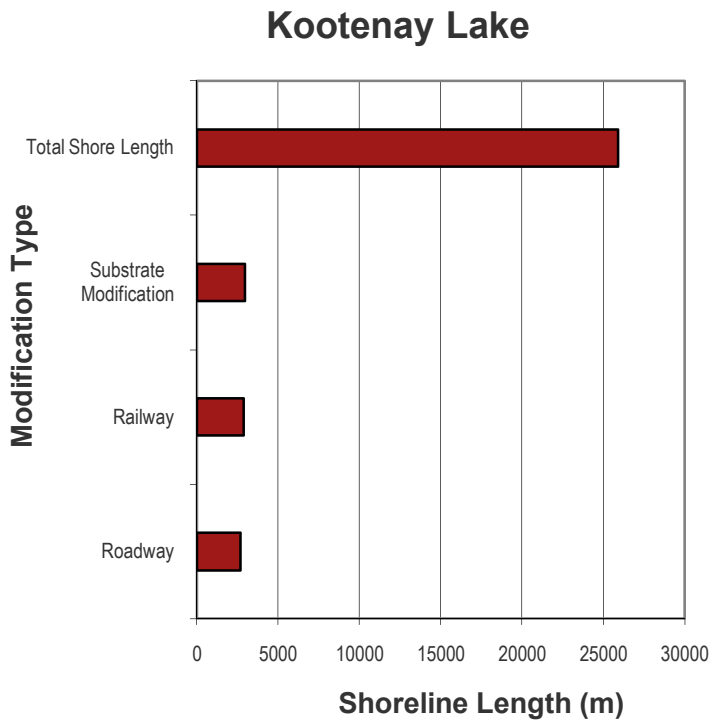

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

Category	% of Shoreline	Shorelength (m)
Roadway	10%	2692
Railway	11%	2905
Substrate Modification	12%	2980
Total Shore Length		25904

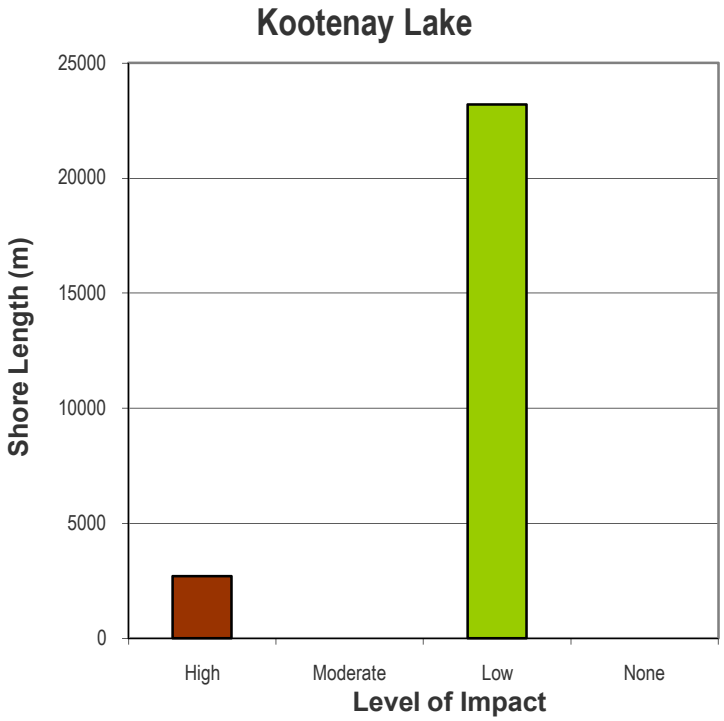

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	10.39%	2692
Moderate	0.00%	0
Low	89.61%	23213
None	0.00%	0
	Total Shore Length	25904.5

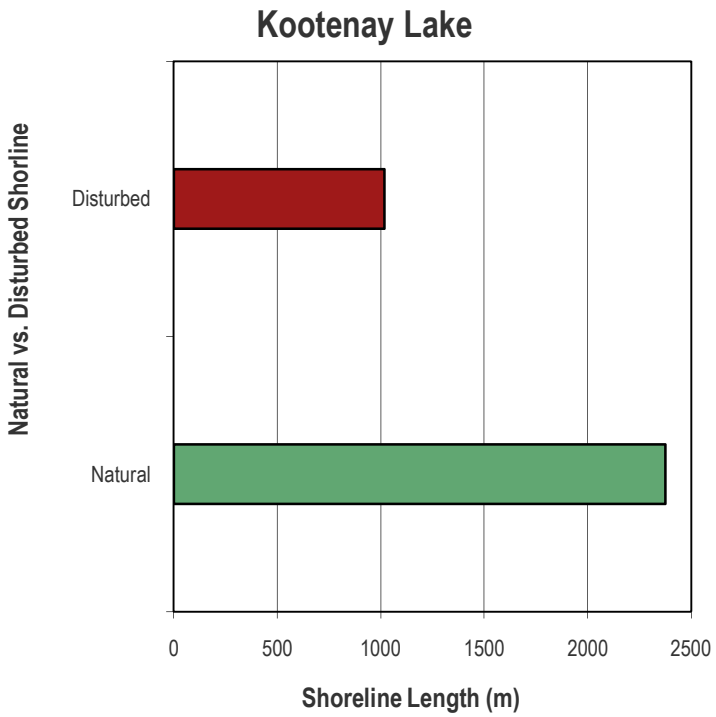

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

	% of Shoreline	Shore Length (m)
Natural	70.00%	2375
Disturbed	30.00%	1018
	Total	3392.8

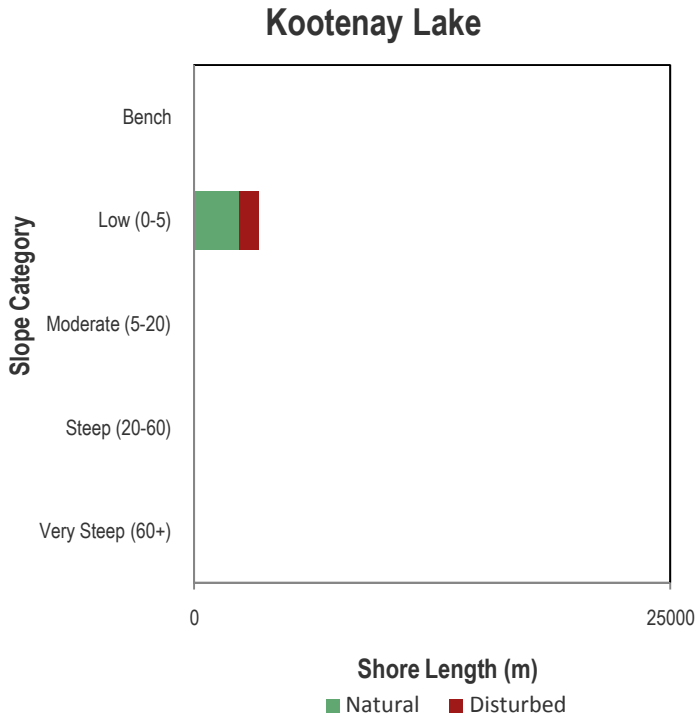

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	0.0	0	0	0	0	0
Steep (20-60)	0.0	0	0	0	0	0
Moderate (5-20)	0.0	0	0	0	0	0
Low (0-5)	100.0	3393	2375	1018	70.0	30.0
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	3393	2375	1018	70.0	30.0

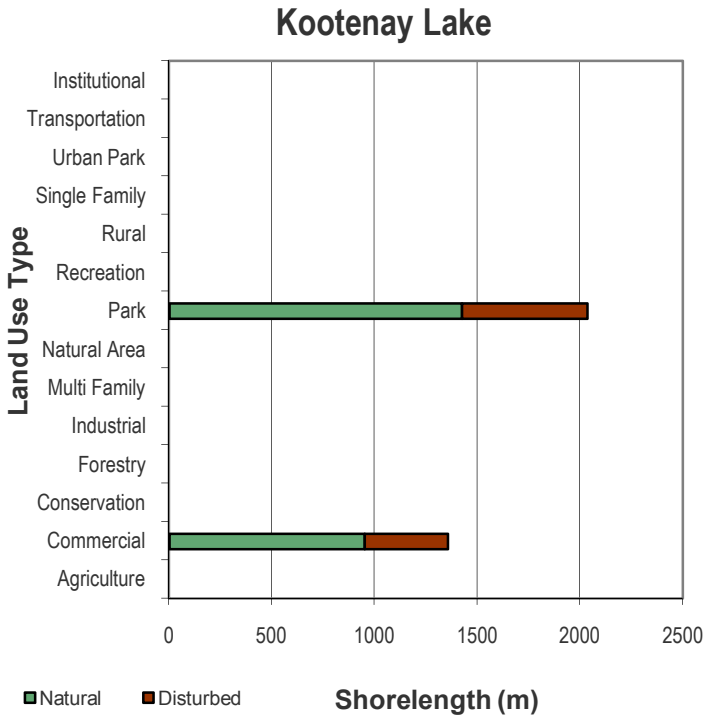

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	40.0%	1357	950	407	70.0%	30.0%
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	0.0%	0	0	0	0.0%	0.0%
Park	60.0%	2036	1425	611	70.0%	30.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	0.0%	0	0	0	0.0%	0.0%
Single Family	0.0%	0	0	0	0.0%	0.0%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	0.0%	0	0	0	0.0%	0
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	3392.8				

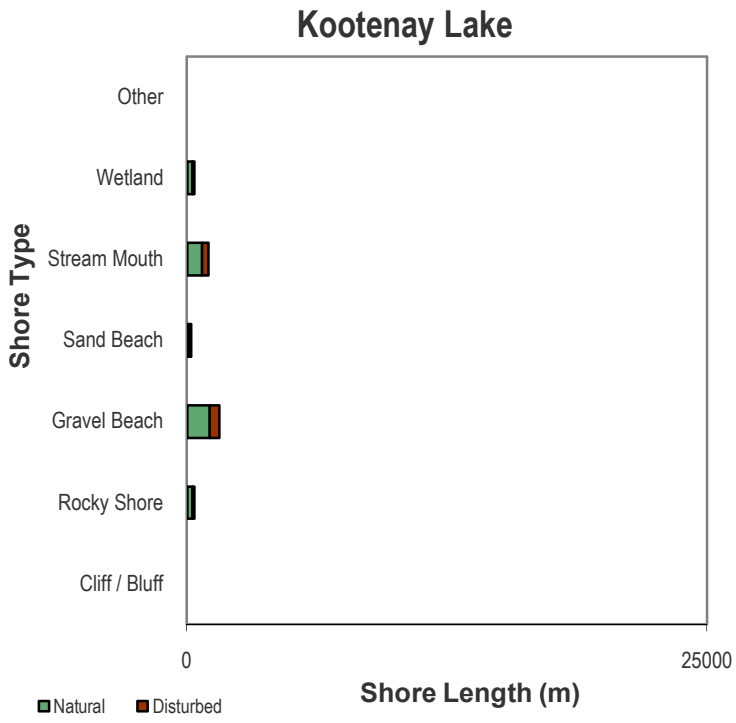

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.0%	0	0	0.0	0	0
Rocky Shore	10.0%	339	237	101.8	70.0%	30.0%
Gravel Beach	45.0%	1527	1069	458.0	70.0%	30.0%
Sand Beach	5.0%	170	119	50.9	70.0%	30.0%
Stream Mouth	30.0%	1018	712	305.3	70.0%	30.0%
Wetland	10.0%	339	237	101.8	70.0%	30.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	3393				

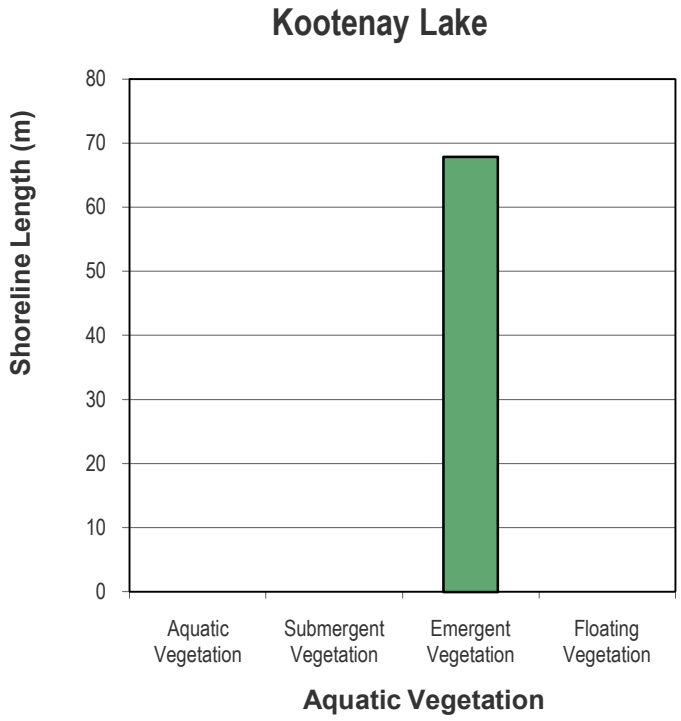

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	0.0%	0
Submergent Vegetation	0.0%	0
Emergent Vegetation	2.0%	68
Floating Vegetation	0.0%	0

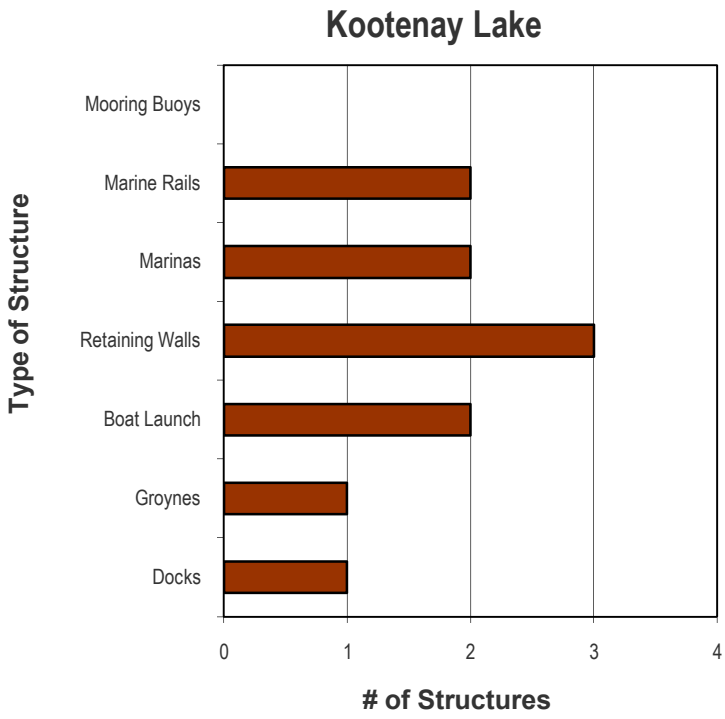

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

Type	Total #	# Per km
Docks	1	0.29
Groynes	1	0.29
Boat Launch	2	0.59
Retaining Walls	3	0.88
Marinas	2	0.59
Marine Rails	2	0.59
Mooring Buoys	0	0.00

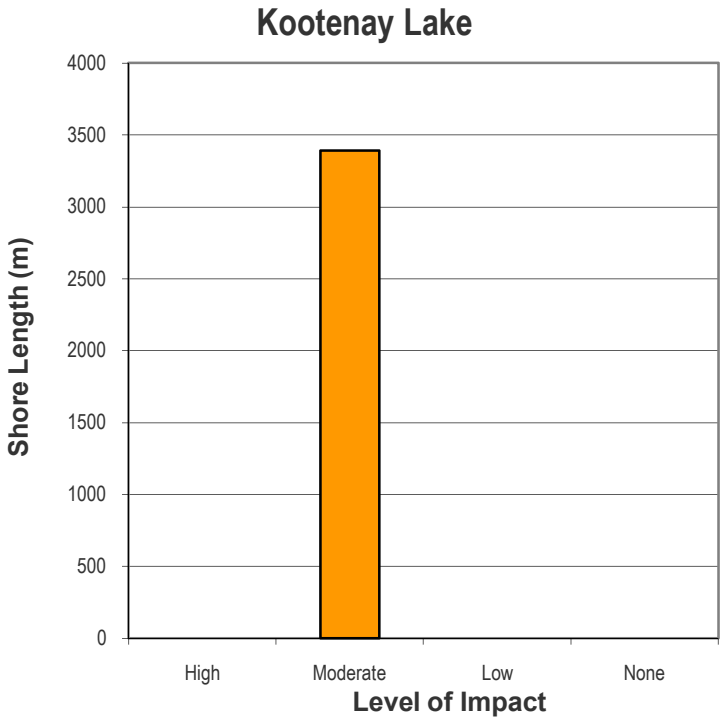

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	0.00%	0
Moderate	100.00%	3393
Low	0.00%	0
None	0.00%	0
	Total Shore Length	3392.8