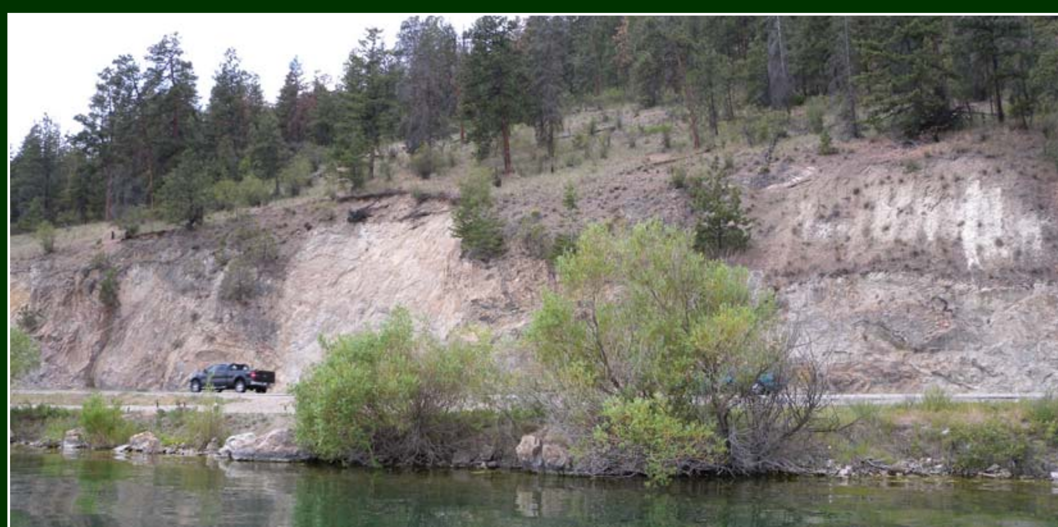
Foreshore Inventory and Mapping

KALAMALKA & WOOD LAKE



Prepared For:
Okanagan Collaborative Conservation Program

Prepared By:
Ecoscape Environmental Consultants Ltd.

March, 2010
File No.: 09-370

FORESHORE INVENTORY AND MAPPING

Okanagan Collaborative Conservation Program

Kalamalka & Wood Lakes

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EXECUTIVE SUMMARY

This report has been prepared based upon the belief that it is possible to manage our watersheds and their natural surroundings in a sustainable manner. The intent of this document is to provide relevant stakeholders with information to facilitate future land use planning along the Kalmalka and Wood Lake foreshore. This project is step one 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. 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. This index follows similar methods that were developed for Shuswap Lake, Windermere Lake and is similar to other ongoing assessments along Shuswap Lake, Tie and Rosen Lakes, and Columbia Lake.

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

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

Kalmalka and Wood Lake are extremely important lakes and are integral to the communities that surround them. The lake acts as our drinking water source, is critical habitat for numerous fish and wildlife species, and is a focus point of nearly all lakeshore communities. Kalamalka Wood Lake have the following different local government areas who are partly responsible for managing the lake shoreline: Regional District North Okanagan, District of Lake Country, and the District of Coldstream.

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

Kalamalka Lake

- It is estimated that 53.7% of the shoreline has a high level of impact which accounts for 25.0 kmof shoreline. Areas of moderate and low impact account for 10.7% or 5.0 km and 33.3% or 15.5 km of the shoreline respectively. Impacts along the shoreline include lakebed substrate modification, riparian vegetation removal, construction of retaining walls, docks and other anthropogenic features;

- The most predominant land use around the lake was natural area parks (28%), followed by transportation (23.3 %). Single family areas were the third most commonly observed land use type, accounting for 22.3% of the shoreline;

- Stream confluences were the most rare shore type around the Kalamalka Lake, accounting for only 2.3 % of the shoreline length. This rare shore type was 66% disturbed. Wetland habitats accounted for 4.5% of the shoreline and in these aresa the disturbance was much less, with only 23% of the shore length impacted. The most predominant shore types around the lake are Gravel beaches and rocky shores, which account for about 45% and 27% of the shoreline length respectively. Cliff / bluff and sand beaches were found along 17% and 3.7% of the shoreline respectively; and,

- Aquatic vegetation occurs along 6.8% of the shoreline length. Of this, emergent vegetation was the most commonly observed (e.g., emergent grasses, willows, or other areas with vegetation inundated during high water). Native beds of submergent vegetation were not documented along shoreline very extensively, due to the large littoral zones. There were some small patches of floating vegetation that were observed.

The following summarizes habitat modifications observed:

- Docks were the most common modification observed, with a total of 360 structures recorded.
- Retaining walls were the next most common modification, with a total of 213 separate structures stretching over an estimated 7 km (15%) of the shoreline. In many cases, retaining walls extended beyond the high water level of the lake and typical construction practices observed were not compliant with Best Management Practices.
- Groynes were common, with a total of 26 recorded.
- There were a total of 11 boat launches and 9 marinas with over 6 slips.
- Substrate modification was observed on 40% of the shore length and was most commonly associated with retaining walls, transportation land uses, and beach grooming.

Wood Lake

- It is estimated that 88% of the shoreline has a high level of impact which accounts for 15.2 km of shoreline. Areas of moderate and low impact account for 5.7% or 1.0 km and 5.6% or 1.0 km of the shoreline respectively. Impacts along the shoreline include lakebed substrate modification, riparian vegetation removal, construction of retaining walls, docks and other anthropogenic features;

- The most predominant land use around the lake was transportation (71%), followed by rural (9.9 %). Single family areas were the third most commonly observed land use type, accounting for 8.3% of the shoreline;

- Stream confluences were the most rare shore type around the Kalamalka Lake, accounting for only 0.8 % of the shoreline length. This rare shore type was 100% disturbed. Wetland habitats accounted for 1.4% of the shoreline and in these areas the disturbance was much less, with only 10% of the shore length impacted. The most predominant shore types around the lake are Gravel beaches and rocky shores, which account for about 62.6% and 19.9% of the shoreline length respectively. Cliff / bluff and sand beaches were found along 0.8% and 14.5% of the shoreline respectively; and,

- Aquatic vegetation occurs along 12.4% of the shoreline length. Of this, emergent vegetation was the most commonly observed (e.g., emergent grasses, willows, or other areas with vegetation inundated during high water). Some native beds of submergent vegetation were not documented along shoreline, but due to the large littoral zones not all were identified. There was no floating vegetation observed.

The following summarizes habitat modifications observed:

- Docks were the most common modification observed, with a total of 67 structures recorded.
- Retaining walls were the next most common modification, with a total of 42 separate structures stretching over an estimated 1 km (6%) of the shoreline. In many cases, retaining walls extended beyond the high water level of the lake and typical construction practices observed were not compliant with Best Management Practices.
- Groynes were common, with a total of 7 recorded.
- There were a total of 11 boat launches and 9 marinas with over 6 slips.
- Substrate modification was observed on 62% of the shore length (10.7 km) and was most commonly associated with retaining walls, transportation land uses, and beach grooming.

The findings of the FIM indicate that the foreshore areas of Kalamalka and Wood Lake have 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 significant 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 Kalamalka 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.

REPORT DISCLAIMER

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

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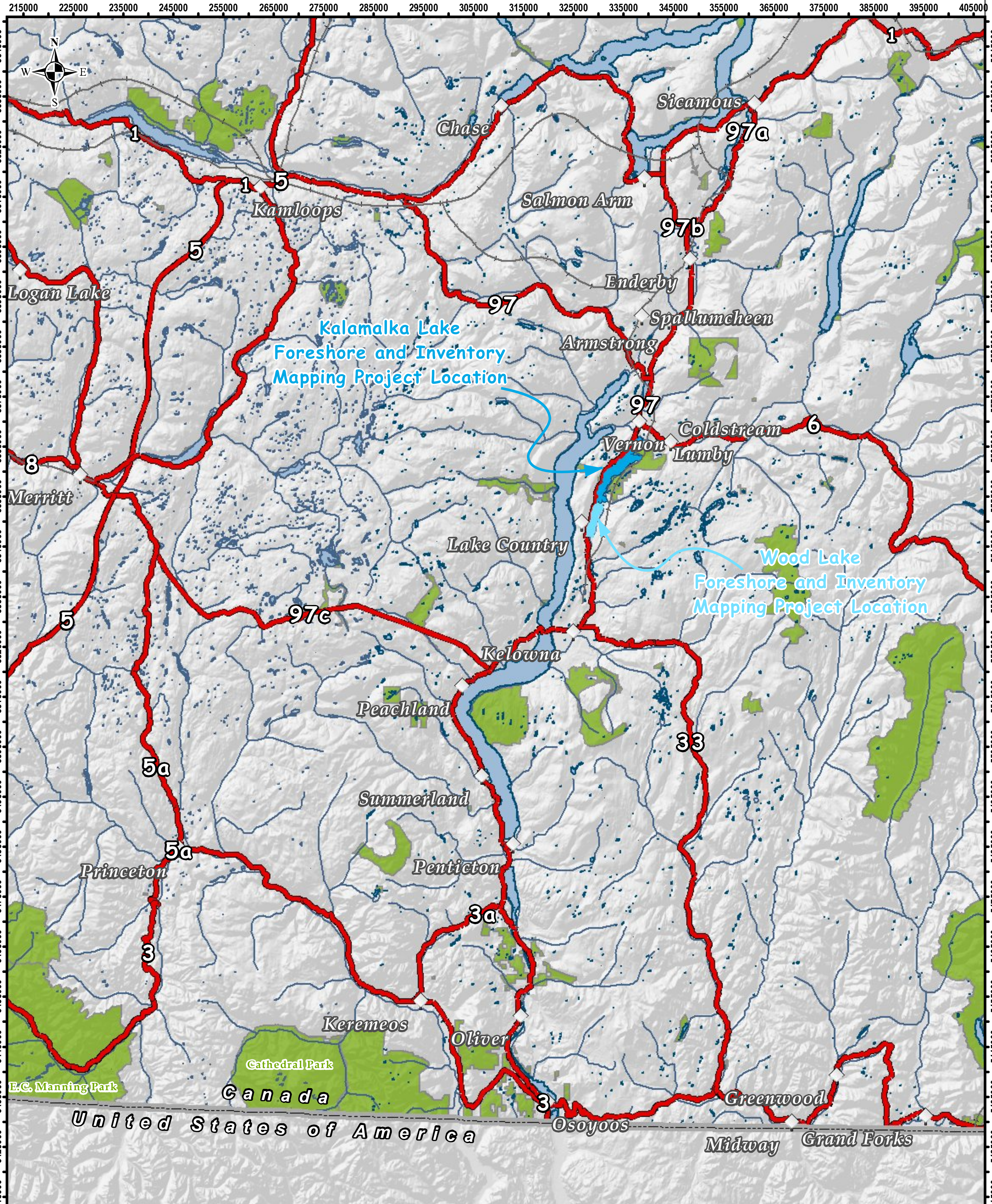
1.0 INTRODUCTION

Kalamalka and Wood Lake are key resources within the Okanagan. These lakes offer scenic beauty, year-round recreational opportunities such a fishing, are source drinking waters, and providing key habitat for numerous fish and wildlife species. Due to the desire to live and recreate in the Okanagan, development pressure is increasing along all of the large lakes and shorelines are being impacted. This increase in development pressure has subsequently resulted in the need for development of land use policies such as Official Community Plans (OCP), Zoning Bylaws, and other landuse planning tools. It is widely acknowledged that development pressure has the potential to or has already impacted fish, wildlife, and/or water quality in the Okanagan Valley large Lakes. As a result of this, key stakeholders including Okanagan Collaborative Conservation Program, Regional District North Okanagan, District of Lake Country, District of Coldstream, and Okanagan Basin Water Board (OBWB) have gathered and presented data to document the baseline conditions of Wood and Kalamalka Lake. This process will help ensure that land use decision making processes are consistent between the different levels of government and based on sufficient inventory to monitor and track objectives and goals using spatially relevant data (i.e., GIS) in the future.

It is a complex relationship between development pressure, the natural environment, and social, economic and cultural values. To balance these various community values, a solid understanding of aquatic and riparian resource values, land use interests, concerns of local residents and the long-term planning objectives is required. Thus, by collecting detailed, spatially accurate information of existing shoreline habitats and their condition, more informed land use planning decisions can be made that better balance the different pressures that exist. Foreshore Inventory and Mapping (FIM) is a standard shoreline mapping methodology that was employed to map the shorelines of Kalamalka and Wood Lakes. 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

Wood and Kalamalka Lake are part a series of lakes referred to as the Okanagan Large Lakes. The shoreline of Wood and Kalamalka Lake encompass shoreline areas within the District of Lake Country, District of Coldstream, and Regional District North Okanagan. The intent of this project was to inventory the shoreline of the lakes to understand the current condition of the shoreline and facilitate better long term management. Without important inventory information such as this, it will not be possible to monitor whether management objectives for the lake have been met over time. The mapping protocol will allow stakeholders to understand what the current condition of the shoreline is, to set objectives for better shore management in Official Community Plans or other policy documents, and measure and monitor changes in the shoreline overtime. Data collected during this assessment will be incorporated into a variety of planning policies at multiple levels of government to provide consistency in shoreline management policies between agencies. The methodology employed for this assessment is discussed in detail below and is an accepted standard that is being used to map shorelines around the province.



Kalamalka Lake and Wood Lake

Foreshore Inventory and Mapping

Figure 1 - Project Location

10 5 0 10 20 30 Kilometers

1:1,000,000

2.1 Project Partners

Numerous different parties have contributed to the success of this project. Foreshore Inventory and Mapping (FIM) protocols have been developed over the last five (5) years and have become a standardized approach to shoreline inventory. 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. Okanagan Collaborative Conservation Program;

2. Okanagan Basin Water Board (OBWB)

3. Community Mapping Network (CMN) and Department of Fisheries and Oceans (DFO); and,

4. Ministry of Environment (MoE)

2.2 Objectives

The project objectives were as follows:

1. Compile existing map base resource information for theKalamalka and Wood lakes;

2. Foster collaboration between the District of Lake Country (DLC), Regional District North Okanagan (RDNO), District of Coldstream, DFO and the MoE and utilize available expertise when possible;

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

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

5. Obtain spatially accurate digital video of the shoreline of the lakes;

6. Provide access to the video and GIS geo-database through the Okanagan Ecosystem Atlas and other sources;

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

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

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

3.0 FORESHORE INVENTORY & MAPPING METHODOLOGY

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

3.1 Field Surveys

FIM field surveys were conducted June 16, 17, and 18, 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 Kalamalka and Wood lakes.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for the entire shoreline and littoral zones of Kalamalka and Wood Lakes. For the purposes of this assessment, aquatic vegetation included all plant forms and communities occurring below the lake highwater level. Although some of the plants are not truly aquatic, all are hydrophitic and contribute to fish habitat. Vegetation mapping was completed using air photos, shoreline videos, and site photographs. Aquatic Vegetation polygons are similar to Zones of Sensitivity identified by the Okanagan and Windermere projects. Vegetation communities were classified using the

Wetlands of British Columbia – A guide to identification (Mackenzie and Moran, 2004) and were categorized as:

Marsh (Wm)

A marsh is a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating watertable is typical in marshes, with early-season high 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.

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.

3.2.2 GIS and FIM Database Management

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

- Data and photos were backed up to a computer/laptop on a daily basis;
- Photos were taken and photo logs were used to facilitate data review and interpretation;
- Air photo interpretation was completed using high resolution air photos that were 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 subsequently mapped the shoreline using air photo interpretation, attempting to map the shoreline within ±5 m horizontal accuracy. This shoreline is sufficiently accurate for planning purposes required within this document and is believed to be within 5 m of the mean annual high water level for at least 80% of the lake. Thus, caution should be taken when using this line to interpret the mean annual high water level of the lake using this GIS shoreline feature. Finally, accuracy of this line is likely the best along steep shorelines and worse along low gradient sandy shorelines because of topography.

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

5.0 RESULTS

The following section provides an overview analysis of Kalmalka and Wood Lakes. 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.

A jurisdictional analysis of the following areas has also been prepared for each of the different subsets of shoreline areas. The following jurisdictional subsets of the shorelines were analyzed.

1. Regional District North Okanagan Electoral Area B
2. District of Lake Country
3. District of Coldstream

The graphical results for the entire Wood and Kalmalka Lakes analysis are presented directly within the text below. A discussion of results for each of the jurisdictional analyses below is also presented, and the graphs and tables for these analyses are presented in appendices for ease of reading.

5.1 Biophysical Characteristics of the Lakes

Foreshore Inventory and Mapping was completed on 46,669 m (46.6 km) of shoreline on Kalmalka Lake and 17,231 m (17.1 km) on Wood Lake. The total length of disturbed shoreline on Kalamalka Lake was 22,794 m (22.8 km) and the total length of natural shoreline was 23,875 m (23.9 km). This level of disturbance represents nearly 50% of the total shoreline length (Figure 2). On Wood Lake, the total length of disturbed shoreline was 14,326 m (14.3 km) and the total length of natural shoreline was 2,906 (2.9 km).

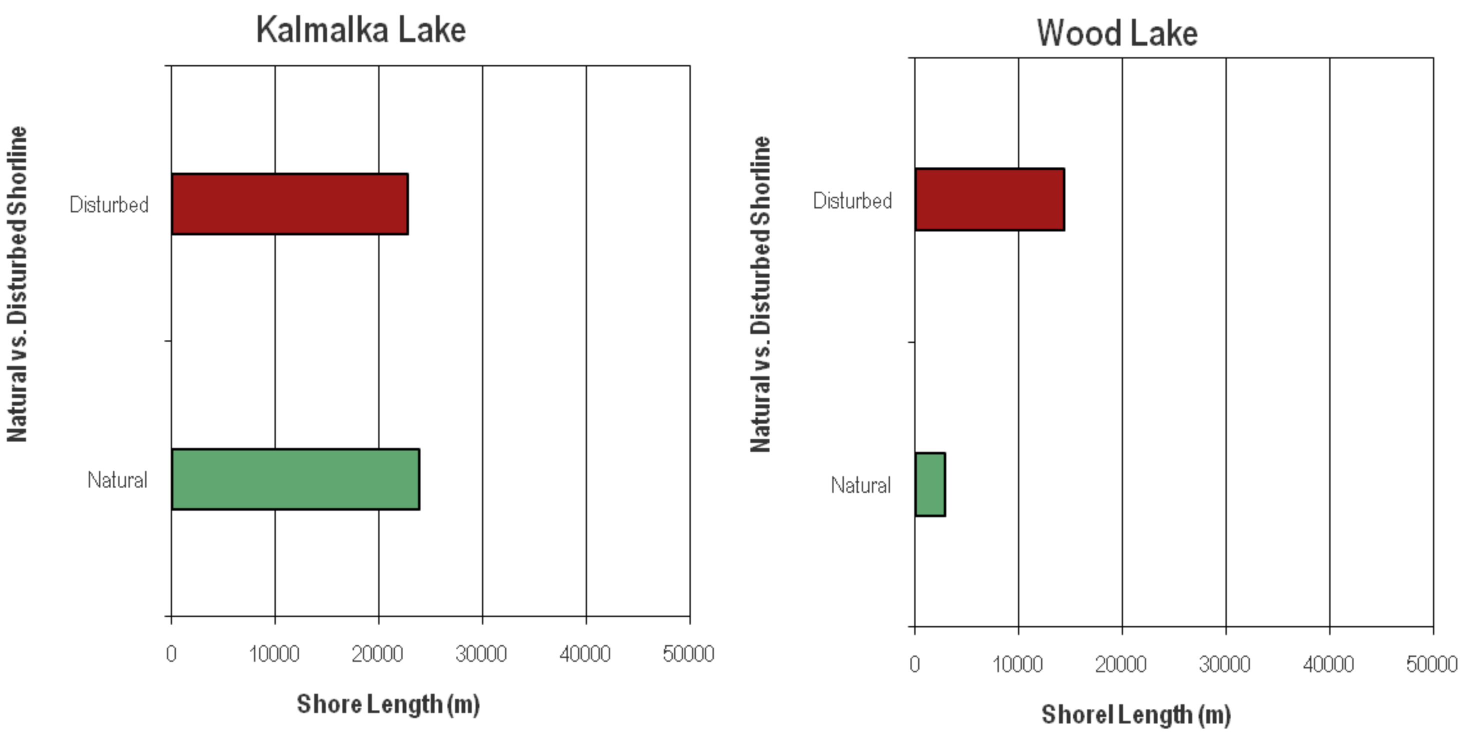


Figure 2 The total shoreline length that is either natural or disturbed on Kalamalka and Wood Lake.

Areas of a lower gradient tend to have the highest level of disturbance, likely because they are easier to develop. Benches, Low and Moderate gradient areas on Kalamalka Lake were disturbed along 69.8% (0.8 km), 62.4% (4.6 km) and 66.8% (9.0 km) of their respective shore lengths within these slope categories. Along steeper shorelines in Kalmalka Lake, disturbance only occurred along 39.0% (13.1 km) and 1.7% (0.05 km) of the steep and very steep shore lengths respectively.

In Wood Lake, many steep shoreline areas were heavily disturbedwhen compared to Kalamalka Lake. This difference is attributed to the rail and highways that occur along the shoreline in many areas. In Wood Lake, Benches, Low, and Moderate gradient areas were disturbed along 90.1% (0.2 km), 74.4% (6.4 km), and 100% (1.5 km) of their shore lengths respectively within these slope categories. Steeper shorelines in Wood Lake were disturbed along 90.1% (6.1 km) of the shoreline.

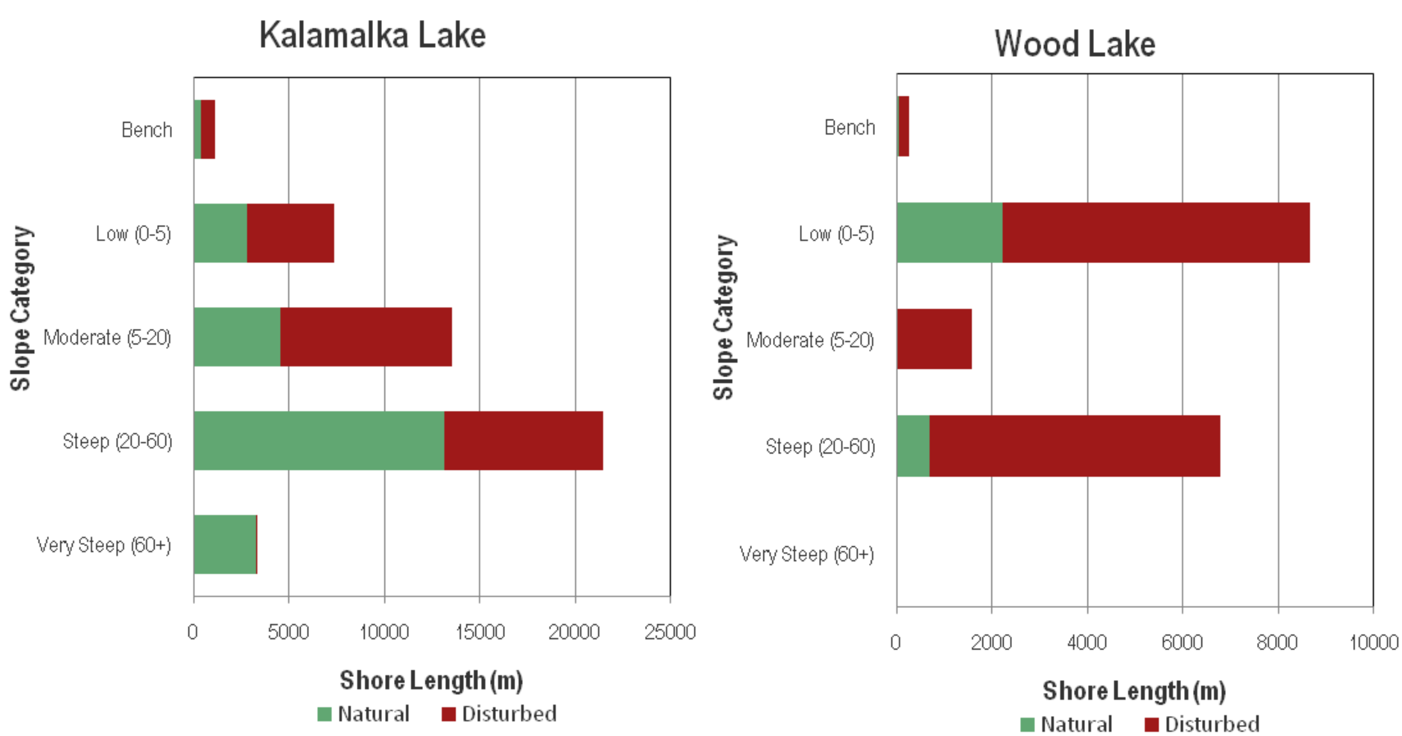


Figure 3 The total shoreline length that is either natural or disturbed within the different slope categories of Kalamalka and Wood Lake.

Natural parks areas were the most prevalent land use along the Kalamalka Lake shoreline, representing approximately 28% of the shoreline or 13.1 km. Within these natural parks areas, the shoreline was 90.3% natural and 9.7% disturbed. Transportation was the next most common land use observed along the Kalamalka Lake Shores, accounting for 23.3% of the shoreline or 10.9 km. Within transportation land use areas, the shoreline was approximately 78.3% disturbed and 21.7% natural. Single family residential areas were the next most prevalent land use, occurring along 22.3% of the shoreline or 10.4 km. Single family residential areas were highly disturbed, with 82.0% of their shore length disturbed due to factors such as riparian vegetation loss, retaining walls, etc.. Rural areas represented approximately 8.1 km (17.3%) of shoreline. Within these residential areas, over 79.9% of the shoreline was natural.

Transportation land uses along Wood Lake were predominant, accounting for 70.5% of the shore length or 12.1 km. Within these transportation land use areas, the shoreline was 88.6% disturbed due to factors such as lake infill. Rural areas were the next most common land use observed around Wood Lake, and accounted for 9.9% of the shoreline. Within these rural areas, 54.4% of the shore length was natural and 45.6% was disturbed. Single family residential areas accounted for 8.3% of the shore length and within these areas only 2% of the shore line remains in natural condition.

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Multifamily and commercial areas were present along both Wood and Kalamalka Lake. Shorelines in multi family of both lakes were 100% disturbed. Within commercial areas, disturbances along the shoreline in excess of 90% in both Wood and Kalamalka Lake.

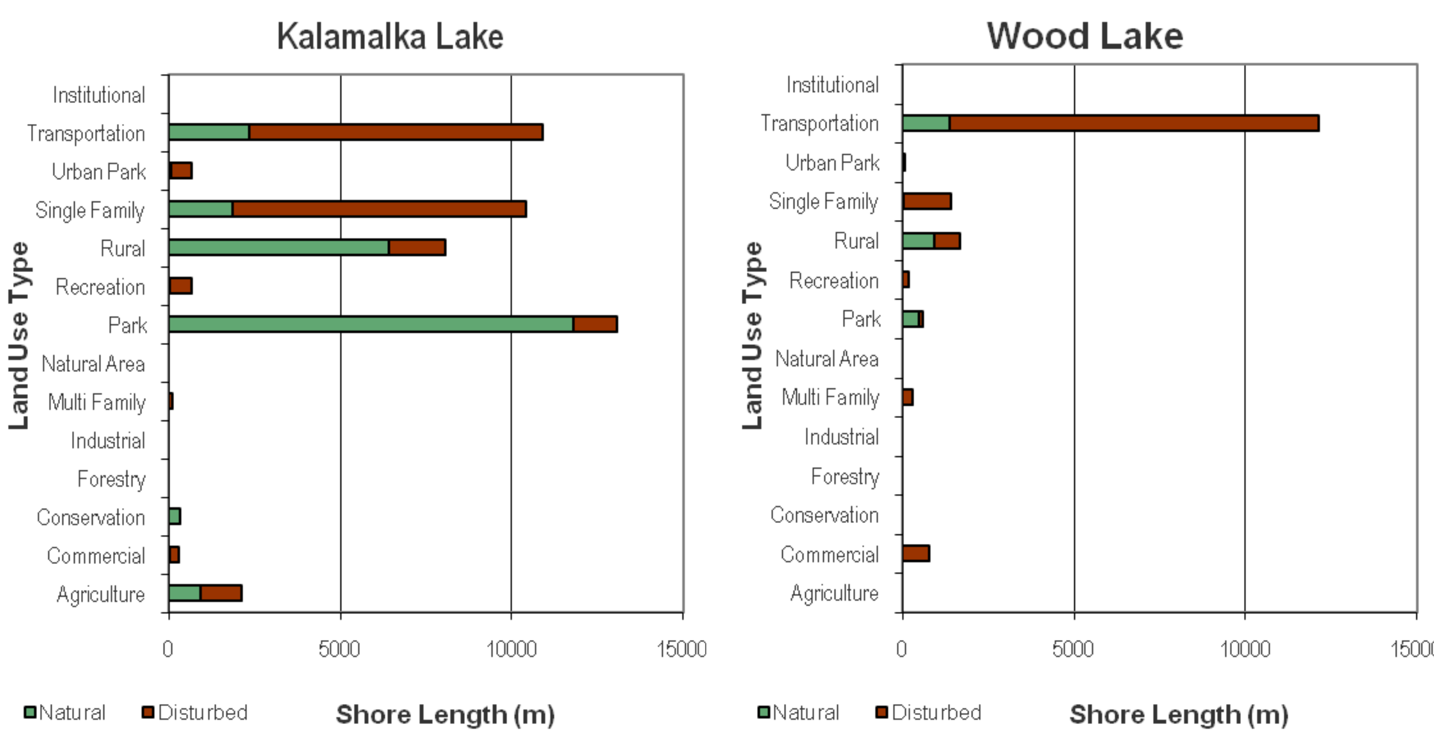


Figure 3 presents the natural and disturbed shore length by the different types of land use types occurring around Okanagan Lake South.

The most predominant shore types observed along Kalamalka Lake were gravel beach and rocky shores, which accounted for 45.0% (~21.1 km) and 27.1% (~12.6 km), respectively. Gravel shorelines were disturbed along 66.3% of the length, or approximately 13.9 km. Rocky shores had a much lower level of disturbance, with only approximately 25.2% or 3.2 km of the shore length being disturbed. Cliff / bluff were the next most prevalent shore type, for about 17.4% of the shoreline, or approximately 8.1 km. Cliff / bluff shore types were relatively natural, with 60.4% of the shore length remaining in natural condition. This shore type was the predominant shore type of natural parks areas, explaining why so much of the shoreline is natural. Sandy shores, wetlands, and stream confluences were not very common and represented only 3.7%, 4.5% and 2.5% of the total shoreline length, respectively. Wetland shore types were relatively natural, with 76.6% of the shoreline remaining in a natural condition. Many wetlands were located in rural areas.

The most predominant shore type in Wood Lake was gravel beaches, which accounted for 62.6% (10.8 km) of the shore length. Gravel beaches were disturbed along 80.4% of the shorelength. Rocky shorelines occurred along 19.9% of the Wood Lake shorelength and within these areas the shoreline was 100% disturbed. The high disturbance was due to transportation related impacts associated with the highway. Sandy beaches areas accounted for 14.5% of the lake. Wetland areas occurred around 1.4% of the shoreline and within these areas the shoreline wetlands shore lengths were 90% natural (0.2 km of shoreline). More detailed wetland mapping will better characterize wetlands these areas.

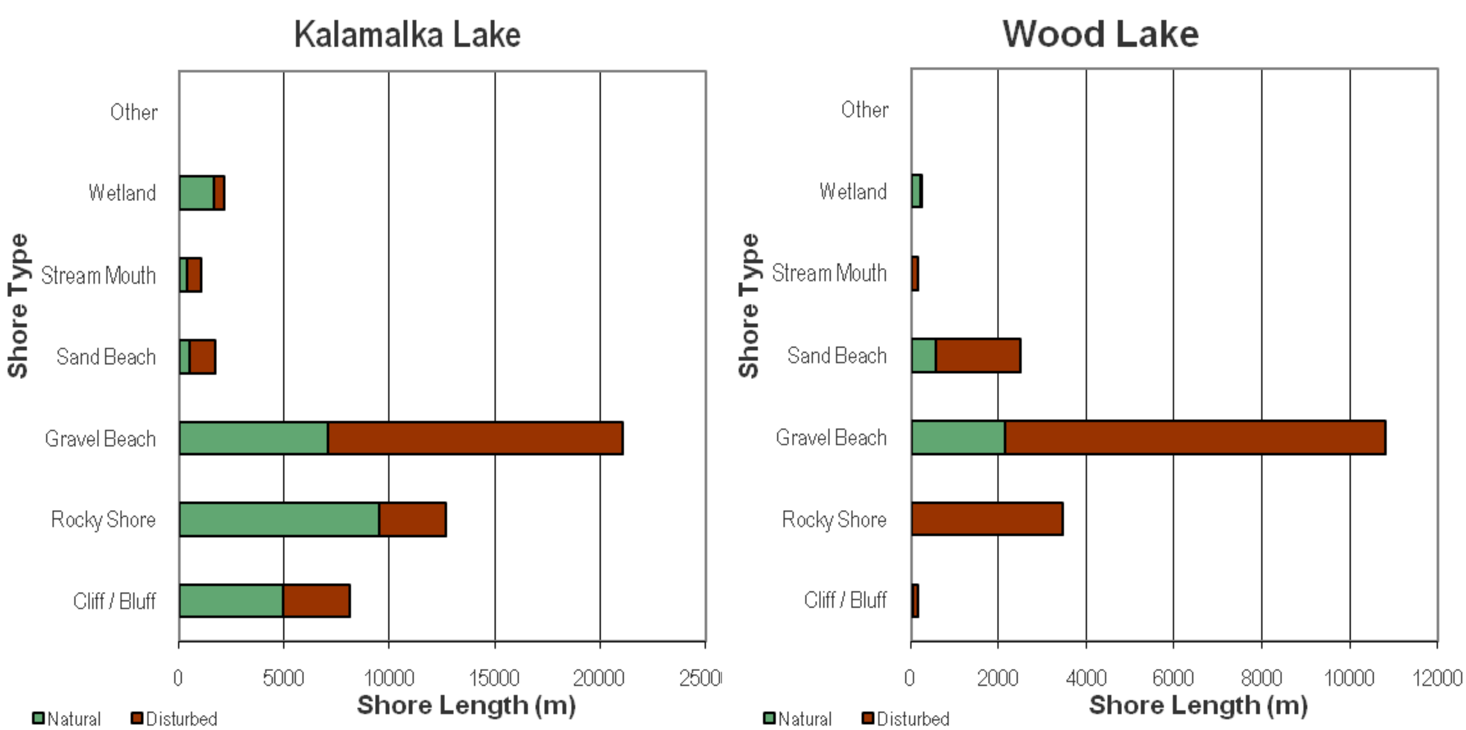


Figure 4 presents the length of natural and disturbed shoreline along each of the different shore types on Kalamalka and Wood Lake.

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 3.2 km of the shoreline of Kalamalka Lake that has aquatic vegetation, which represents approximately 6.8% of the total shoreline length in the Lake. The total area of both dense and sparsely vegetated areas with aquatic vegetation (floating, emergent, or submergent) is 24,859 m^2. The most common vegetation type observed was emergent vegetation, which occurred along 4.9% (2.3 km) of the Kalamalka Lake shore length. Floating and submergent vegetation accounted for 1.1% (0.5 km) and 1.4% (0.7 km) of the shorelines respectively. Detailed mapping of submergent vegetation was difficult due to the large littoral areas observed. It is highly probable that there are additional submergent vegetation areas that have not been inventoried as part of this assessment.

In Wood Lake, aquatic vegetation occurred along 12.4% of the shoreline or 2.1 km. Emergent vegetation occurs along 9.4% (1.6 km) of the shoreline. Submergent vegetation was also present and occurs along 3.0% or 0.5 km). As above, detailed mapping of submergent vegetation was difficult.

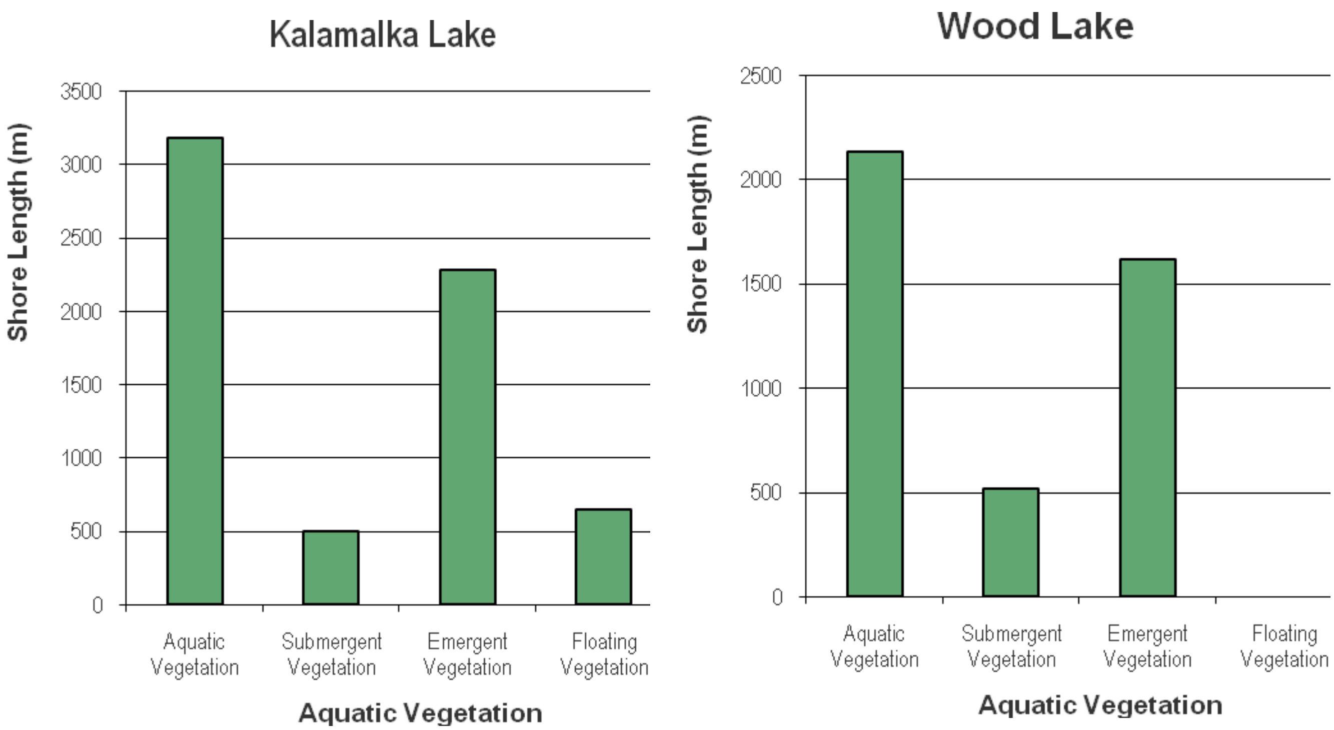


Figure 5 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Kalamalka and Wood Lakes.

On Kalamalka Lake docks were the most commonly observed type of shoreline modification. There were a total of 360 docks on the lake. Retaining walls were the second most common modification observed, with 213 retaining walls being observed. Groynes were observed on the lake and there was a total of 26 present. There are a total of 9 marinas with greater than 6 boat slips and 11 boat launches. There were a total of 10 marine rails observed on Kalamalka Lake. The above summarizes the current structures that occur on, over, and around Kalamalka Lake

On Wood Lake, docks were also the most commonly observed modification, with a total of 67 structures present. A total of 42 retaining walls were observed on the lake. There were also a total of 7 groynes, 3 boat launches, and 3 marinas with greater than 6 slips.

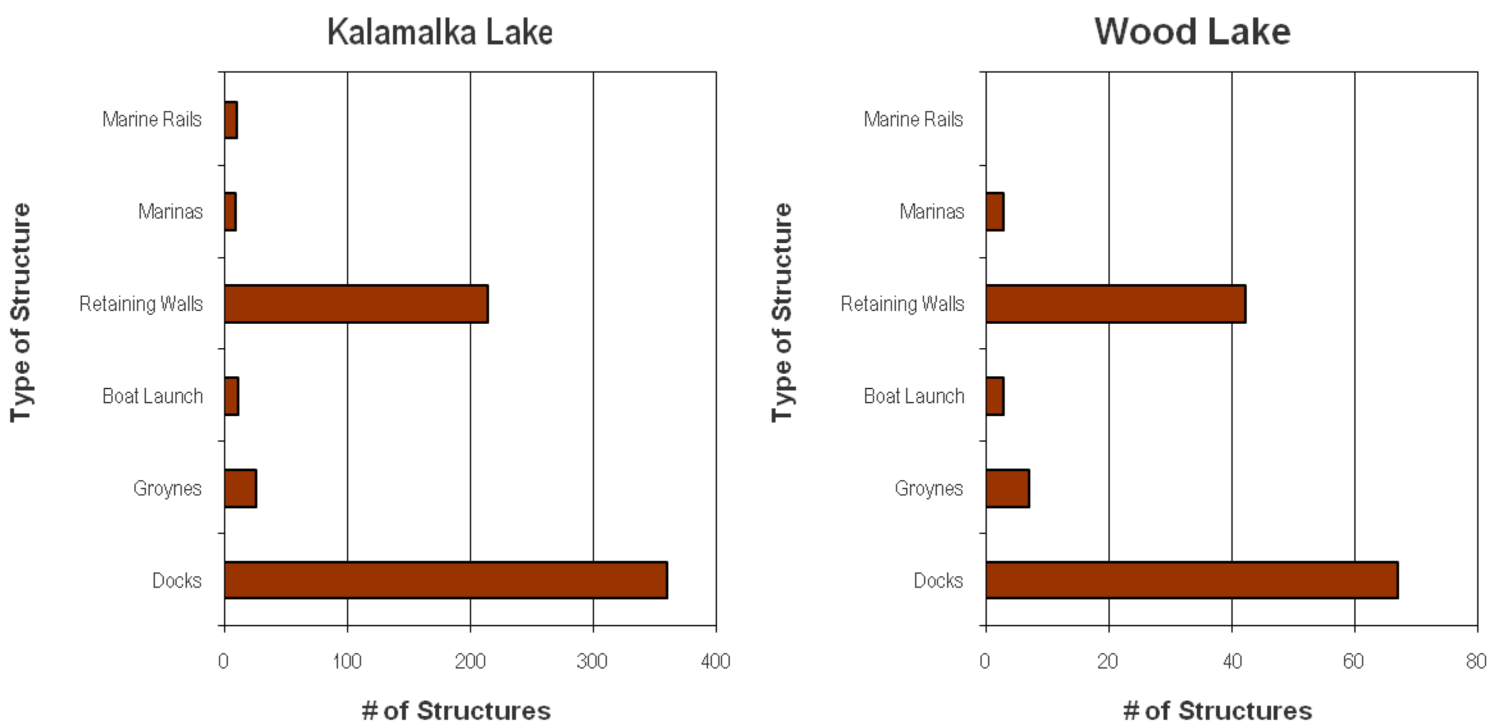


Figure 6 presents the total number of different shoreline modifications that occur around Kalamalka and Wood Lake.

The percentage of the shoreline that was impacted by transportation (roads, railways), retaining walls, and substrate modification was recorded along Kalamalka 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 40% or 18.8 km of shoreline has experienced some form of substrate modification in the form of beach grooming or highway fills. Transportation impacts from railways were the next most prevalent modification and were present along 28% or 13.0 km of shore line. Retaining walls have also had a substantial impact to the shoreline and it is estimated that 15% or 7.0 km of the shore has been impacted by retaining walls. Retaining walls were observed both above and below the high water level (i.e., some walls had a visible water line indicating that they have encroached below the high water level).

On Wood Lake, a similar scenario was also present, except that the lake has also been impacted by roadways. Substrate modification was present along 62% (10.7 km) of the lake. Roadway impacts were present along approximately 38% or 6.7 km of the lake. Railway was associated with approximately 28% or 4.8 km. Finally, retaining walls were present along 6% or 1.1 km.

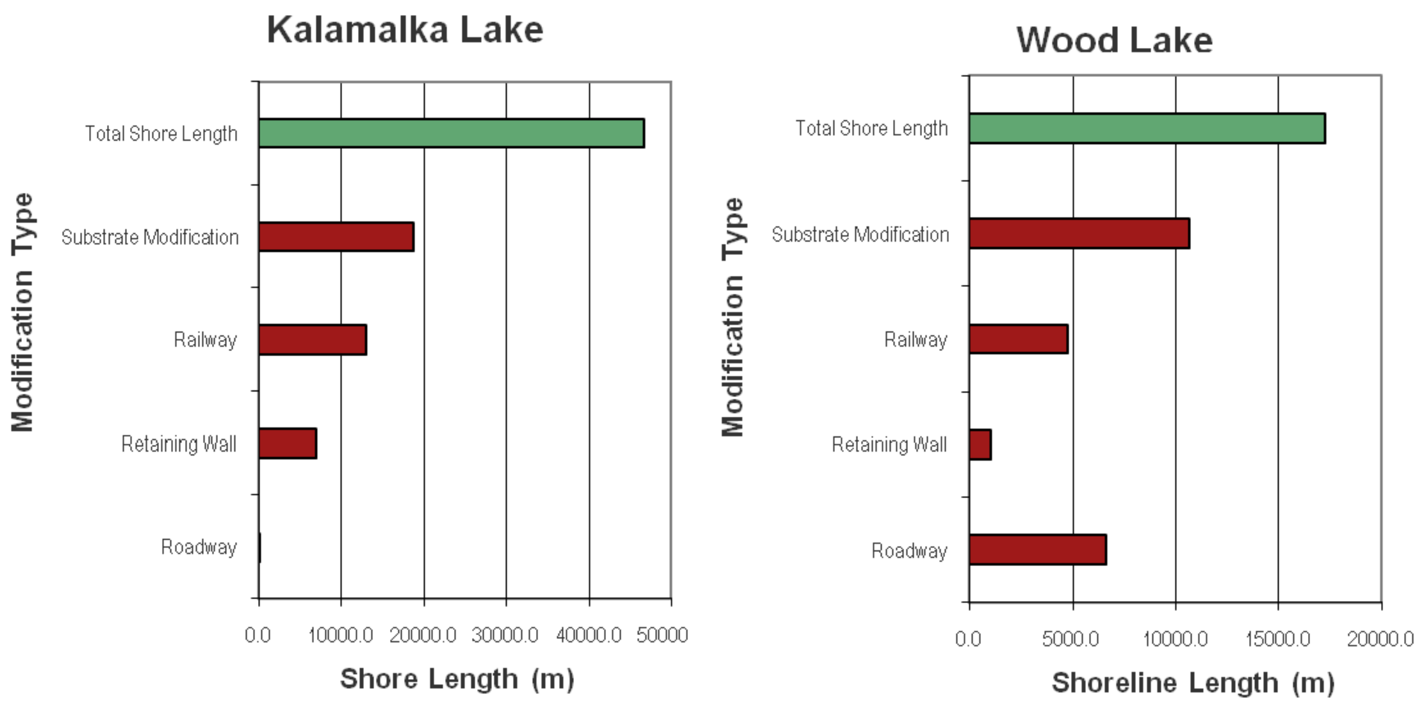
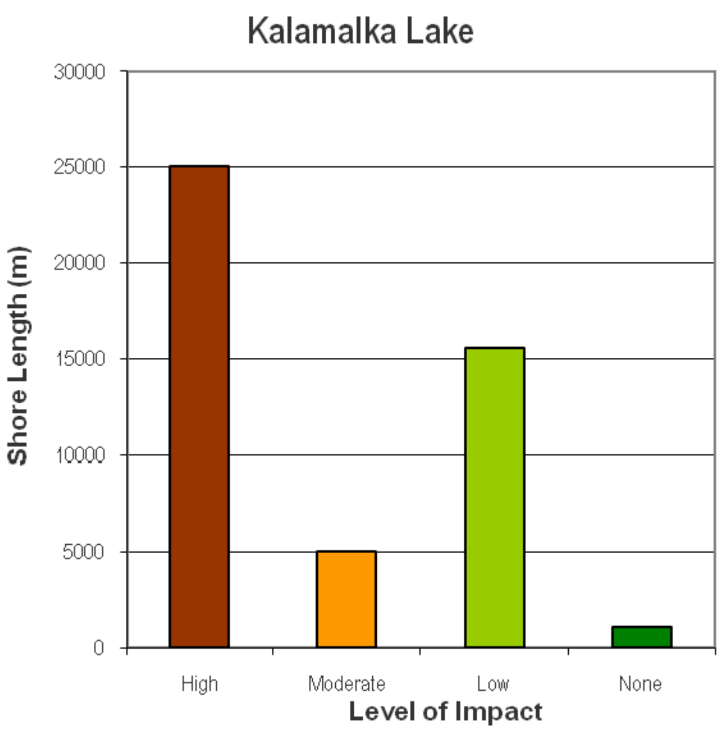


Figure 7 presents the total shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kalamalka and Wood Lake.

The foreshore modifications by the different mechanisms described above for Kalamalka Lake have resulted in a high level of impact around approximately 53.7% or 25.0 km of the shoreline. Areas of moderate and low impact account for about 10.7% (5.0 km) and 33.32% (15.6 km) of the shoreline respectively. Kalmalka had approximately 2.3% of the shoreline that remained 100% natural in condition.

On Wood Lake, 88.5% (15.2 km) of the shoreline has experienced a high level of impact. Moderate and low impact shorelines were present along 5.7% (1.0 km) and 5.8% (1.0km) of the shoreline respectively.



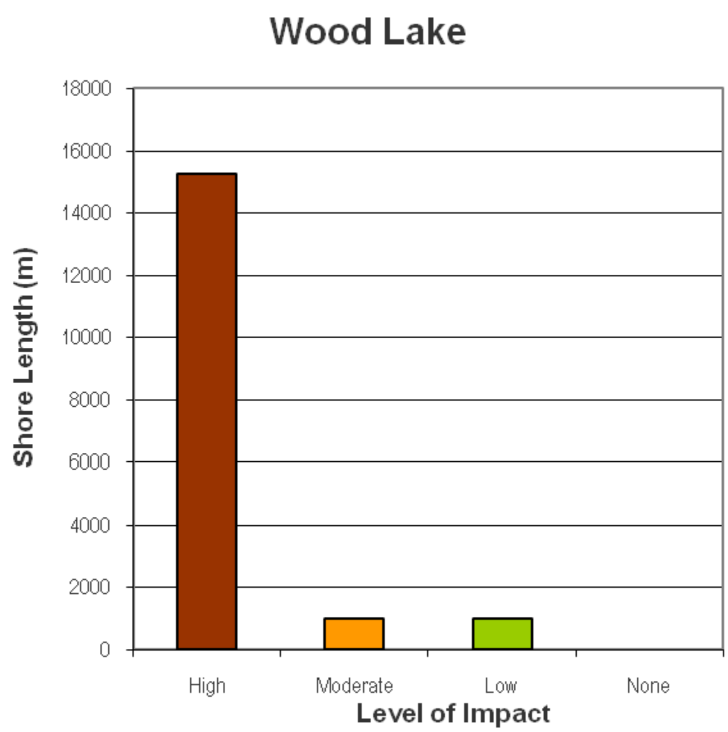


Figure 8 presents the level of impact (High, Moderate, Low, or None) observed along Kalamalka and Wood Lake.

5.2 Summary of Foreshore Modifications

The foreshores of Wood and Kalmalka Lakes have experienced varying degrees of impacts. On Kalmalka Lake, steeper sloped areas (i.e., cliff bluff shorelines) tended to be more natural whereas lower gradient shorelines tended to have a higher level of impact. On Wood Lake, both steep and lower gradient slopes were impacted. The following section is intended to summarize foreshore modifications that were observed during the field surveys in point form:

- Substrate modification on private lands and due highways, coupled with poor construction of retaining walls was the most significant impact observed adjacent or below the high water level of the shoreline as a result of urban land development.

The construction of these features has resulted in the loss of aquatic vegetation (actual loss has not been determined), and a loss in productivity due to substrate modification. This impact is similar to other interior lakes that have been surveyed including Windermere, Moyie, and Shuswap.

- In many areas it is apparent that emergent shrubby vegetation below the high water level (e.g., willows and cottonwoods), grasses and sedges, and other types of aquatic vegetation has been impacted. It is believed that most of this vegetation removal is the result of beach creation (i.e., beach grooming), substrate modification, or from road fills. The losses of soil material that aquatic vegetation grows in will likely take years or decades to naturally regenerate, if at all. The continued losses of this vegetation will further impact juvenile salmonids during high water in the spring when they are known to feed upon organisms within the vegetation (Adams and Haycock, 1989). Due to the extensive development that was observed around the lake, it is not possible to quantify losses that have already occurred.

- Submergent vegetation was not mapped in detail as part of this assessment. The Ministry of Environment has digitized historical survey data that could be used to identify potential submergent vegetation areas to update the dataset. This data will also allow an assessment of potential vegetation losses that may have occurred since the data was collected.

- Riparian vegetation disturbance has changed the vegetation type from natural broadleaf or coniferous associations to landscaped, lawn, or un-vegetated associations. The noticiable 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 Wood and Kalmalka Lakes, 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 Kalamalk and Wood Lake have resulted in the loss of at least 252 m^2 of lost foreshore habitat (i.e., below high water level) and 420 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 along many areas. In these areas, there was little evidence of bioengineering to soften constructed edges along the shoreline. However, in cases where the roadway was offset from the high water level, riparian conditions between the roadway/railway and the lakes tended to be better than those riparian areas observed in single family residential areas.

- Docks were the most prevalent of shoreline modifications. These overwater structures varied in size and were built using a variety of materials. Based on field inventory many of these structures may not be compliant with current Standard Best Practices or foreshore protocol requirements. Docks pose a significant challenge to fisheries and land use managers. The demands for moorage are extensive. A significant number of 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. Docks pose a significant challenge to fisheries and land use managers. The demands for moorage are extensive and finalizing plans that balance moorage needs with protection of habitat will be an ongoing challenge over the next decade.

5.3 Regional District North Okanagan - Electoral Area B

The Regional District North Okanagan Electoral Area B only occurs along the shorelines of Kalamalka Lake. Area B occurs on both the eastern and western shorelines of the lake and includes many natural parks areas. The western side of the lake is generally used as a transportation corridor, and this land use accounts for 37% of the shore length within the RDNO Electoral Area B. On the eastern shoreline, most of the shoreline is natural parks areas, which account for 47.2% of the shoreline areas. Nearly 60% of the shoreline areas within Area B remain natural. Single family development occurred along 10.5% of the shoreline length, and in these areas the shoreline was 53% disturbed.

There were a total of 88 docks and 1 boat launch observed in Area B. Retaining walls were documented 47 times, and occurred along approximately 4% or 1 km of shoreline. Four groynes were also observed along the shoreline. Substrate modification was apparent along 42% of the shoreline and 41% of the shoreline was impacted by railway (the cause of the substrate modification).

5.4 District of Lake Country

The District of Lake Country has shoreline areas along all of Wood Lake and approximately the southern third of Kalamalka Lake. Within Lake Country, transportation land uses were the most common, occurring along 42% (13.4 km) of the shoreline. Rural areas were the next most predominant shore type observed, occurring along 27% of the shoreline. Single family development was the next most common land use type observed during the survey. Within rural areas, the shoreline was 75.6% natural, whereas along single family development areas the shoreline was only 5.7% natural.

There were a total of 189 docks observed within the District of Lake Country. There were a total of 20 groynes, 8 boat launches, and 10 marinas with over six slips. Retaining walls were commonly observed with a total of 111 observed that accounted for 11% (3.6 km) of the shoreline. Roads and railways accounted for 21% and 23% of the shoreline length respectively. Substrate modification was prevalent along 48% of the shoreline length, which accounted for 15.3 km of shoreline.

5.5 District of Coldstream

The District of Coldstream occurs at the northern end of Kalamalka Lake. The total shoreline occurring within Coldstream is 5.7 km long and is 87% disturbed. Single family development is the most common land use occurring within the District and occurs along 81% of the shoreline. Within these single family areas, the shoreline is 92% disturbed. Other land uses occurring in Coldstream are rural areas (10%) amd urban parks (7%).

There were a total of 150 docks observed in Coldstream. There were also 9 groynes, 5 boat launches, and 2 marinas. There were a total of 97 retaining walls that occur along 3.3 km or 58% of the shoreline . All shoreline disturbances within Coldstream were due to land development because there were no significant transportation land uses identified.

6.0 KEY MANAGEMENT CONSIDERATIONS

6.1 Fisheries and Wildlife Overview and Considerations

Kalamalka Lake and Wood Lake are connected by a small channel and have similiar fisheries. However, there are some slight differences between the two. In Kalamalka Lake, rainbow trout, lake trout, and kokanee are the most sought after gamefish -in that order. In Wood Lake, only kokanee and rainbow trout are sought after. Wood known is known for having good kokanee production (Redfish Consulting, 2007), and recommendations have been made to make this stock a priority for management. The Ministry of Environment currently has ongoing projects to gather important information about this stock. Stream habitat degradation in Coldstream Creek and Middle Vernon Creek have been identified as key concerns related to overall fisheries productivity for these sport fish in general.

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 for some species in the lake (i.e., kokanee in Wood Lake) and their life history requirements. For other species, knowledge is much more limited (e.g., lake trout, whitefish, etc.). Coupled with this, there is only a rudimentary understanding of how land development impacts (e.g., is lake trout spawning affected by dock density, etc.) each of the different fish species and life stages within these lakes and the interactions between the two (i.e., do populations migrate between Wood / Kalamalka to spawn, etc.). 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).

Due to the lack of knowledge surrounding specific species habitat areas and requirements around Kalamalka and Wood Lake, a conservative approach must be taken. The rapid rate of development will continue to threaten each of these fish stocks, if we cannot identify and maintain knowledge of these key habitat areas. 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 these lakes and the risk this disturbances poses to fish species, retention of remaining natural areas should be a priority.

A key wildlife concern within the Okanagan Lake system is the Western Ridges Mussel. Recent surveys by the Ministry of Environment have identified several key areas where this species is known to occur. Although not identified within Wood and Kalmalka Lake, the fish assemblages are nearly identical and it is possible that this species occurs but has not yet been documented within the system. The life cycle of the Western Ridge Mussel is complicated, involving more than one host. However, little is known about the hosts of the species. Species with complex life cycles can often be utilized as indicators of overall biological or watershed health. The spatial collected by the Ministry of Environment will help with long term management of the species.

6.2 Land Development Considerations

Land development activities are largely governed by local governments, through zoning and bylaws. 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 play a key role in a sustainable land development environment and maintenance of our fish and wildlife habitats. Many of these terrestrial areas rely upon the shore line areas of Kalmalka and Wood 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 our 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. Current management objectives in the Okanagan are to integrate ongoing terrestrial assessments (e.g., Sensitive Ecosystem Inventory/Terrestrial Ecosystem Mapping) with FIM data to help better facilitate this land planning.

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).

Numerous mapping exercises have been completed to date in the Okanagan. Current focus right now is to integrate the different terrestrial / wildlife (i.e., SEI/TEM) and watershed data (e.g., FIM/SHIM) into a more comprehensive approach that considers both key areas.

6.3 Water Quality and Quantity Considerations

Water quality and quantity in Kalamalka Lake will likely become more difficult to manage in the future. With predicted increasing populations, there will be a subsequent increase in demand that will put stress on different areas of the lake or its watershed and the species that rely upon these areas. Water quantity concerns were a key issue identified for many fish stocks in the Okanagan Lake Watershed (Redfish Consulting, 2007). Currently, there are numerous ongoing source and basin water initiatives to help provide governments with better water management information. This information will be important to help better manage important areas of Okanagan Lake for fish, wildlife, and people in the future.

Key concerns for water quantity and the lake level from a biological perspective on Wood and Kalamalka Lake include potential losses of spawning habitat for numerous species, losses of important littoral areas, losses of riparian vegetation (due to lower water tables), losses of wetland areas, and many others. Other key quantity issues are maintenance of fish flows in important spawning tributaries during low year or drought periods. Finally, localized water quality could become an issue in certain locations if temperature or nutrients in the lake increase in shallow littoral areas (e.g., due to new storm water outfalls, etc.). Wood Lake is already known to have water quality issues with phosphorus, and can result in undesirable algal blooms (Redfish Consulting, 2007). The potential for algal blooms or other types of problems impacts drinking water quality and has even been documented impacting kokanee production in Wood Lake (Redfish Consulting, 2007). Localized water quality could become an issue in certain locations if temperature or nutrients in the lake increase in shallow littoral areas (e.g., due to new storm water outfalls, etc.). Okanagan basin lakes are generally clean and have good overall water quality, however, anecdotal evidence suggests that near shore environments are increasingly becoming covered in algae. These near shore areas are important to public perception of water quality and excessive algal growth may be an indication of increased shoreline nutrient loading. Water quality objectives have been set for Okanagan basin lakes and seasonal monitoring of open-water sites, which represent overall lake quality, ensure long-term protection of these lakes. The majority of lake management programs (including the current BC Ministry of Environment Okanagan large lakes water quality monitoring program [http://www.env.gov.bc.ca/epd/regions/okanagan/waterqual/reports.htm]) focus on measurements of water chemistry and phytoplankton, which centre on the reduction of nutrients and nuisance algal blooms in the open-water area of lakes. However, near shore areas of Okanagan basin lakes are in greatest need of protection, as they receive the greatest amount of use (recreation, fishing, water withdrawal, etc.). The near shore zone is an area of a lake that is most susceptible to degradation and tends to concentrate contaminants, compared to offshore locations. It is also one of the first areas of a lake to be affected by watershed nutrient loading, including septic tank seepage and stormwater runoff.

Recent water chemistry analyses were undertaken to provide a framework for assessing how chemical conditions varied due to differences in shoreline development across a variety of Okanagan basin lake sites and due to influences in lake water chemistry. The results demonstrated that water chemistry conditions did not track differences in the amount of shoreline development among study sites. This is likely due to the strong influence of communication of shoreline waters with the central open-water regions of lakes (which do not closely track local shoreline developments, but rather whole-lake scale responses). Near shore water chemistry does not appear to directly correlate with human activities, but benthic algae (periphyton) can capture these signals, and thus are better than chemical measurements. Given the sensitivity of benthic algae to environmental change, and their widespread distribution in lakes, using benthic algae in biomonitoring protocols provide a more sensitive and earlier warning of near shore water quality impairment than phytoplankton (affected by diluted, open-lake water conditions). High resolution identification of diatom algae (to species or subspecies taxonomic level) was carried out at the same sites as the water chemistry analyses to assess the ability of diatoms to detect differences in shoreline disturbance. Results showed that high-resolution diatom counts are able to identify sites which have deviated from natural community compositions for the region. With the future use of a Reference Condition Approach study, the use of diatom counts, in conjunction with pigment assessments, would to be a promising methodology for biomonitoring effects of human activities in lakeshore environments throughout the Okanagan basin.

6.4 Cumulative Impacts Considerations

To completely understand cumulative impacts, you must have a baseline condition to compare to. Ongoing FIM projects in the Okanagan and other basin lakes have given governments 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 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 highly 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.

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. In the Okanagan, previous assessments such as the Sensitive Ecosystem Inventory are available as a basis. Numerous different possibilities exist for areas identified as sensitive, including Section 219 No Build / No Disturb Covenants, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), or by other mechanisms (donation to trust, etc.).

   The Ministry of Environment has prepared the Okanagan Large Lakes Protocol, which is currently being utilized as a management tool for kokanee and western ridged mussel in Okanagan Lakes. Integration of this document with local land use policy documents will help facilitate more integrated planning between local governments and withi the Foreshore Inventory and Mapping Project presented here are important.

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 is required.** Bioengineering has many different meanings. Concise guidelines and functional requirements of the walls should be developed and incorporated into BMPs to ensure a consistent standard practice of bioengineering.

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 monitroing is required because current practices does not appear to be working effectively (i.e., there were numerous, recent examples of construction inconsistent wtih BMPs).

   The Ministry of Environment recently assessed a 30 km segment of Okanagan Lake shoreline for a compliance assessment. Within that segment there were 35 properties randomly selected that was assessed. 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. It is recommended that storm water management plans be required as part of development processes. Standard best practices have been developed and current regulations do not allow development of storm water treatment systems within setback areas.

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

2. **Wetland habitats were quite rare on Wood and Kalamalka Lake and great care should be taken to maintain the wetland habitats that remain.** Although, wetlands were rare on this lakes, 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.

3. **Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM) are useful terrestrial mapping tools and these inventories should be completed**. These assessments help land managers identify sensitive terrestrial zones which can be integrated into the FIM, SHIM, and WIM GIS datasets. At this time, most areas of the Okanagan have been completed. There are however, a few 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.

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

5. **A carrying capacity analysis of Wood and Kalamalka 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 flows, etc.) and some populations are at risk (e.g., kokanee). 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.

6. **A survey, on a home by home basis, should be conducted to help educate home owners.** A home owner report card could be prepared that would provide land owners with a review of the current condition of their properties. The assessment should provide them with sufficient information to help land owners work towards improving habitats on their property. This assessment is not intended to single out individual owners, but rather to help owners understand the important habitat values present on their properties.

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

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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

Kalamalka Lake

FORESHORE INVENTORY AND MAPPING
FIGURE BINDER

Wood Lake

FORESHORE INVENTORY AND MAPPING

FIGURE BINDER

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APPENDIX A

Foreshore Inventory and Mapping Methodology

APPENDIX B
Kalamalka Lake Data Tables

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

	% of Shoreline	Shore Length (m)
Natural	51.16%	23875
Disturbed	48.84%	22794
	Total	46669.6

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kalamalka 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	3268	3213	55	98.3	1.7
Steep (20-60)	45.9	21438	13078	8360	61.0	39.0
Moderate (5-20)	29.0	13517	4491	9026	33.2	66.8
Low (0-5)	15.7	7346	2761	4585	37.6	62.4
Bench	2.4	1100	332	768	30.2	69.8
Total	100.0	46670	23875	22794	51.2	48.8

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

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	4.6%	2127	936	1191	44.0%	56.0%
Commercial	0.7%	305	19	286	6.4%	93.6%
Conservation	0.7%	337	337	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	0.2%	94	0	94	0.0%	100.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	28.0%	13072	11801	1271	90.3%	9.7%
Recreation	1.4%	667	25	642	3.7%	96.3%
Rural	17.3%	8058	6435	1624	79.9%	20.1%
Single Family	22.3%	10427	1880	8547	18.0%	82.0%
Urban Park	1.5%	689	78	611	11.3%	88.7%
Transportation	23.3%	10893	2364	8529	21.7%	78.3%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	46669.6				

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	17.4%	8115	4905	3210.2	60.4%	39.6%
Rocky Shore	27.1%	12649	9463	3185.9	74.8%	25.2%
Gravel Beach	45.0%	21019	7083	13935.4	33.7%	66.3%
Sand Beach	3.7%	1724	457	1267.4	26.5%	73.5%
Stream Mouth	2.3%	1055	353	701.5	33.5%	66.5%
Wetland	4.5%	2108	1614	494.0	76.6%	23.4%
Other	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Total	100.00%	46670				

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	6.8%	3186
Submergent Vegetation	1.1%	503
Emergent Vegetation	4.9%	2285
Floating Vegetation	1.4%	651

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

Type	Total #	# Per km
Docks	360	7.71
Groynes	26	0.56
Boat Launch	11	0.24
Retaining Walls	213	4.56
Marinas	9	0.19
Marine Rails	10	0.21

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

Category	% of Shoreline	Shorelength (m)
Roadway	0%	4.7
Retaining Wall	15%	7024.3
Railway	28%	13040.8
Substrate Modification	40%	18737.1
Total Shore Length		46669.6

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, or Low on Kalamalka Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	53.67%	25045
Moderate	10.67%	4978
Low	33.32%	15551
None	2.35%	1095
	Total Shore Length	46669.6

APPENDIX C
Wood Lake
Data Tables

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

	% of Shoreline	Shore Length (m)
Natural	16.86%	2906
Disturbed	83.14%	14326
	Total	17231.6

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Wood 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	#DIV/0!	#DIV/0!
Steep (20-60)	39.3	6767	667	6101	9.9	90.1
Moderate (5-20)	9.0	1550	0	1550	0.0	100.0
Low (0-5)	50.3	8665	2214	6451	25.6	74.4
Bench	1.4	250	25	225	9.9	90.1
Total	100.0	17232	2906	14326	16.9	83.1

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

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	#DIV/0!	#DIV/0!
Commercial	4.7%	802	18	784	2.3%	97.7%
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	1.8%	310	0	310	0.0%	100.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	3.4%	585	491	94	83.9%	16.1%
Recreation	1.1%	186	6	180	3.4%	96.6%
Rural	9.9%	1698	924	774	54.4%	45.6%
Single Family	8.3%	1433	28	1405	2.0%	98.0%
Urban Park	0.4%	76	53	23	70.0%	30.0%
Transportation	70.5%	12141	1385	10756	11.4%	88.6%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	17231.6				

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.8%	133	27	106.3	20.0%	80.0%
Rocky Shore	19.9%	3434	0	3433.7	0.0%	100.0%
Gravel Beach	62.6%	10791	2120	8671.4	19.6%	80.4%
Sand Beach	14.5%	2491	544	1946.7	21.8%	78.2%
Stream Mouth	0.8%	144	0	143.6	0.0%	100.0%
Wetland	1.4%	240	216	24.0	90.0%	10.0%
Other	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Total	100.00%	17232				

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	12.4%	2131
Submergent Vegetation	3.0%	514
Emergent Vegetation	9.4%	1618
Floating Vegetation	0.0%	0

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

Type	Total #	# Per km
Docks	67	3.89
Groynes	7	0.41
Boat Launch	3	0.17
Retaining Walls	42	2.44
Marinas	3	0.17
Marine Rails	0	0.00

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

Category	% of Shoreline	Shorelength (m)
Roadway	38%	6617.5
Retaining Wall	6%	1085.3
Railway	28%	4797.6
Substrate Modification	62%	10687.8
Total Shore Length		17231.6

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, or Low on Wood Lake.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	88.48%	15246
Moderate	5.69%	980
Low	5.84%	1006
None	0.00%	0
	Total Shore Length	17231.6

APPENDIX D
RDNO Electoral Area B
Data Tables

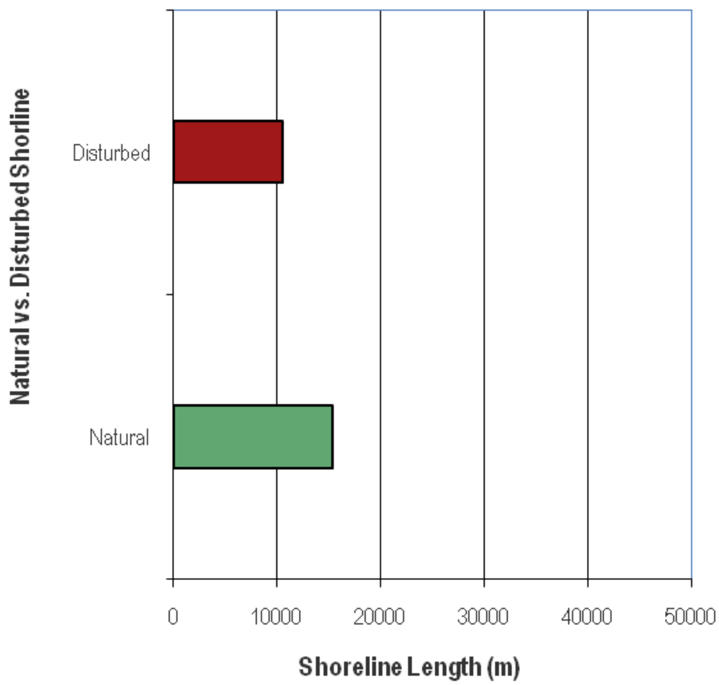

Figure 1: The total shoreline length that is natural and disturbed within Regional District North Okanagan Electoral Area B.

Table 1: The total shore length of natural and disturbed shorelines along the RDNO Electoral Area B.

	% of Shoreline	Shore Length (m)
Natural	59.45%	15416
Disturbed	40.55%	10515
	Total	25930.8

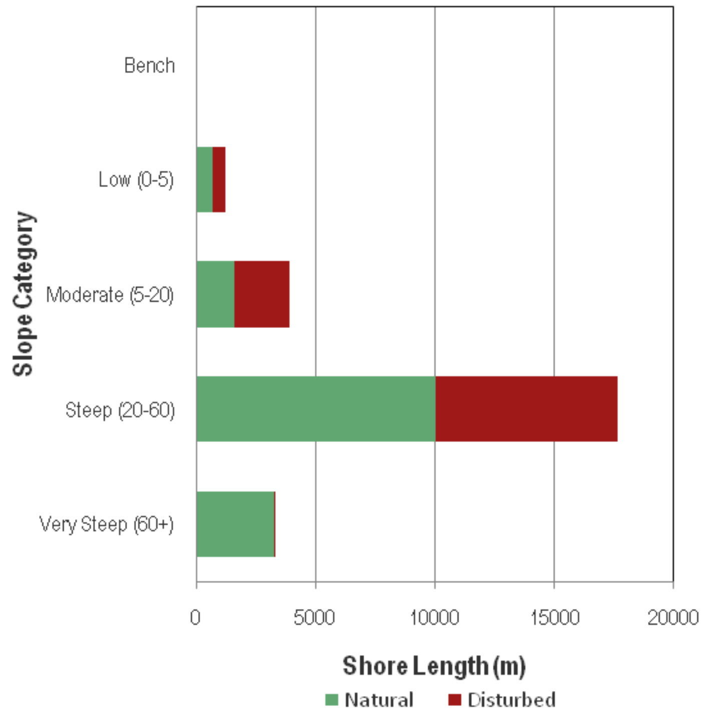

Figure 2: The total shoreline length that is natural and disturbed within each different slope category in Regional District North Okanagan Electoral Area B.

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in the RDNO Electoral Area B.

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	12.6	3268	3213	55	98.3	1.7
Steep (20-60)	67.9	17609	10025	7584	56.9	43.1
Moderate (5-20)	15.0	3881	1541	2340	39.7	60.3
Low (0-5)	4.5	1173	637	536	54.3	45.7
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	25931	15416	10515	59.5	40.5

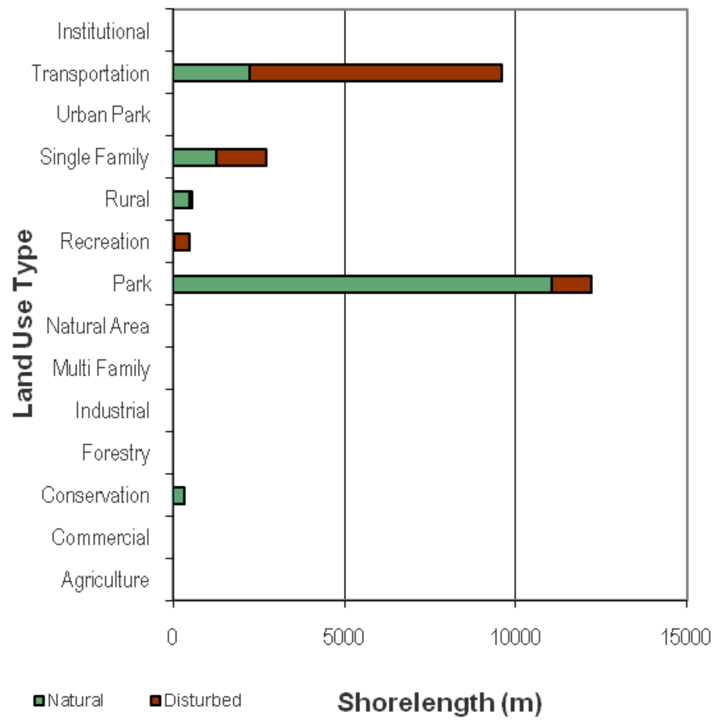

Figure 3: The total shoreline length that is natural and disturbed within each different land use category in Regional District North Okanagan Electoral Area B.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around the RDNO Electoral Area B.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	#DIV/0!	#DIV/0!
Commercial	0.0%	0	0	0	#DIV/0!	#DIV/0!
Conservation	1.3%	337	337	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	#DIV/0!	#DIV/0!
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	47.2%	12235	11048	1187	90.3%	9.7%
Recreation	1.9%	493	25	468	5.0%	95.0%
Rural	2.1%	548	484	65	88.2%	11.8%
Single Family	10.5%	2716	1262	1454	46.5%	53.5%
Urban Park	0.0%	0	0	0	#DIV/0!	#DIV/0!
Transportation	37.0%	9601	2260	7341	23.5%	76.5%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	25930.8				

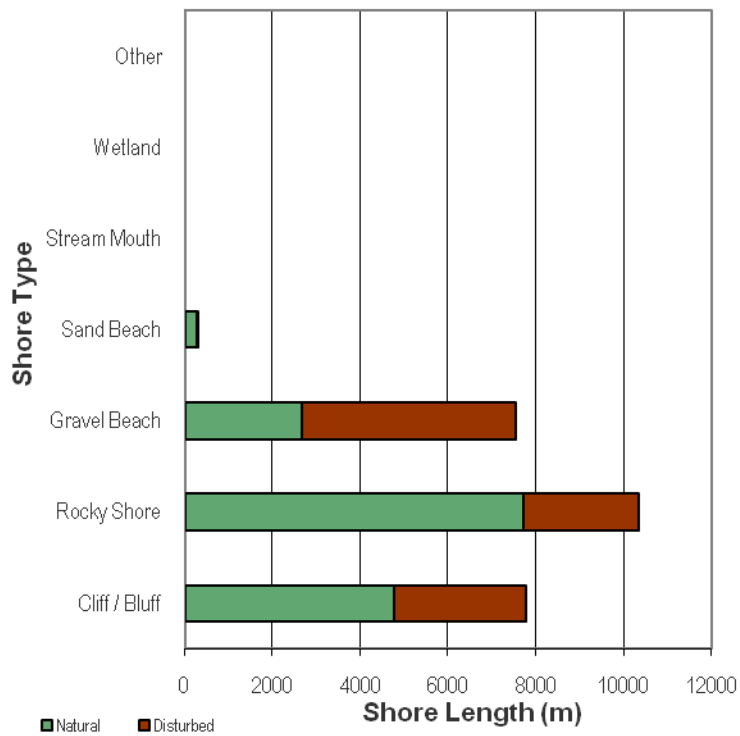

Figure 4: The total shoreline length that is natural and disturbed within each different shore type category in Regional District North Okanagan Electoral Area B.

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around the RDNO Electoral Area B.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	29.9%	7766	4757	3009.3	61.2%	38.8%
Rocky Shore	39.9%	10336	7714	2622.0	74.6%	25.4%
Gravel Beach	29.0%	7522	2670	4852.9	35.5%	64.5%
Sand Beach	1.2%	306	275	30.6	90.0%	10.0%
Stream Mouth	0.0%	0	0	0.0	0.0%	0.0%
Wetland	0.0%	0	0	0.0	0.0%	0.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	25931				

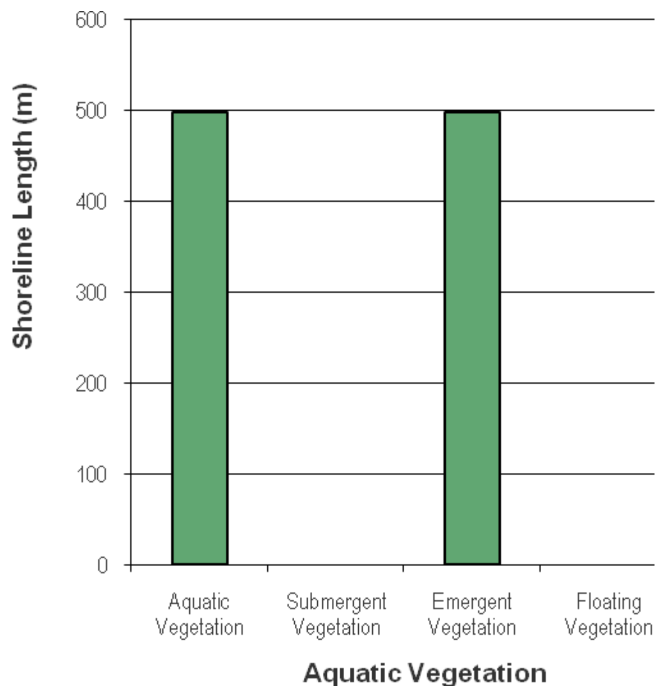

Figure 5: The total shoreline length with aquatic, submergent, emergent, and floating vegetation within Regional District North Okanagan Electoral Area B.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along the RDNO Electoral Area B.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	1.9%	498
Submergent Vegetation	0.0%	0
Emergent Vegetation	1.9%	498
Floating Vegetation	0.0%	0

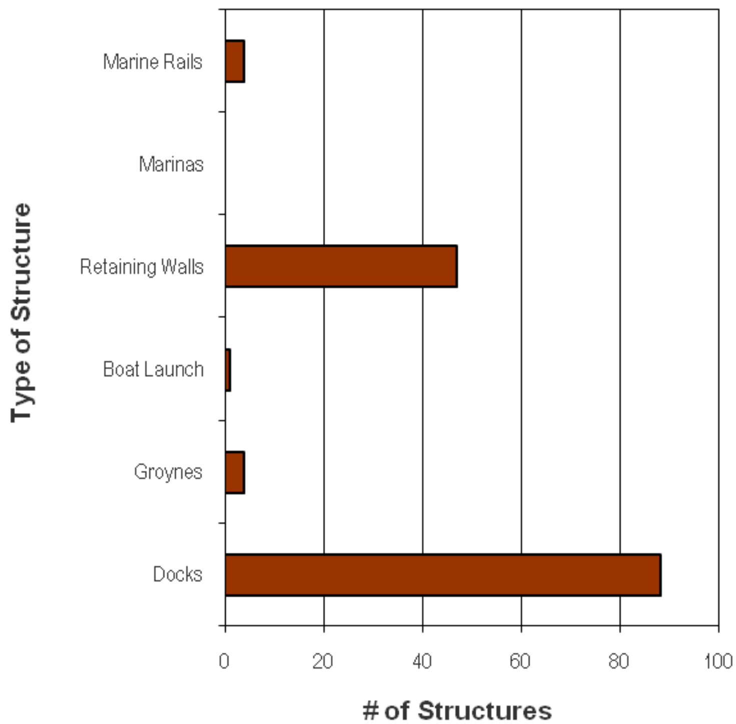

Figure 6: The total number of different modifications found within Regional District North Okanagan Electoral Area B.

Table 6: The total number and density (# per km) of different shoreline modifications occurring around the RDNO Electoral Area B.

Type	Total #	# Per km
Docks	88	3.39
Groynes	4	0.15
Boat Launch	1	0.04
Retaining Walls	47	1.81
Marinas	0	0.00
Marine Rails	4	0.15

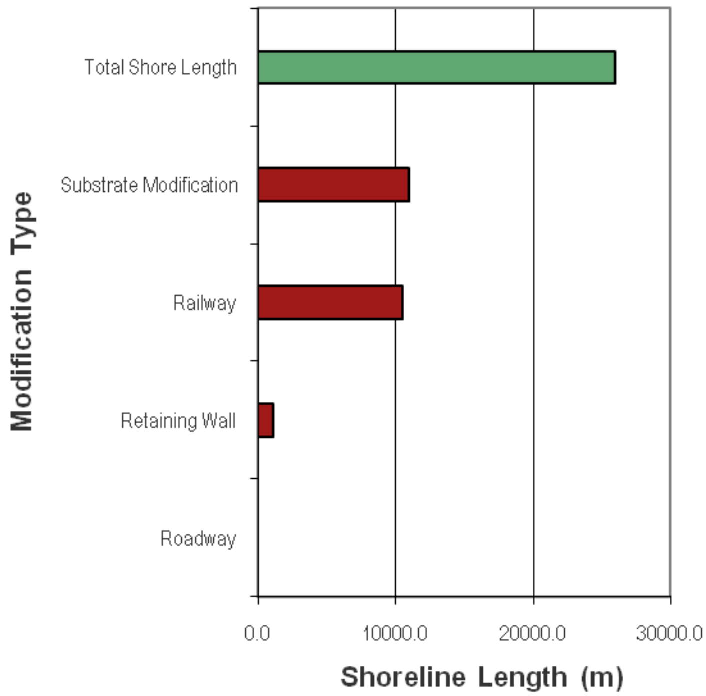

Figure 7: The total shore length of different shore modifiers found within Regional District North Okanagan Electoral Area B.

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along the RDNO Electoral Area B.

Category	% of Shoreline	Shore Length (m)
Roadway	0%	0.0
Retaining Wall	4%	1105.9
Railway	41%	10559.9
Substrate Modification	42%	11012.4
Total Shore Length		25930.8

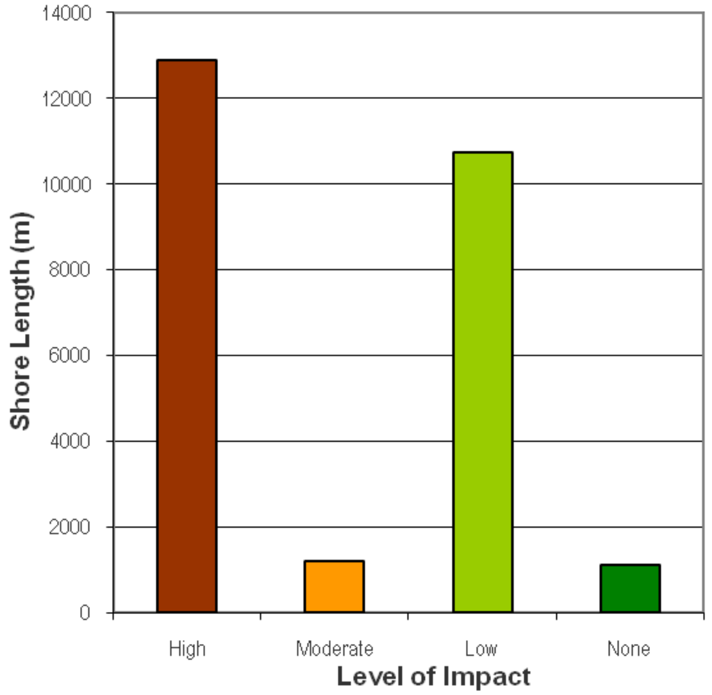

Figure 8: The Level of Impact of the shorelines within Regional District North Okanagan Electoral Area B.

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, or Low in the RDNO Electoral Area B.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	49.71%	12890
Moderate	4.63%	1202
Low	41.43%	10744
None	4.22%	1095
	Total Shore Length	25930.8

APPENDIX E
District of Lake Country
Figures & Data Tables

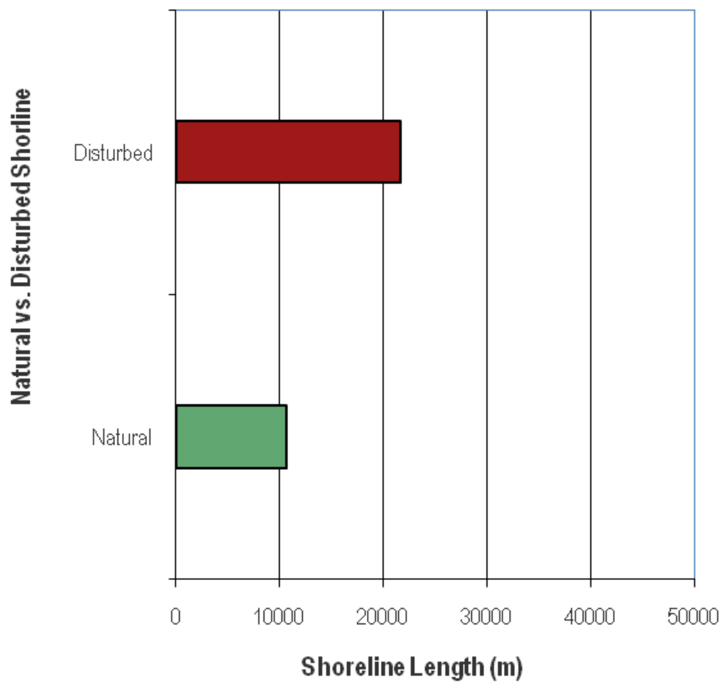

Figure 1: The total length of natural and disturbed shorelines within the District of Lake Country.

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

	% of Shoreline	Shore Length (m)
Natural	32.99%	10635
Disturbed	67.01%	21605
	Total	32239.8

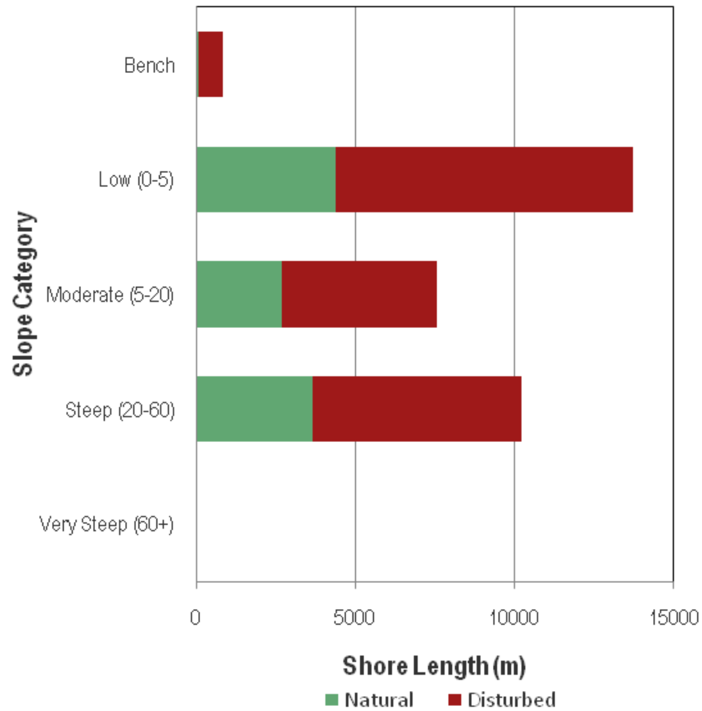

Figure 2: The total shoreline length that is natural and disturbed within each different slope category in The District of Lake Country.

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

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	#DIV/0!	#DIV/0!
Steep (20-60)	31.6	10194	3619	6575	35.5	64.5
Moderate (5-20)	23.4	7533	2653	4880	35.2	64.8
Low (0-5)	42.5	13716	4339	9377	31.6	68.4
Bench	2.5	797	25	772	3.1	96.9
Total	100.0	32240	10635	21605	33.0	67.0

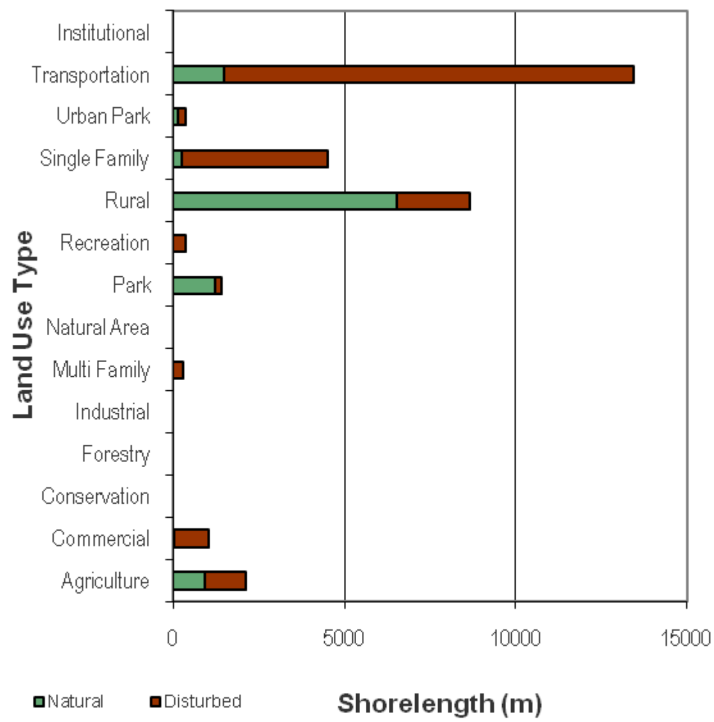

Figure 3: The total shoreline length that is natural and disturbed within each different land use category in the District of Lake Country.

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

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	6.6%	2127	936	1191	44.0%	56.0%
Commercial	3.3%	1057	28	1030	2.6%	97.4%
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	1.0%	310	0	310	0.0%	100.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	4.4%	1421	1243	178	87.5%	12.5%
Recreation	1.1%	360	6	354	1.8%	98.2%
Rural	26.8%	8655	6543	2112	75.6%	24.4%
Single Family	14.0%	4512	258	4254	5.7%	94.3%
Urban Park	1.1%	364	131	232	36.1%	63.9%
Transportation	41.7%	13433	1489	11944	11.1%	88.9%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	32239.8				

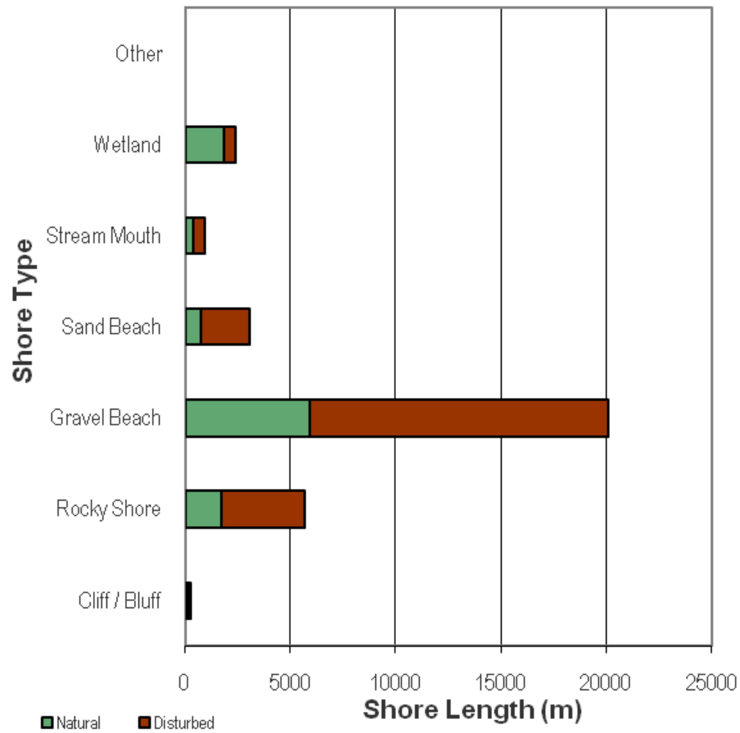

Figure 4: The total shoreline length that is natural and disturbed within each different shore type category in the District of Lake Country.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.7%	217	109	108.0	50.2%	49.8%
Rocky Shore	17.5%	5637	1721	3915.2	30.5%	69.5%
Gravel Beach	62.2%	20061	5897	14164.7	29.4%	70.6%
Sand Beach	9.5%	3058	725	2333.1	23.7%	76.3%
Stream Mouth	2.9%	920	353	566.2	38.4%	61.6%
Wetland	7.3%	2347	1829	517.9	77.9%	22.1%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	32240				

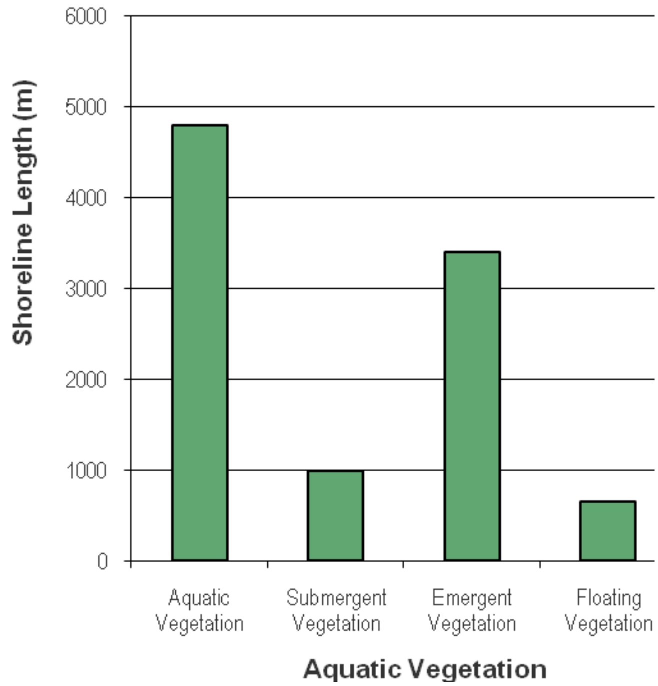

Figure 5: The total shoreline length with aquatic, submergent, emergent, and floating vegetation within the District of Lake Country.

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	14.9%	4795
Submergent Vegetation	3.1%	992
Emergent Vegetation	10.6%	3405
Floating Vegetation	2.0%	651

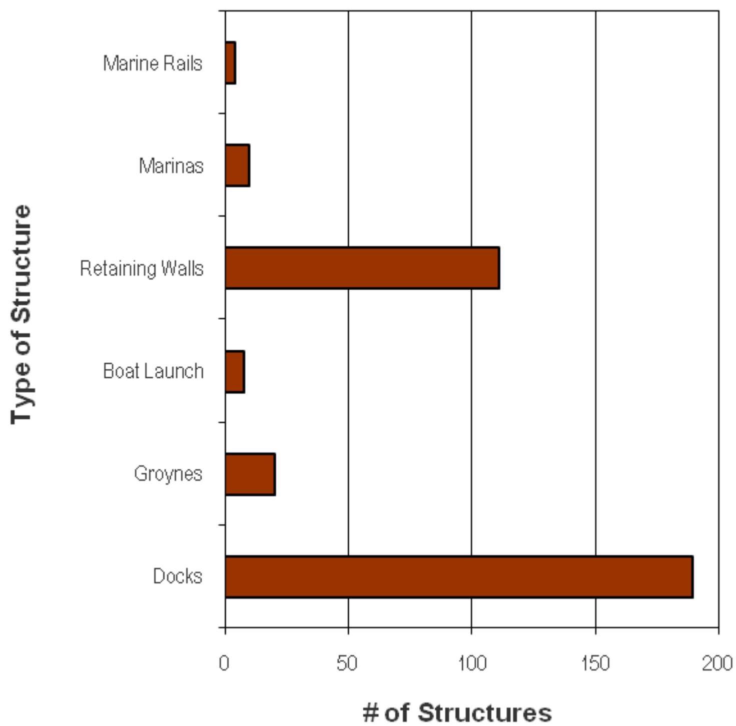

Figure 6: The total number of different modifications found within the District of Lake Country.

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

Type	Total #	# Per km
Docks	189	5.86
Groynes	20	0.62
Boat Launch	8	0.25
Retaining Walls	111	3.44
Marinas	10	0.31
Marine Rails	4	0.12

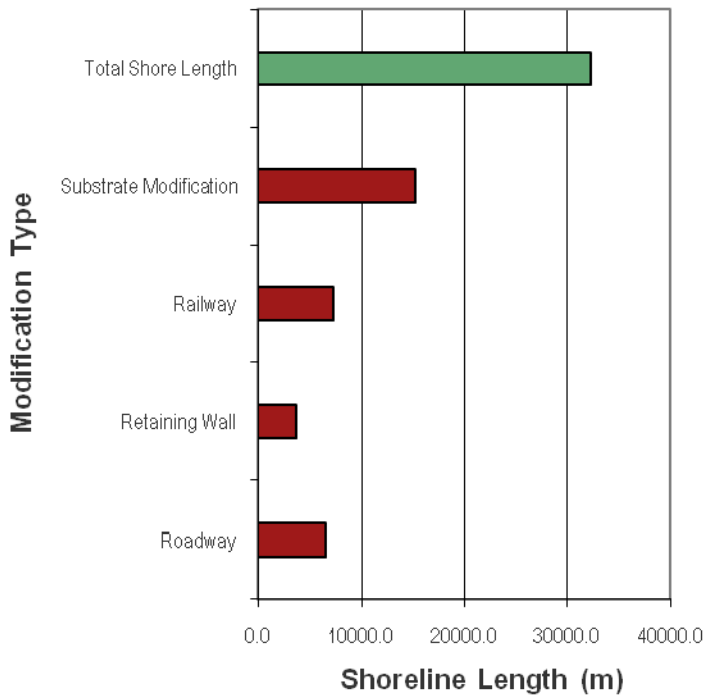

Figure 7: The total shore length of different shore modifiers found within the District of Lake Country.

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

Category	% of Shoreline	Shorelength (m)
Roadway	21%	6617.5
Retaining Wall	11%	3670.8
Railway	23%	7278.5
Substrate Modification	48%	15317.6
Total Shore Length		32239.8

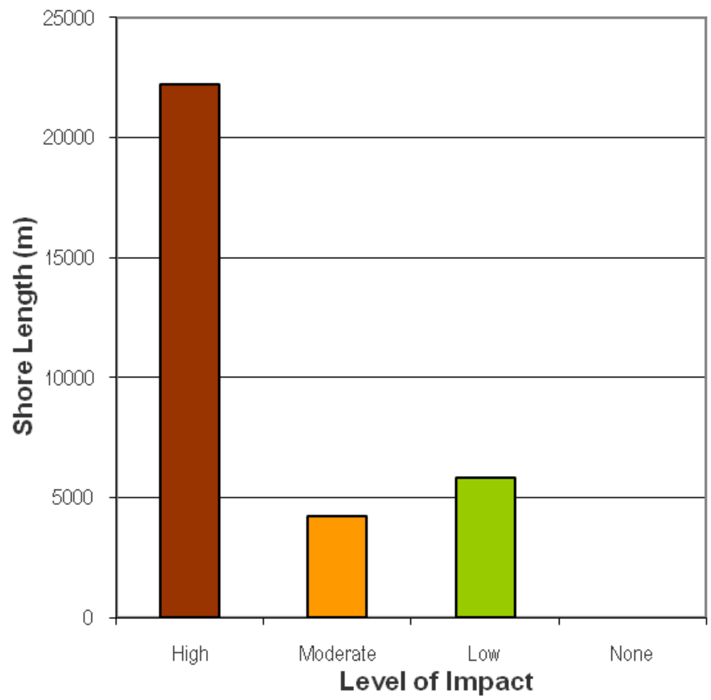

Figure 8: The Level of Impact of the shorelines within the District of Lake Country.

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, or Low in The District of Lake Country.

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	68.93%	22223
Moderate	13.04%	4203
Low	18.03%	5814
None	0.00%	0
	Total Shore Length	32239.8

APPENDIX F
District of Coldstream
Figures & Data Tables

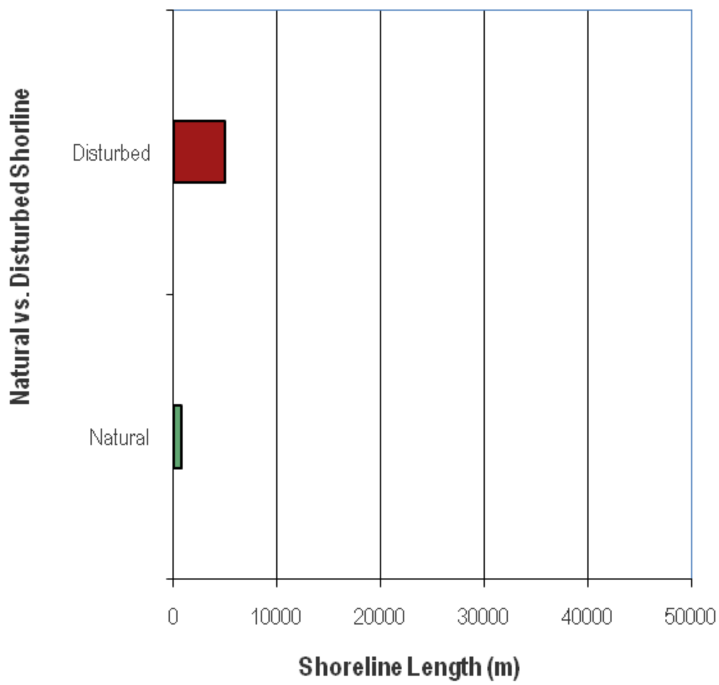

Figure 1: The total shoreline length that is natural and disturbed within the District of Coldstream.

Table 1: The total shore length of natural and disturbed shorelines along the District of Coldstream.

	% of Shoreline	Shore Length (m)
Natural	12.75%	731
Disturbed	87.25%	5000
	Total	5730.6

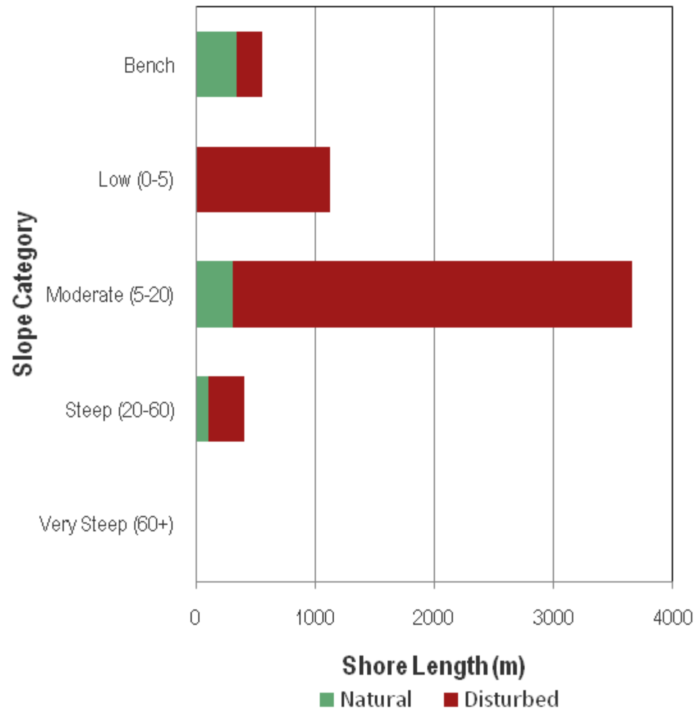

Figure 2: The total shoreline length that is natural and disturbed within each different slope category in the District of Coldstream.

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories along the District of Coldstream.

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	0.0
Steep (20-60)	7.0	402	101	302	25.0	75.0
Moderate (5-20)	63.7	3653	298	3355	8.2	91.8
Low (0-5)	19.6	1122	0	1122	0.0	100.0
Bench	9.7	553	332	221	60.0	40.0
Total	100.0	5731	731	5000	12.7	87.3

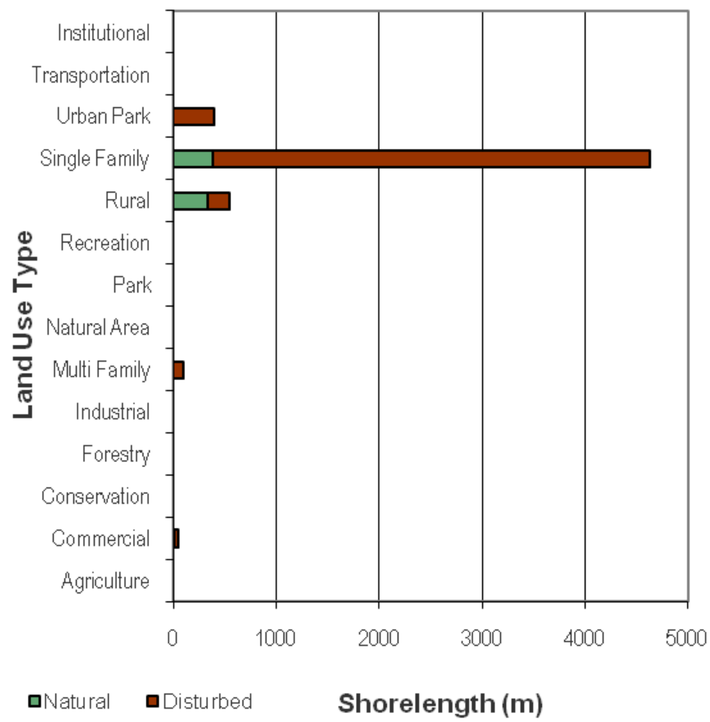

Figure 3: The total shoreline length that is natural and disturbed within each different land use category in the District of Coldstream.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around the District of Coldstream.

	% 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	0.9%	50	10	40	20.1%	79.9%
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	1.6%	94	0	94	0.0%	100.0%
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	9.7%	553	332	221	60.0%	40.0%
Single Family	80.8%	4632	389	4244	8.4%	91.6%
Urban Park	7.0%	401	0	401	0.0%	100.0%
Transportation	0.0%	0	0	0	0.0%	0.0%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	5730.6				

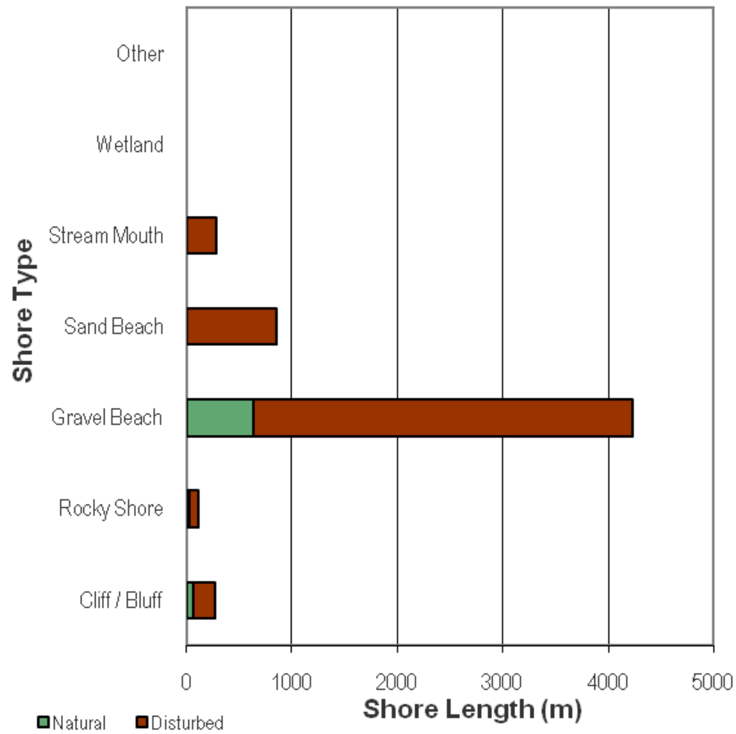

Figure 4: The total shoreline length that is natural and disturbed within each different shore type category in the District of Coldstream.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	4.6%	266	66	199.1	25.0%	75.0%
Rocky Shore	1.9%	110	27	82.5	25.0%	75.0%
Gravel Beach	73.7%	4226	637	3589.2	15.1%	84.9%
Sand Beach	14.8%	850	0	850.4	0.0%	100.0%
Stream Mouth	4.9%	279	0	278.9	0.0%	100.0%
Wetland	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Other	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Total	100.00%	5731				

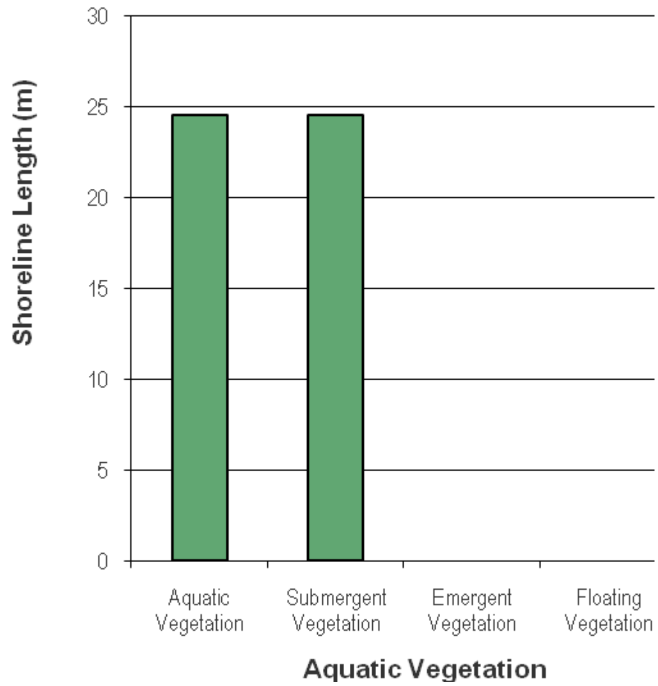

Figure 5: The total shoreline length with aquatic, submergent, emergent, and floating vegetation within the District of Coldstream.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along the District of Coldstream.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	0.4%	25
Submergent Vegetation	0.4%	25
Emergent Vegetation	0.0%	0
Floating Vegetation	0.0%	0

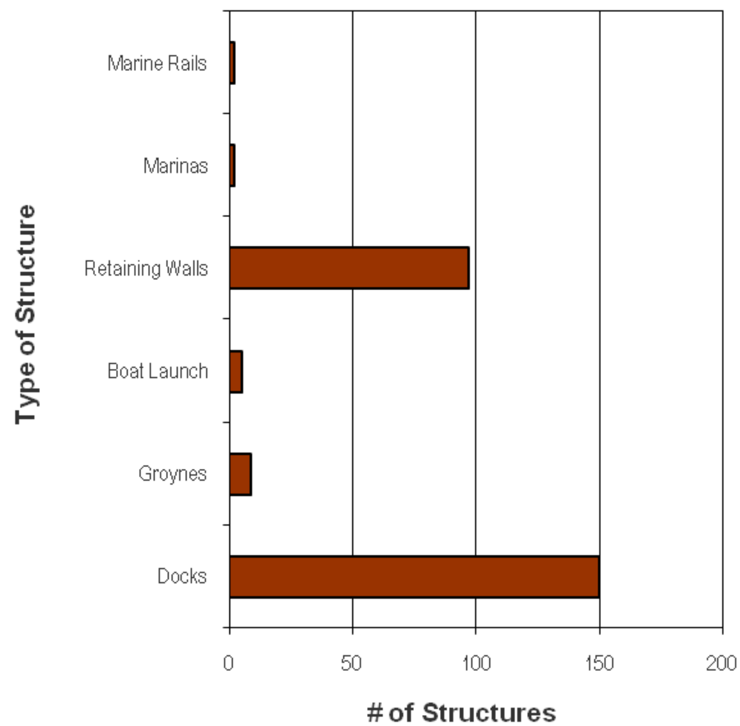

Figure 6: The total number of different modifications found within the District of Coldstream.

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

Type	Total #	# Per km
Docks	150	26.18
Groynes	9	1.57
Boat Launch	5	0.87
Retaining Walls	97	16.93
Marinas	2	0.35
Marine Rails	2	0.35

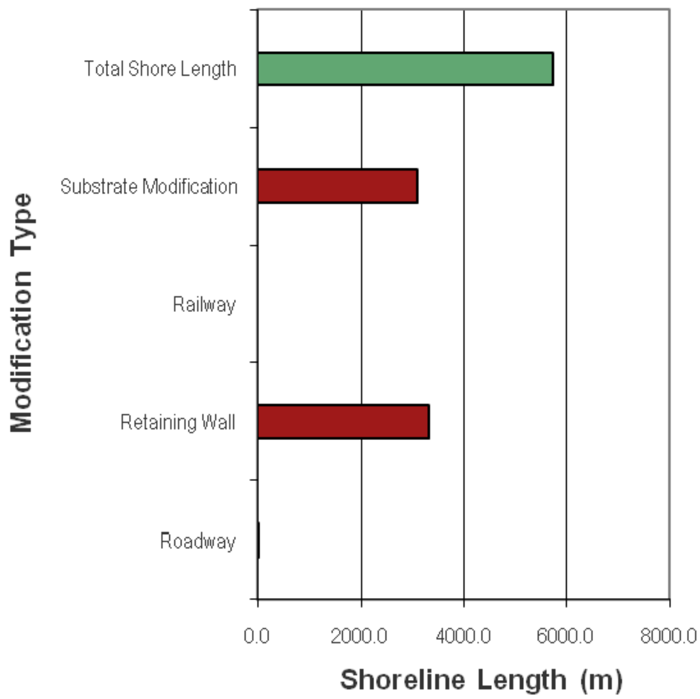

Figure 7: The total shore length of different shore modifiers found within the District of Coldstream.

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along the District of Coldstream.

Category	% of Shoreline	Shorelength (m)
Roadway	0%	4.7
Retaining Wall	58%	3333.0
Railway	0%	0.0
Substrate Modification	54%	3094.9
Total Shore Length		5730.6

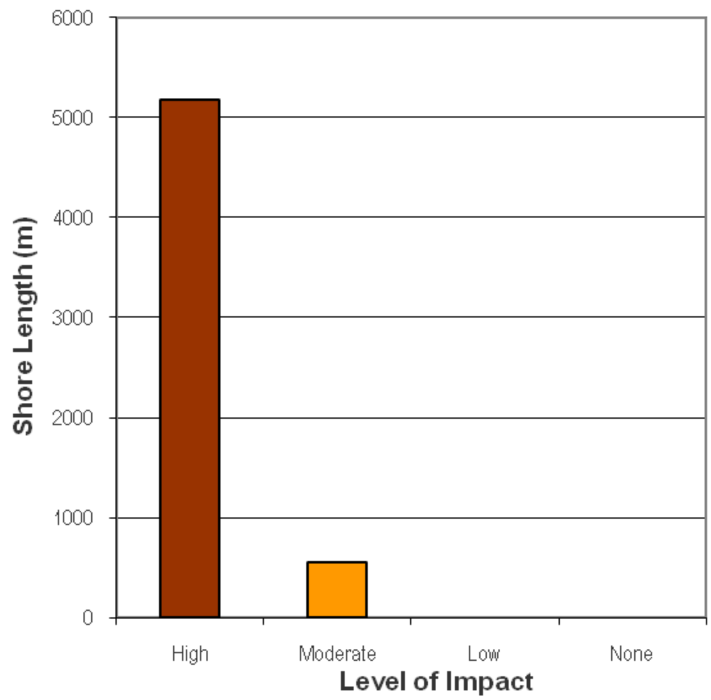

Figure 8: The Level of Impact of the shorelines within Regional District North Okanagan Electoral Area B.

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, or Low in the District of Coldstream

Level of Impact	Level of Impact (% of Shoreline)	Shore Length
High	90.35%	5178
Moderate	9.65%	553
Low	0.00%	0
None	0.00%	0
	Total Shore Length	5730.6