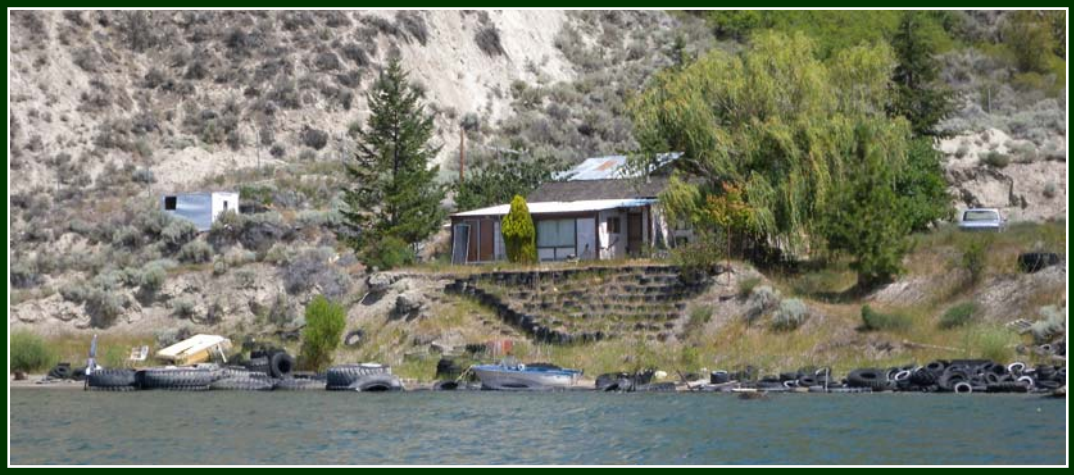
Foreshore Inventory and Mapping

OKANAGAN LAKE SOUTH



Prepared For:
Regional District of South Okanagan

Prepared By:
Ecoscape Environmental Consultants Ltd.

March, 2010
File No.: 09-440

ECOSCAPE
Environmental Consultants Ltd.

FORESHORE INVENTORY AND MAPPING

Regional District of Okanagan Similkameen

Okanagan Lake South

Prepared For:

Regional District Okanagan Similkameen
101 Martin St.
Penticton, BC
V2A 5J9

Prepared By:

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

March, 2010

File No. 09-440

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The following parties carried out fieldwork for this assessment:
Kristina Robbins, Ecosystems Biologist, Ministry of Environment
Wes Miles, Environmental Technician, Regional District Central Okanagan
Jillian Tamblyn, Environmental Planner, Regional District Okanagan Similkameen
Brad Mason, Fisheries and Oceans Canada, Community Mapping Network
Mike Ladd, Area Supervisor, BC Parks
Jerry R. Mitchell, Resource Inventory Specialist
Mark Weston, Conservation Officer
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Jillian Tamblyn, (RDOS), Kristina Robbins (MoE), Brad Mason (CMN)

The author of this report was:
Jason Schleppe, M.Sc., R.P.Bio. (Ecoscape)
Mike Sokal, PhD., Impact Assessment Biologist, Ministry of Environment, helped prepare Section 7.3.

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

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

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EXECUTIVE SUMMARY

This report summarizes the current condition of the shoreline areas of Okanagan Lake south and is intended to help relevant stakeholders manage the shoreline in a sustainable manner. The intent of this document is to provide relevant stakeholders with information to facilitate future land use planning on the Okanagan Lake South foreshore. This project is step one of a 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 are 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, Moyie and Monroe Lake and is similar to other ongoing assessments along Mabel, 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. Once objectives have been prepared, the methodology will allow managers to assess and measure whether the specific shoreline objectives have been met over time.

Okanagan Lake is one of the most significant features of our valley. The lake acts as our drinking water source, is critical habitat for numerous fish and wildlife species, and is a focus point of lakeshore communities. The south end of Okanagan has the following different local government areas which are partly responsible for managing the lake shoreline: Regional District Okanagan Similkameen, District of Summerland, District of Peachland, City of Penticton, and the Penticton Indian Band.

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

- It is estimated that 48.6% of the shoreline has a high level of impact which accounts for 46.1 km of shoreline. Areas of moderate and low impact account for 15.3% or 14.5 km and 36.1% or 34.2 km of the shoreline respectively. Impacts along the shoreline include lakebed substrate modification (e.g., infill below HWL), vegetation removal, construction of retaining walls, docks and other ladnscaping features;

- The most predominant land use around the lake was rural (32.3%), followed by natural areas in Okanagan Mountain Park shorelines (24.5 %). Transportation areas were the third most commonly observed land use type, accounting for 14.0% of the shoreline (i.e., areas along Highway 97). Single family residential areas accounted for 13.9% or 13.2 km of the shoreline;

- Wetlands were the most rare shore type around the Okanagan Lake South, accounting for only 0.9 % of the shoreline length. Significant impacts to wetland communities were apparent in many areas. The most predominant shore types around the lake are Cliff / Bluff and Gravel beach shores, which account for about 43.6% and 30.6% respectively. Rocky shores and sand beaches were found along 14.0 % and 7.8% of the shoreline respectively. Stream confluences accounted for 2.5% or 2.3 km of the shoreline; and,

- Aquatic vegetation occurs along 6.5% 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. No areas of floating vegetation were observed.

The following summarizes habitat modifications observed:

- Docks were the most common modification observed, with a total of 333 structures recorded.
- Retaining walls were the next most common modification, with a total of 212 separate structures stretching over an estimated 9.8 km (10%) 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 relatively frequent, with a total of 164 recorded.
- There were a total of 23 boat launches and 9 marinas with over 6 slips.
- Substrate modification was observed on 47% of the shore length 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 Okanagan Lake South 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. Despite these impacts, many areas around the shoreline remain in a relatively natural condition. The lake shore still supports diverse communities in rural areas, where the often steep, highly erodible soils are not readily developable. Maintaining of the rural nature of the shore line areas will help reduce future impacts along the shoreline.

Future land development should direct intensive development to previously developed areas using infill. Infill development will provide opportunities to restore shoreline features and habitat function.

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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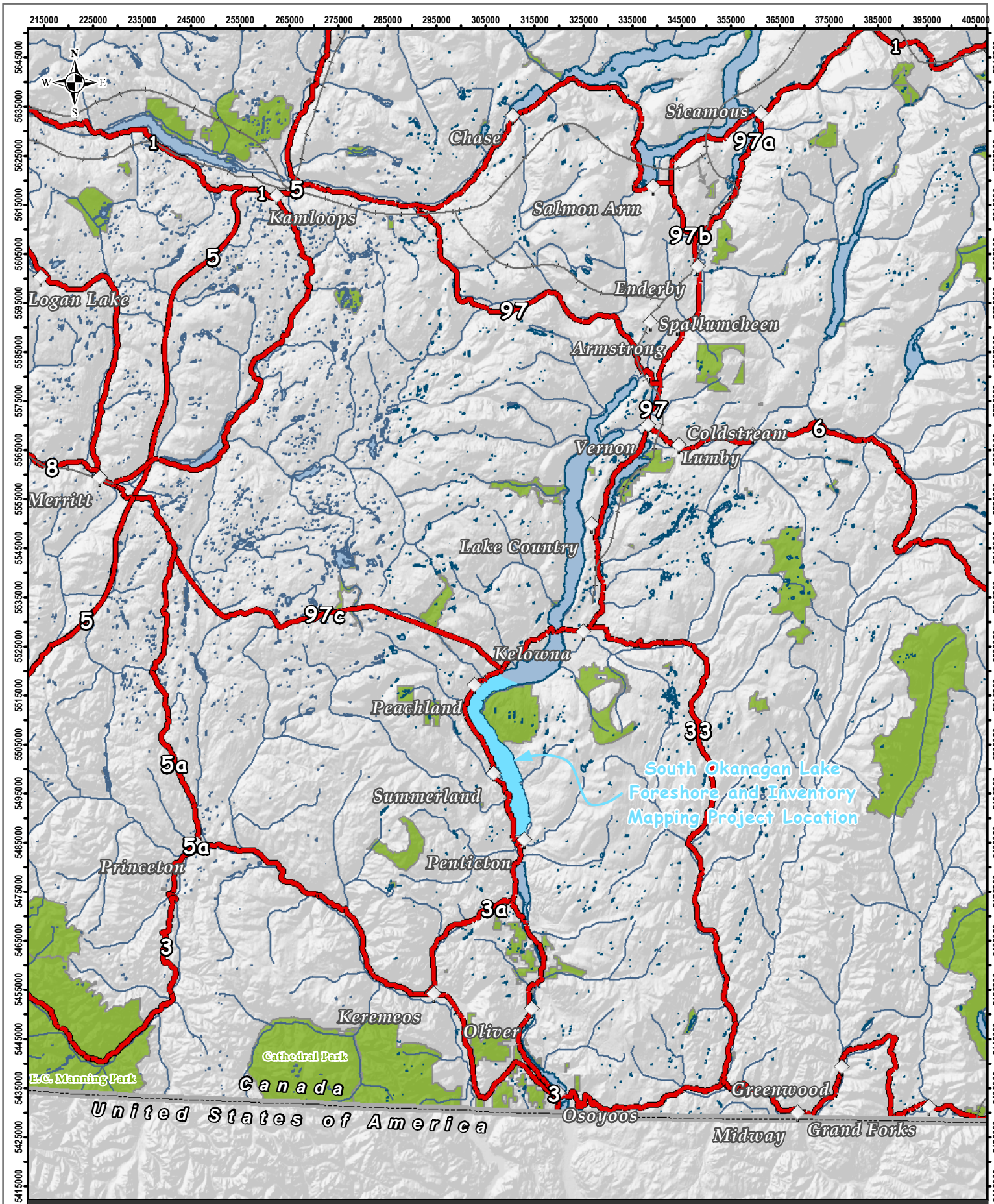
1.0 INTRODUCTION

Okanagan Lake acts is the focus of Okanagan communities, offering scenic beauty, year-round recreational opportunities, a source drinking water, and providing key habitat for numerous fish and wildlife species. This key asset of our communities has resulted in increased development pressure along the lakes shorelines. This increase in development pressure has 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 Okanagan Lake. As a result, key stakeholders including Fisheries and Oceans Canada (DFO), BC Ministry of Environment (MOE), the Regional District Okanagan Similkameen (RDOS) and Okanagan Basin Water Board (OBWB) have gathered and presented data to document the baseline conditions of Okanagan Lake South. 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 the natural environment, and social, economic and cultural values. To balance these various community values, a solid understanding of aquatic and riparian resource values, land use interests, concerns of local residents and the long-term planning objectives is required. Thus, by collecting detailed, spatially accurate information of existing shoreline habitats and their condition, more informed land use planning decisions can be made that better balance the different pressures that exist. Foreshore Inventory and Mapping (FIM) is a standard shoreline mapping methodology that was employed to map the shoreline of Okanagan Lake South. 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

Okanagan Lake South encompasses shoreline areas within the District of Peachland, District of Summerland, City of Penticton, Penticton Indian Band, and Regional District Okanagan Similkameen. The intent of this project was to inventory the shoreline of the lake 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 develop or 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.



ECOSCAPE Environmental Consultants Ltd.

Okanagan Basin WATER BOARD

RDOS OKANAGAN-SIMILKAMEEN

South Okanagan 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 its conception. These contributing partners are recognized in Appendix A (Detailed methods).

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

1. Regional District Okanagan Similkameen (RDOS) and member municipalities;
2. Okanagan Basin Water Board (OBWB)
3. Community Mapping Network (CMN), Fisheries and Oceans Canada (DFO)
4. Ministry of Environment (MoE)

2.2 Objectives

The project objectives were as follows:

1. Compile existing map base resource information for the Okanagan Lake South;
2. Foster collaboration between the local governments, DFO and the Province and utilize available expertise when possible;
3. Provide an overview of foreshore habitat condition on the lake;
4. Inventory foreshore morphology, land use, riparian condition and anthropogenic alterations;
5. Obtain spatially accurate digital video of the shoreline of the lake;
6. Provide access to the video and GIS geo-database through the RDOS 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. Providing information that can be integrated 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 22, 23, and 26, 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.

Segment 72 is the only segment that will require further data correction and manipulation. Works conducted during the summer of 2009 to update the Central Okanagan Lake areas needs to be merged and incorporated into this segment. During review and processing of the Central Okanagan Lake dataset, this segment should be reviewed and adjusted as necessary to incorporate appropriate breaks at jurisdictional boundaries and parks / private holding boundaries.

Ecoscape understands that ongoing efforts to amalgamate all FIM data within the Okanagan into one data set is ongoing. Parties using the data should ensure that they have the most recent versions of the FIM dataset for Okanagan Lake South.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for the entire shoreline and littoral zone. For the purposes of this assessment, aquatic vegetation included all plant forms and communities occurring below the lake highwater level. Although some of the plants are not truly aquatic, all are hydrophitic and contribute to fish habitat. Vegetation mapping was completed using air photos, shoreline videos, and site photographs. Aquatic Vegetation polygons are similar to Zones of Sensitivity identified by the Okanagan and Windermere projects. Vegetation communities were classified using the Wetlands of British Columbia – A guide to identification (Mackenzie and Moran, 2004) and as the descriptions below have been taken directly (or nearly direct) from this book.

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.

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.

Swamp

A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs on sites with a flowing or fluctuating, 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.

Aquatic Vegetation

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

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

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

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

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

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

3.2.2 GIS and FIM Database Management

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

- Data and photos were backed up to a computer/laptop on a daily basis;

- Photos were taken and photo logs were used to facilitate data review and interpretation;

- Air photo interpretation was completed using high resolution air photos that were 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 the Okanagan Lake south system. Data is presented graphically in the text for ease of interpretation. 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 Okanagan Similkameen - Electoral Area E
2. Regional District Okanagan Similkameen - Electoral Area F
3. District of Summerland
4. City of Penticton
5. District of Peachland
6. Penticton Indian Band

The graphical results for the entire Okanagan Lake South 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.

5.1 Biophysical Characteristics of the Lakes

Foreshore Inventory and Mapping was completed on 94,833 m (94.8 km) of shoreline on Okanagan Lake South. The total length of disturbed shoreline was 46,595 m (46.6 km) and the total length of natural shoreline was 48,238 m (48.2 km). This level of disturbance represents nearly 50% of the total shoreline length (Figure 2). Areas of a lower gradient tend to have the highest level of disturbance, likely because they are easier to develop. In some areas, historical disturbances were naturalizing.

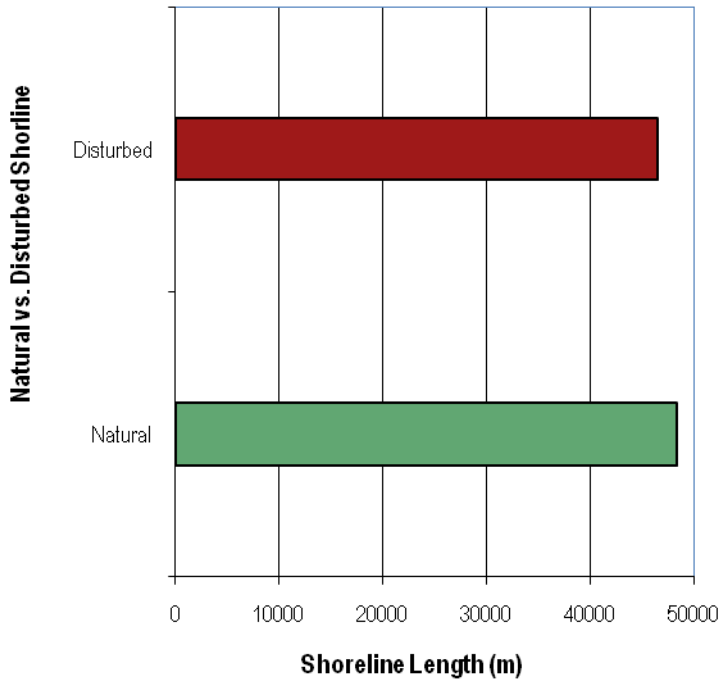


Figure 2 The total shoreline length that is either natural or disturbed on Okanagan Lake South.

Areas of a lower gradient tended to have the highest level of disturbance, likely because they are easier to develop. Benches and Low and Moderate gradient areas had disturbance along approximately 59.6% (5.3 km), 81.7% (33.1 km) and 50.3% (3.2 km) of their respective shore lengths. Along steeper shorelines, disturbance only occurred along 6.8% (2.0 km) and 33% (2.8 km) of the steep and very steep shore lengths respectively.

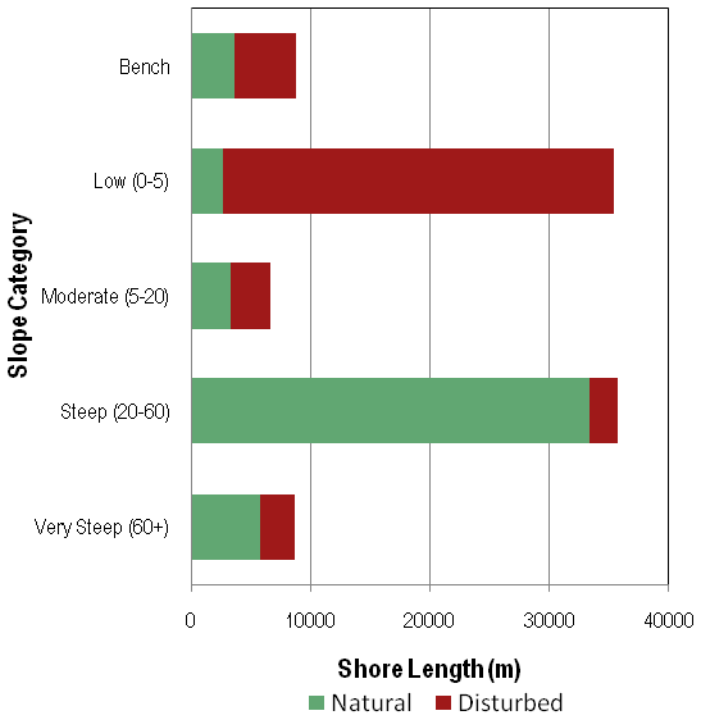


Figure 3 The total shoreline length that is either natural or disturbed within the different slope categories of Okanagan Lake South.

Rural areas were the most prevalent land use along the Okanagan Lake South shoreline, representing approximately 32.3% of the shoreline or 30.6 km. Within these rural areas, the shoreline was generally 73.2% natural and 26.8% disturbed. Natural park areas were the next most prevalent land use observed, accounting for 24.5% of the shoreline or 23.1 km. Within natural park areas, the shoreline was approximately 95.6% natural and 4.4% disturbed. Transportation (roads and rails) was the next most prevalent land use, occurring along 14.0% of the shoreline or 13.2 km. Transportation areas were highly disturbed, with 96.8% of their shore length disturbed due to factors such as lake fill. Single family residential areas represented approximately 13.1 km (13.9%) of shoreline. Within these residential areas, over 92.3% of the shoreline was disturbed.

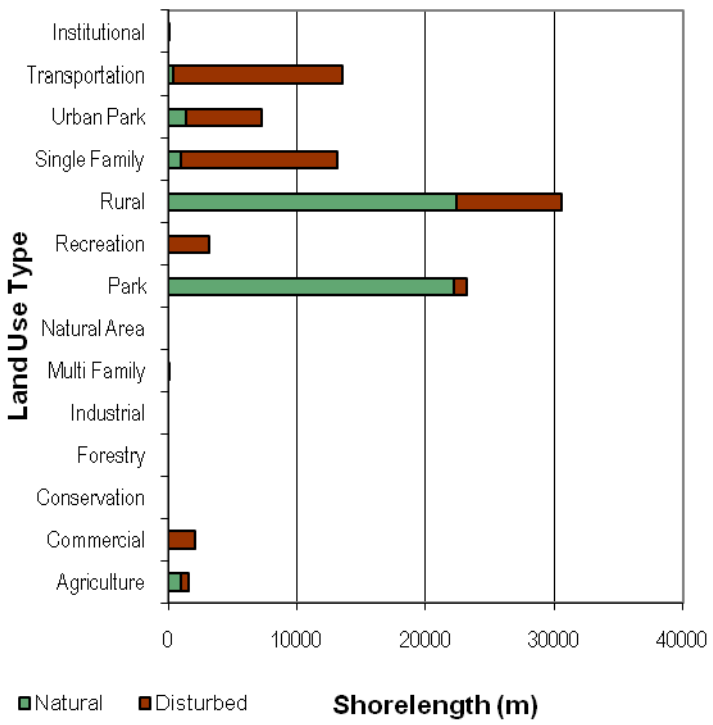


Figure 3 presents the natural and disturbed shore length by the different types of land use types occurring around Okanagan Lake South.

The most predominant shore types observed were cliff/bluff and gravel beach shores, which accounted for 43.6% (~41.3 km) and 30.6% (~28.9 km), respectively. Cliff/bluff shorelines were only disturbed along 35% of the length, or approximately 14.4 km. Gravel beaches had a higher level of disturbance, with approximately 75.6% or 21.9 km of the shore length being disturbed respectively. Rocky shores were the next most prevalent shore type, for about 14.0% of the shoreline, or approximately 13.2 km. Rocky shore types were relatively natural, with 97.6% 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. Sand shore types and stream confluences were not very common and represented only 7.8% and 2.5% of the total shoreline length, respectively. The remaining shoreline areas were natural wetlands and other shore types, which accounts for 0.9% and 0.6% of the shoreline respectively.

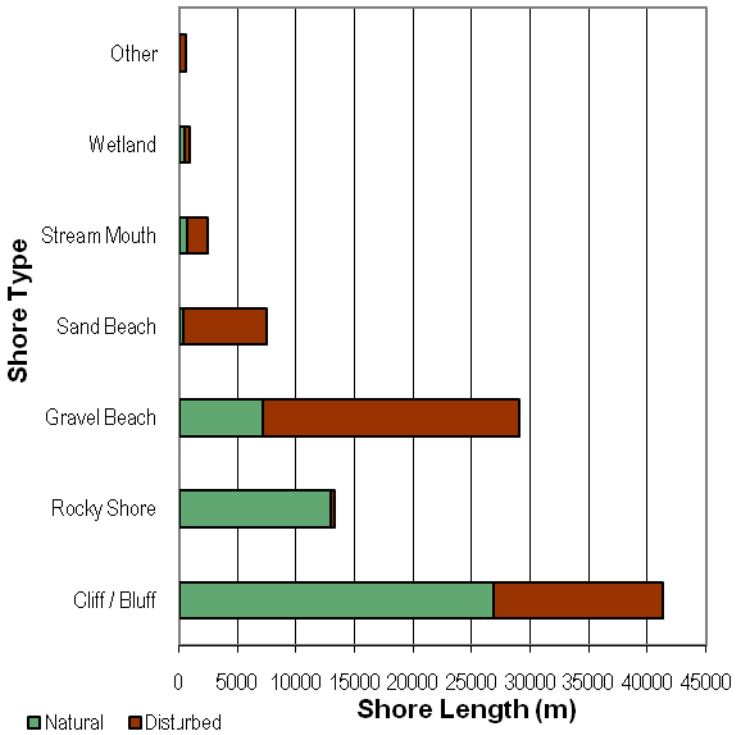


Figure 4 presents the length of natural and disturbed shoreline along each of the different shore types on Okanagan Lake South.

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 6.1 km of the shoreline that has aquatic vegetation, which represents approximately 6.5% of the total shoreline length. The total area of both dense and sparsely vegetated areas with aquatic vegetation (floating, emergent, or submergent) is 98,643 m^2. Nearly 100% vegetation that was observed was either emergent shrubs or grass like vegetation and this emergent type of vegetation accounted for 6.5% of the Okanagan Lake South shoreline. Detailed mapping of submergent vegetation was difficult due to the large littoral areas observed. It is highly probable that there is additional submergent vegetation areas that have not been inventoried as part of this assessment. Until such a time as a more detailed inventory is conducted, the Ministry of Environment has digitized historical surveys that were completed in the 1970's.

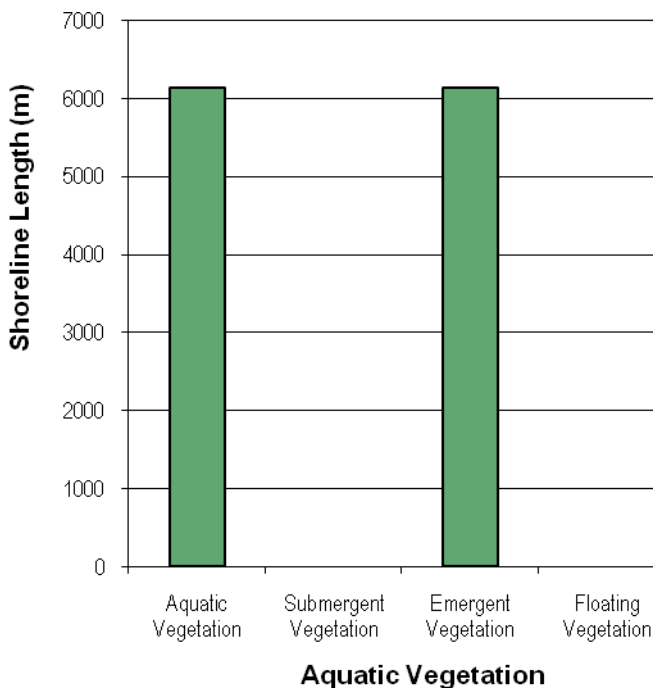


Figure 5 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake South.

Docks were the most commonly observed type of shoreline modification. There were a total of 333 docks on Okanagan Lake South. Retaining walls were the second most common modification observed, with 212 retaining walls being observed. Groynes were relatively frequent occurrences on the lake, with a total of 164 observed. There are a total of 9 marinas with greater than 6 boat slips and 23 boat launches. There was a total of 8 marine rails observed on Okanagan Lake South. The above summarizes the current structures that occur on, over, and around Okanagan Lake South.

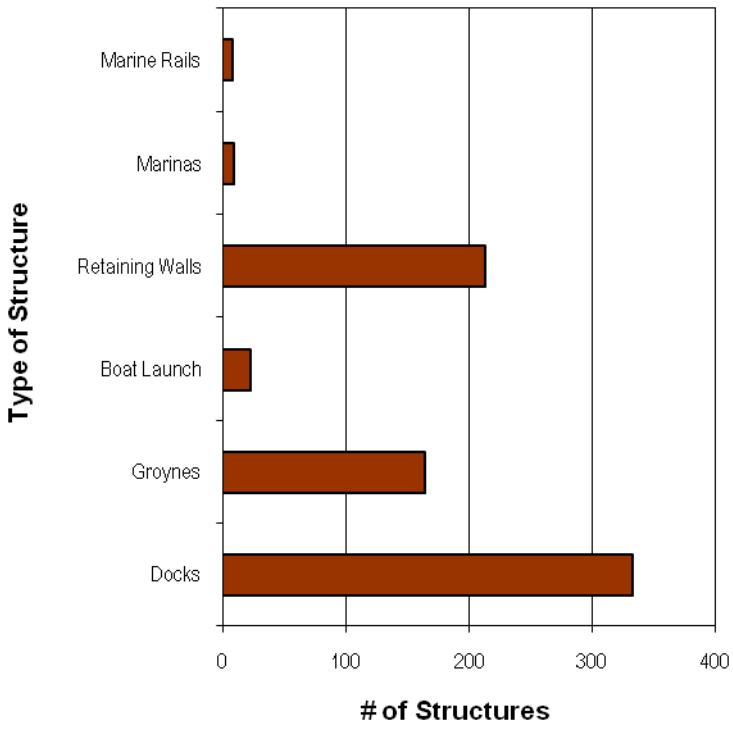


Figure 6 presents the total number of different shoreline modifications that occur around Okanagan Lake South.

The percentage of the shoreline that was impacted by transportation (roads, railways), retaining walls, and substrate modification was recorded to allow an estimation of the approximate shoreline length that has been affected by these different mechanisms (Figure 7). By far, substrate modification was the most substantial impact that was observed along the shoreline. In total, it is estimated that 47% or 44.3 km of shoreline has experienced some form of substrate modification; whether this is beach grooming or highway fills. Transportation impacts from roadways were the next most prevalent modification and were present along 19% or 17.9 km of shore line. Retaining walls have also had a substantial impact to the shoreline and it is estimated that 10% or 9.8 km of 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).

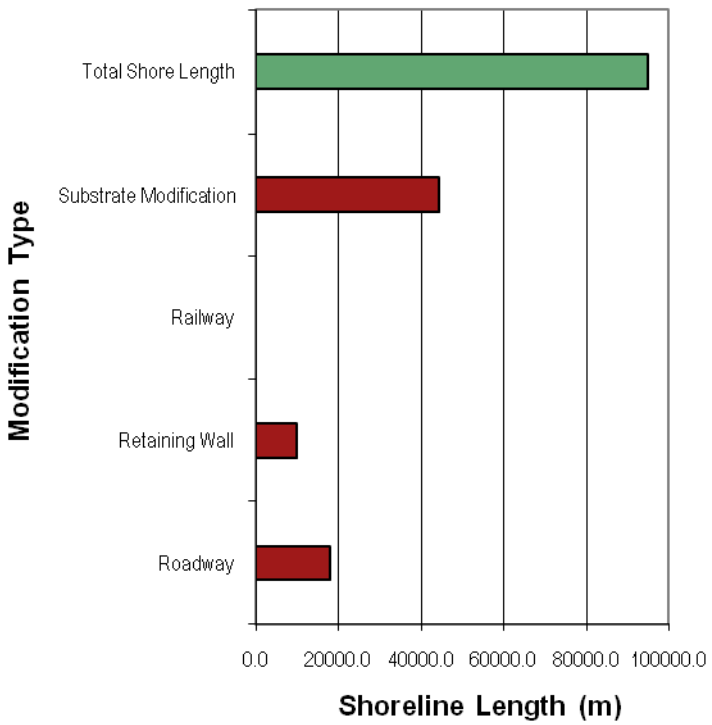


Figure 7 presents the total shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake South.

The foreshore modifications by the different mechanisms described above have resulted in a high level of impact around approximately 48.7% or 46.1 km of the shoreline. Areas of moderate and low impact account for about 15.26% (14.5 km) and 36.1% (34.2 km) of the shoreline respectively.

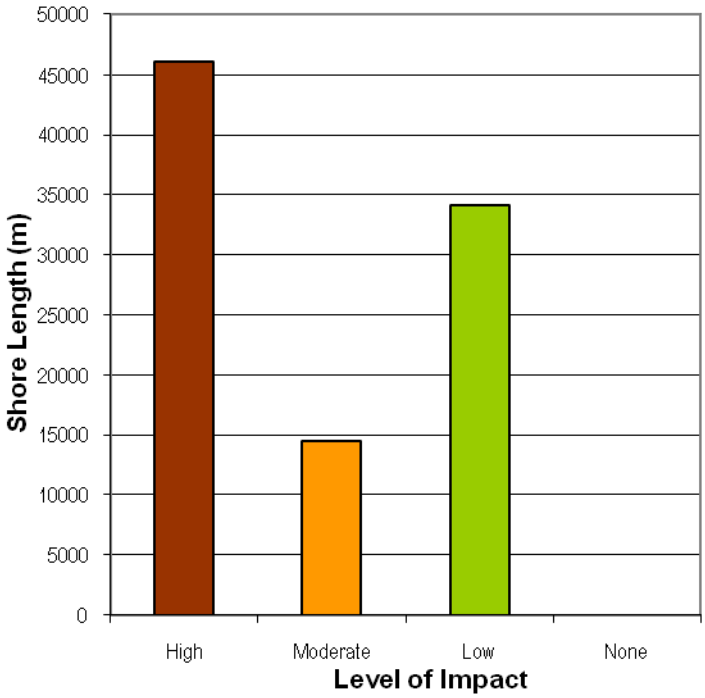


Figure 8 presents the level of impact (High, Moderate, Low, or None) observed along Okanagan Lake South.

5.2 Summary of Foreshore Modifications

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

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

- Retaining walls were documented in nearly all developed areas. Retaining walls were constructed out of varying materials. In some instances, substrates from the lakebed were used to construct the walls. It is probable that some of the retaining walls constructed around the lake were not required to protect the shore from erosion and have been constructed purely for aesthetic purposes (i.e., landscaping). Thus, construction of some of these walls could have been avoided. In many cases, shoreline protection could have been achieved by utilizing bioengineering approaches to help mitigate impacts of the walls. 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. 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 Okanagan Similkameen - Electoral Area E

The RDOS Electoral Area E shoreline areas generally include most of the agricultural areas on silt bluffs to the north the City of Penticton through Naramata to Okanagan Mountain Park. The shoreline is predominantly rural, with 70.3% or 11.8 km of the shoreline represented by this land use type either north or south of Naramata. The next most common land use type observed was single family, which accounted for 18.8% or 3.1 km of the shore length and occurred mostly within Naramata. Within rural areas, the shoreline was 82.3% natural, whereas in the single family land use areas the shore length was only 9.9% natural.

The steep, often unstable silt bluffs along this shoreline area provide a buffer for many areas around Okanagan Lake. The steep cliff bluff areas accounted for over 56% of the shore length. These steep, coupled slopes have made significant development of these areas difficult. Gravel beach areas were the next most common shore type, accounting for 35% of the shore length.

Key modifications observed along the RDOS Electoral Area E shorelines included 67 docks, 59 groynes, 48 retaining walls and 1 marina.

5.3 Regional District Okanagan Similkameen - Electoral Area F

The RDOS Electoral Area F shoreline occurs in two distinct locations. To the south, the shoreline area of Electoral Area E is mostly highway fill and significantly impacted by transportation corridors, which accounted for nearly 38.5% if the shoreline (5.9 km). Properties only exist on the opposite side of the highway, and there did not appear to be any foreshore access for these properties. To the north, there are typically steep, cliff / bluff shore lines, that are more rural and natural in character. These shorelines areas have open pine woodland and grassland areas and an associated narrow band of riparian at the toe of the cliff / bluff slope in most areas. There is 28.6% of the shoreline remaining in natural conditions, with 71.4% being disturbed, along these northern shoreline areas of Electoral Area F.

Rural development is the most common type observed in Electoral Area F and accounted for 30% or 4.5 km of shoreline. In these rural areas the shoreline remains 57.7% natural. Single family development areas accounted for 10.7% of the shoreline and these areas were 95% disturbed.

Key modifications that were documented in Electoral Area F shoreline area include 52 docks, 16 groynes, 48 retaining walls, and no marinas. The retaining walls documented account for approximately 11% or 1.6 km of the shoreline in RDOS Electoral Area E. Substrate modification was observed along 83% or 3.6 km of the shoreline. Numerous old roadway segments were responsible for the documented substrate modification observed and many of these areas are naturalizing.

5.3 District of Peachland

The shorelines of Okanagan Lake south within the District of Peachland have been heavily impacted, with only 14% or 1.7 km of the shoreline remaining in a relatively natural condition. The shorelines consist predominantly of Transportation (41.5%), Recreation (24.9%), and Rural areas (17.4%). Many of the areas classified as transportation are currently also acting as park areas; however, this assessment did not treat these areas as formal parks and classified them as transportation. Almost all natural areas remaining in Peachland exist within the rural shoreline areas. Remaining land uses along the shoreline include single family residential areas (9.2%), urban parks (3.7%), and commercial areas (2.8%). Shore types in Peachland are generally lower gradient (68.5%), gravel beaches (74.9%).

Key modifications observed along Peachland shoreline areas included 52 docks, 14 groynes, 37 retaining walls, and 4 marinas with more than 6 slips. Substrate modification was extensive, occurring along 68% of the shoreline. Roadways were also documented along 68% percent of the shore length. Finally, retaining walls occurred along 14% of the shoreline or for approximately 1.6 linear km.

5.3 District of Summerland

The District of Summerland consists predominantly of Single Family residential areas, which account for 37.1% of the shore line. Within these single family areas, the shoreline is only 4.3% natural or 0.2 km indicating there are only a few residual natural features remaining. Rural areas account for 22.9% of the shoreline areas and remain approximately 60% natural. Other key land uses include urban parks (13.3%), transportation corridors (12.9%), agriculture (4.6%) and natural parks areas (4.9%).

Key modifications within the District of Summerland include 113 docks, 50 retaining walls, 39 groynes, 8 boat launches, and 2 marinas with over 6 slips. Substrate modification was very prevalent, and observed along 78% of the Summerland shoreline. Retaining walls and roadways also accounted 16% (2.5 km) and 14% (2.1 km) of the shoreline respectively.

5.3 City of Penticton

The City of Penticton occurs along the southern most 9 km of the Okanagan Lake shoreline. Approximately 53% of the shoreline remains natural, with most of the natural areas occurring along steep shoreline areas on the eastern side of the lake. The shoreline is approximately 47% disturbed, with most of these areas occurring in the southern most part of the lake around Penticton Creek.

Rural areas are the most predominant shore type, accounting for 53.8% of the shoreline. Rural areas occur mostly on the eastern side of the lake, along steep silt bluff shoreline areas which has resulted in 87.5% of the shoreline remaining in natural condition. Urban parks account for the next most predominant shore type, accounting for 24% or 2.4 km of shoreline. Commercial development accounts for approximately 14.3% of the shoreline, or 1.3 km. Commercial areas are 100% disturbed. Some restoration efforts can be attempted in these commercial areas however. Single family areas of Penticton account for 7.9% of the shoreline and within these areas 32.3% of the shoreline remained natural.

There were a total of 16 docks, 10 groynes, 3 boat launches, 13 retaining walls, and 2 marinas within the City. Substrate modification was apparent along 41% or 3.8 km of shoreline. Retaining walls were present along 13% or 1.2 km of shoreline.

5.3 Penticton Indian Band

The Penticton Indian Band is a small section of shoreline, located in the south end of the lake. Within this short 980 m shoreline area, 100% of the shoreline has been modified. The shoreline has been 100% developed, and consists urban parks and single family development.

6.0 KEY MANAGEMENT CONSIDERATIONS

6.1 Fisheries and Wildlife Overview and Considerations

Okanagan Lake contains many important fish species that provide economic benefits to residents of the Okanagan. 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) and their life history requirements. For other species, knowledge is much more limited (e.g., burbot, whitefish, etc.). Coupled with this, there is only a rudimentary understanding of how land development impacts (e.g., is burbot spawning affected by dock density, etc.) each of the different fish species and life stages within Okanagan Lake. The combined lack of knowledge, makes predicting how development affects populations and their habitats difficult (i.e., you can't manage for a species or population if you do not know where they have key habitat characteristics such as spawning).

The species that has been most often studied is kokanee, a land locked sockeye salmon. This species has two specific life history strategies, including shore and stream spawning populations that rely upon Okanagan Lake. Other important species (e.g., rainbow trout, white fish, burbot, etc.) have not been as extensively studied and less is known about important areas that they require to complete their life cycles. Mapping initiatives have identified key kokanee spawning locations and efforts are ongoing to keep detailed records of spawning locations using GIS.

Due to the lack of knowledge surrounding specific species habitat areas and requirements in Okanagan 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.

The following were three of 8 items that were identified as key fisheries management issues for Okanagan Lake (Redfish Cosulting Ltd., 2007):

1. Foreshore development and protection of kokanee shore spawning habitat;
2. Low fish flows in the few tributaries of the lake;
3. Riparian habitat protection in the face of growing development;

As the list suggests, land development has played a key role in shaping the fishery in Okanagan Lake. The data collected during this assessment now provides a baseline summary of land development around Okanagan Lake South, corroborating key fisheries management concerns.

Another key concern within Okanagan Lake is the Western Ridges Mussel. Recent surveys by the Ministry of Environment have identified several key areas where this species is known to occur. 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 shore line areas of Okanagan Lake South 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. Proposed management objectives in the Okanagan are to integrate ongoing terrestrial assessments (e.g., SEI/TEM) 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. Ideas currently being considered include ways to integrate the different terrestrial / wildlife (i.e., SEI/SER) 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 quantity in Okanagan 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 key 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 Okanagan Lake South includes 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 (which are rare), potential losses of critical grebe nesting areas (in the north), and many others. Other key quantity issues are maintenance of fish flows in important spawning tributaries during low year or drought periods.

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. This project has provided stakeholders with the information to begin to measure and track change overtime using a spatial approach. This will play a key role in understanding future change because there is now an ability to understand trends in land use development types. A detailed cumulative review of FIM projects completed to date would could help guide management decisions and should be considered in the future because it may facilitate a cumulative effects assessment.

A review such as this would provide a key summary of land use and shoreline interactions and is a key step forward to better shoreline management.

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. The minimum requirements for protection of lake features is the Riparian Areas Regulation, which has already been integrated in most local municipalities. 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. Current work in the UK indicates that even small habitat islands (i.e., wildlife friendly landscaping) is beneficial to wildlife resources, supporting the incorporation of habitat restoration initiatives into any re-development process (Davies *et al*, 2009). All levels of government should participate in shore line restoration projects during development projects where feasible.

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. There are numerous best management practices that have been developed, which should be incorporated into any land development planning process. Site specific assessment and incorporation of buffers from core habitats is required. 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.).

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 BMPs should be developed that are consistent with standard practices 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, including numerous examples of provincial Water Act violations. An increase in compliance and enforcement monitoring is required because current practices do not appear to be working effectively (i.e., there were numerous, recent examples of construction inconsistent withh BMPs, active infill and beach grooming observed, etc.).

   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. Many SHIM initiatives have been completed in the south Okanagan and efforts should be kept up until all important watercourses are mapped. 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. **Wetlands are extremely productive and important components of our ecosystems and these features should be inventoried**. Numerous low flood and mid flood benches and shore marshes were mapped during this survey. Detailed Wetland Inventory and Mapping (WIM) of these features are recommended. Detailed mapping of terrestrial wetlands is also important to ensure that linkages between foreshore and upland areas are achieved.

3. **Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM) are useful terrestrial mapping tools and these inventories should be completed**. These assessments help land managers identify sensitive terrestrial zones which can be integrated into the FIM, SHIM, and WIM GIS datasets. Many of the areas in the South Okanagan have already been mapped. However, there are still a few areas where mapping has not yet been completed and these areas should be mapped as soon as possible. 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 shoreline areas. These areas were typically areas that had well-established native vegetation or relatively natural shorelines. Development applications proposed in these "islands" of higher habitat quality should avoid disturbance to these "islands" as much as possible. A survey of these small "islands" would clarify which segments contain "islands" and would help aid planning objectives. This could form part of a riparian mapping exercise.

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

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

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

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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

OKANAGAN LAKE SOUTH

FORESHORE INVENTORY AND MAPPING
FIGURE BINDER

APPENDIX A

Foreshore Inventory and Mapping Methodology

APPENDIX B
Okanagan Lake South Data Tables

Table 1: The total shore length of percentage of shore length along Okanagan Lake South

	% of Shoreline	Shore Length (m)
Natural	50.99%	48359
Disturbed	49.01%	46475

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

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	9.0	8571	5740	2831	67.0	33.0
Steep (20-60)	37.6	35654	33318	2336	93.4	6.6
Moderate (5-20)	6.9	6538	3251	3287	49.7	50.3
Low (0-5)	37.3	35382	2537	32844	7.2	92.8
Bench	9.2	8689	3513	5176	40.4	59.6
Total	100.0	94834	48359	46475	51.0	49.0

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

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	1.7%	1633	949	685	58.1%	41.9%
Commercial	2.2%	2073	17	2056	0.8%	99.2%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.1%	49	0	49	0.0%	100.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	24.5%	23193	22172	1022	95.6%	4.4%
Recreation	3.4%	3228	15	3213	0.5%	99.5%
Rural	32.3%	30612	22394	8218	73.2%	26.8%
Single Family	13.9%	13171	1019	12152	7.7%	92.3%
Urban Park	7.7%	7298	1373	5925	18.8%	81.2%
Transportation	14.3%	13528	421	13107	3.1%	96.9%
Institutional	0.1%	48	48	0	0.0%	0.0%
Total	100.0%	94833.6				

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	43.6%	41301	26836	14465.5	65.0%	35.0%
Rocky Shore	14.0%	13263	12939	323.9	97.6%	2.4%
Gravel Beach	30.6%	28987	7070	21916.9	24.4%	75.6%
Sand Beach	7.8%	7434	347	7086.9	4.7%	95.3%
Stream Mouth	2.5%	2389	675	1714.2	28.2%	71.8%
Wetland	0.9%	885	492	392.3	55.7%	44.3%
Other	0.6%	575	0	574.8	0.0%	100.0%
Total	100.00%	94834				

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	6.5%	6137
Submergent Vegetation	0.0%	0
Emergent Vegetation	6.5%	6137
Floating Vegetation	0.0%	0

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

Type	Total #	# Per km
Docks	333	3.51
Groynes	164	1.73
Boat Launch	23	0.24
Retaining Walls	212	2.24
Marinas	9	0.09
Marine Rails	8	0.08

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

Category	% of Shoreline	Shore Length (m)
Roadway	19%	17940.7
Retaining Wall	10%	9830.3
Railway	0%	0.0
Substrate Modification	47%	44311.7
Total Shore Length		94833.6

APPENDIX C
RDOS Electoral Area E
Figures & Data Tables

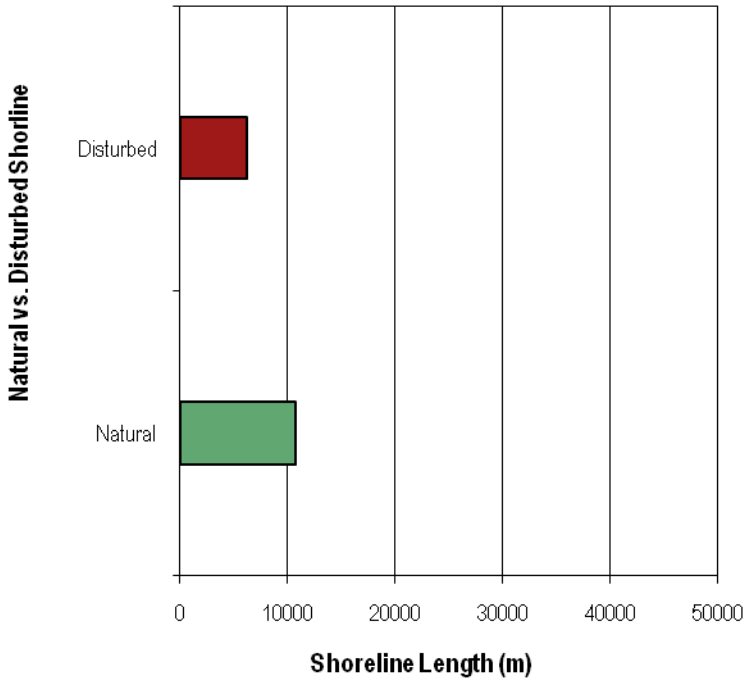

Figure 1: The total length of shoreline that is either natural of disturbed along Okanagan Lake within RDOS Electoral Area E

Table 1: Natural and Disturbed shore line areas in RDOS Electoral Area E

	% of Shoreline	Shore Length (m)
Natural	63.39%	10723
Disturbed	36.61%	6193
	Total	16916.0

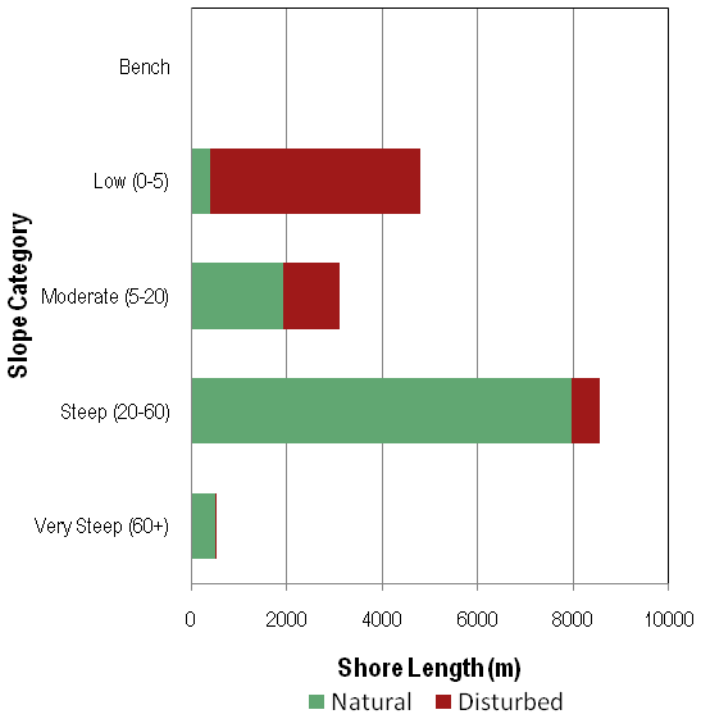

Figure 2: The total natural and disturbed length of shoreline associated with different slopes along Okanagan Lake within RDOS Electoral Area E

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

Slope	% of Total Shore Length	Total Shore Length	Shore Length Natural	Shore Length Disturbed	% Natural	% Disturbed
Very Steep (60+)	2.8	482	477	5	99.0	1.0
Steep (20-60)	50.5	8547	7949	598	93.0	7.0
Moderate (5-20)	18.3	3096	1921	1175	62.0	38.0
Low (0-5)	28.3	4791	376	4415	7.8	92.2
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	16916	10723	6193	63.4	36.6

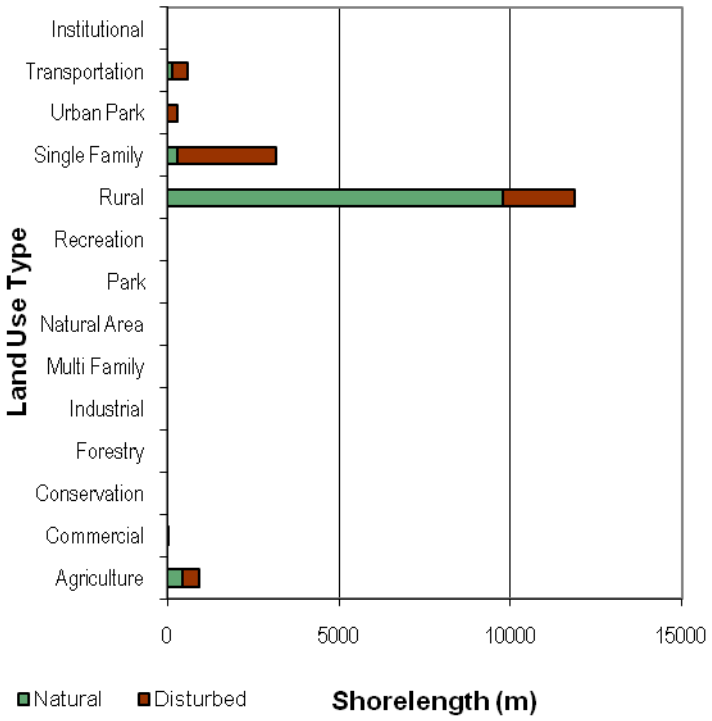

Figure 3: The total natural and disturbed length of shoreline associated with different land uses along Okanagan Lake within RDOS Electoral Area E

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South within RDOS Electoral Area E

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shorelength	% Natural	% Disturbed
Agriculture	5.4%	919	449	471	48.8%	51.2%
Commercial	0.2%	33	2	31	5.0%	95.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	0.0%	0	0	0	0.0%	0.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	70.3%	11886	9781	2105	82.3%	17.7%
Single Family	18.8%	3183	315	2867	9.9%	90.1%
Urban Park	1.8%	313	13	300	4.2%	95.8%
Transportation	3.4%	583	163	420	28.0%	72.0%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	16916.0				

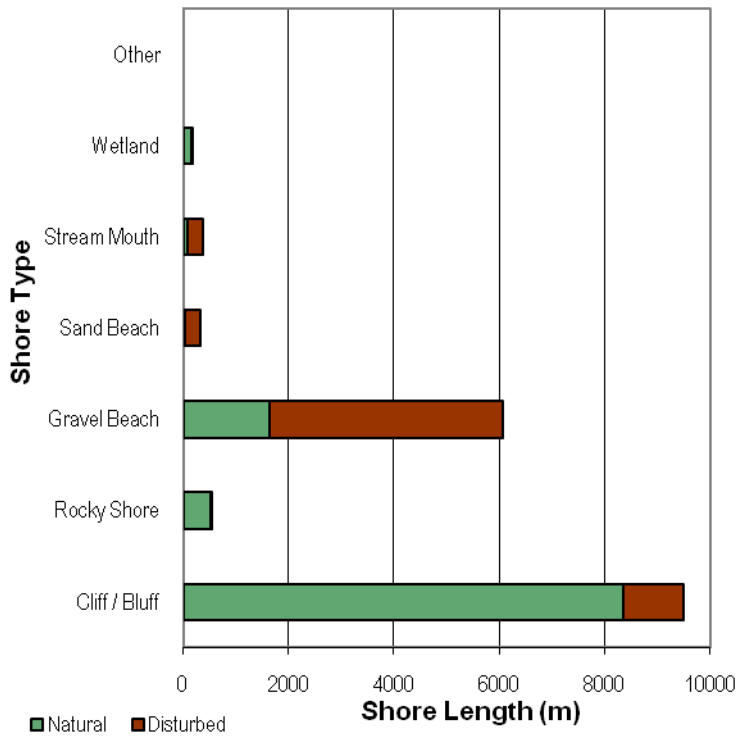

Figure 4: The total natural and disturbed length of shoreline associated with different shore types along Okanagan Lake within RDOS Electoral Area E.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	56.1%	9491	8336	1154.6	87.8%	12.2%
Rocky Shore	3.0%	508	502	5.1	99.0%	1.0%
Gravel Beach	35.8%	6063	1640	4423.4	27.0%	73.0%
Sand Beach	1.9%	327	16	310.3	5.0%	95.0%
Stream Mouth	2.1%	358	75	282.5	21.1%	78.9%
Wetland	1.0%	170	153	17.0	90.0%	10.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	16916				

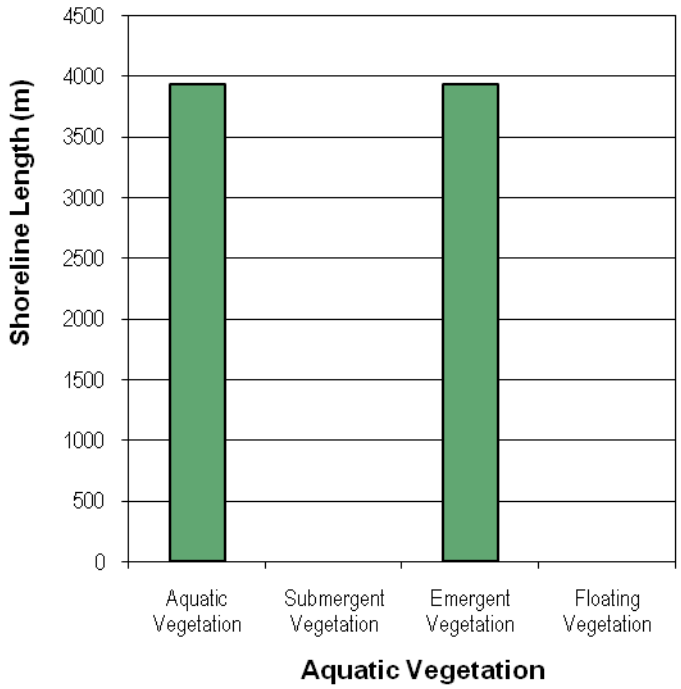

Figure 5: The total length of shoreline with aquatic vegetation (Total, Submergent, Emergent, and Floating) along Okanagan Lake within RDOS Electoral Area E.

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	23.3%	3942
Submergent Vegetation	0.0%	0
Emergent Vegetation	23.3%	3942
Floating Vegetation	0.0%	0

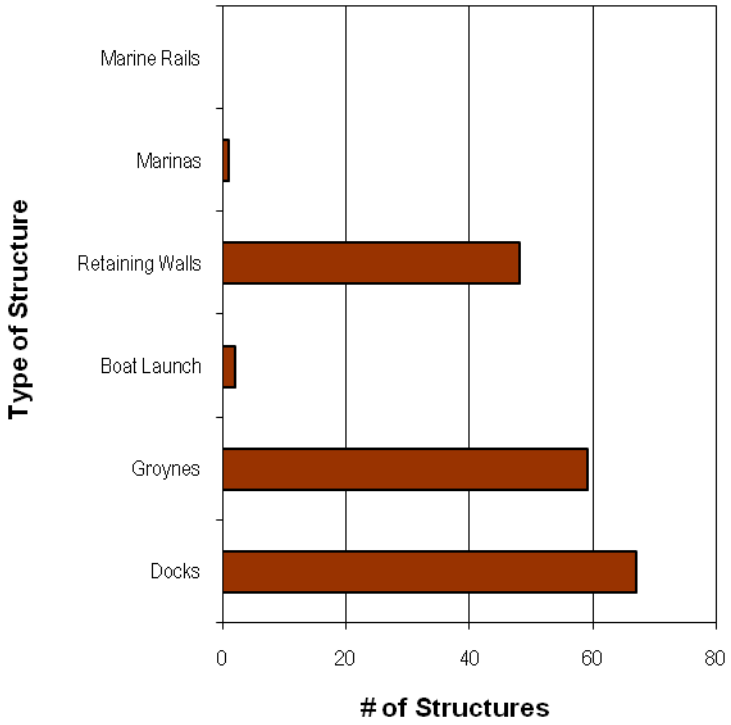

Figure 6: The number of different modifications along Okanagan Lake within RDOS Electoral Area E.

Table 6: The total number and density (# per km) of different shore line modifications occurring around Okanagan Lake South.

Type	Total #	# Per km
Docks	67	3.96
Groynes	59	3.49
Boat Launch	2	0.12
Retaining Walls	48	2.84
Marinas	1	0.06
Marine Rails	0	0.00

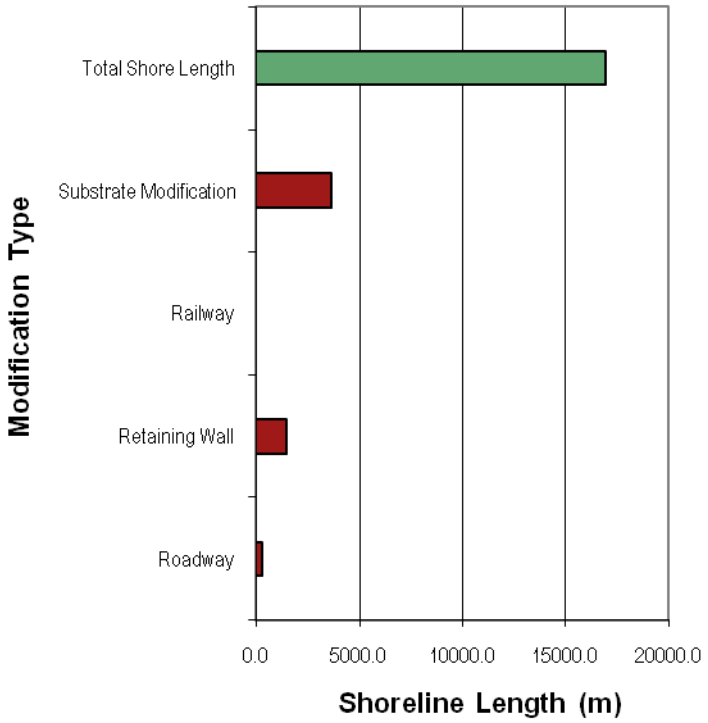

Figure 7: The approximate shore length of different modifications (Substrate Modification, Railway, Retaining Wall, Roadway) along Okanagan Lake within RDOS Electoral Area E.

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

Category	% of Shoreline	Shore Length (m)
Roadway	2%	303.7
Retaining Wall	9%	1480.2
Railway	0%	0.0
Substrate Modification	22%	3669.7
Total Shore Length		16916.0

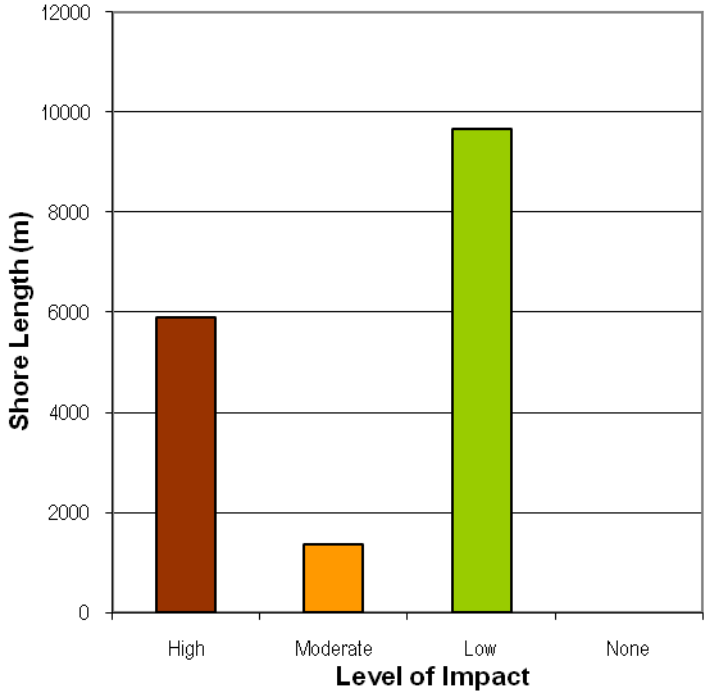

Figure 8: The total shore length classified as having a High, Moderate, or Low Level of Impact rating along Okanagan Lake within RDOS Electoral Area E.

Table 8: The total length of shore line classified as having a High, Moderate, or Low Level of Impact.

	Level of Impact (% of Shoreline)	Shore Length
High	34.79%	5886
Moderate	8.08%	1367
Low	57.12%	9663
None	0.00%	0
Total Lenght of Shoreline		16916.0

APPENDIX D
RDOS Electoral Area F
Data Tables

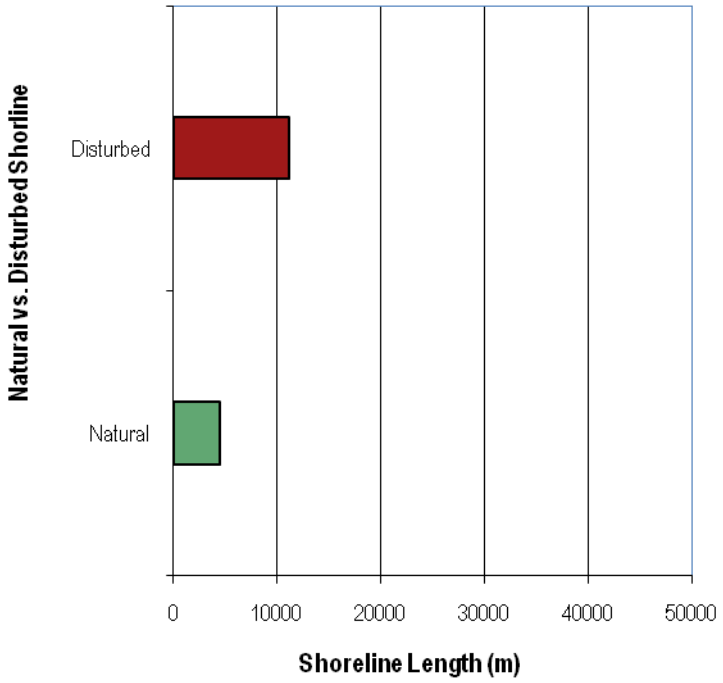

Figure 1: The total shore length that is either natural or disturbed along Okanagan Lake South within RDOS Electoral Area F.

Table 1: The total shore length of natural and disturbed shore lines along Okanagan Lake South within RDOS Electoral Area F

	% of Shoreline	Shore Length (m)
Natural	28.61%	4460
Disturbed	71.39%	11128
	Total	15587.8

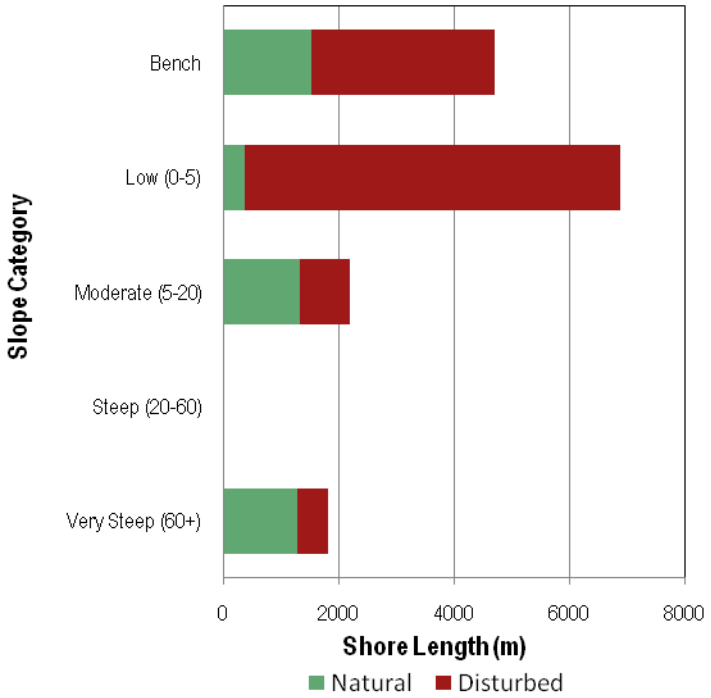

Figure 2: The total shore length that is either natural or disturbed along Okanagan Lake South within RDOS Electoral Area F.

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

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	11.6	1806	1264	542	70.0	30.0
Steep (20-60)	0.0	0	0	0	0	0
Moderate (5-20)	14.0	2178	1307	871	60.0	40.0
Low (0-5)	44.2	6891	364	6527	5.3	94.7
Bench	30.2	4713	1525	3188	32.4	67.6
Total	100.0	15588	4460	11128	28.6	71.4

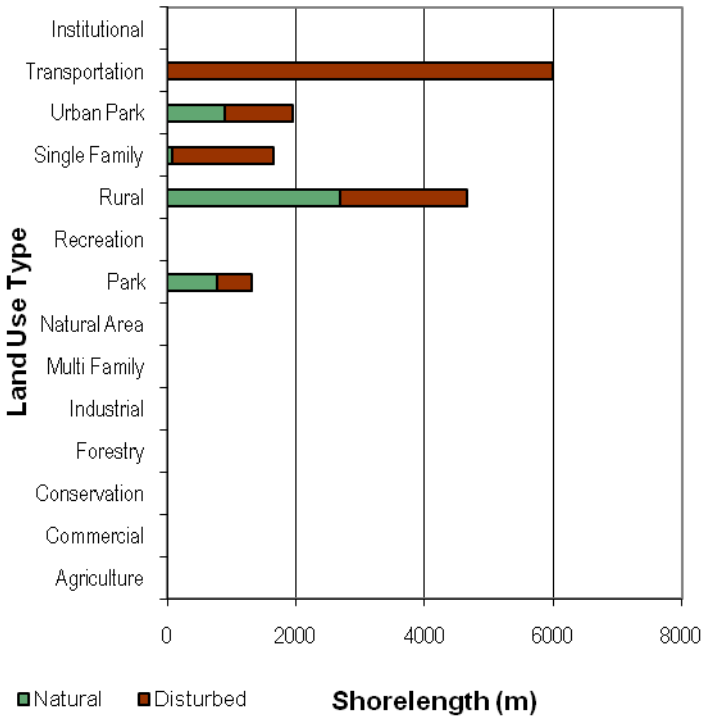

Figure 3: The total shore length that is either natural or disturbed along Okanagan Lake South within RDOS Electoral Area F.

Table 4: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South in RDOS Electoral Area F.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shore Length	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	0.0%	0	0	0	0.0%	0.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	8.4%	1307	784	523	60.0%	40.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	30.0%	4670	2696	1974	57.7%	42.3%
Single Family	10.7%	1663	83	1580	5.0%	95.0%
Urban Park	12.5%	1952	887	1065	45.4%	54.6%
Transportation	38.5%	5995	9	5986	0.2%	99.8%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	15587.8				

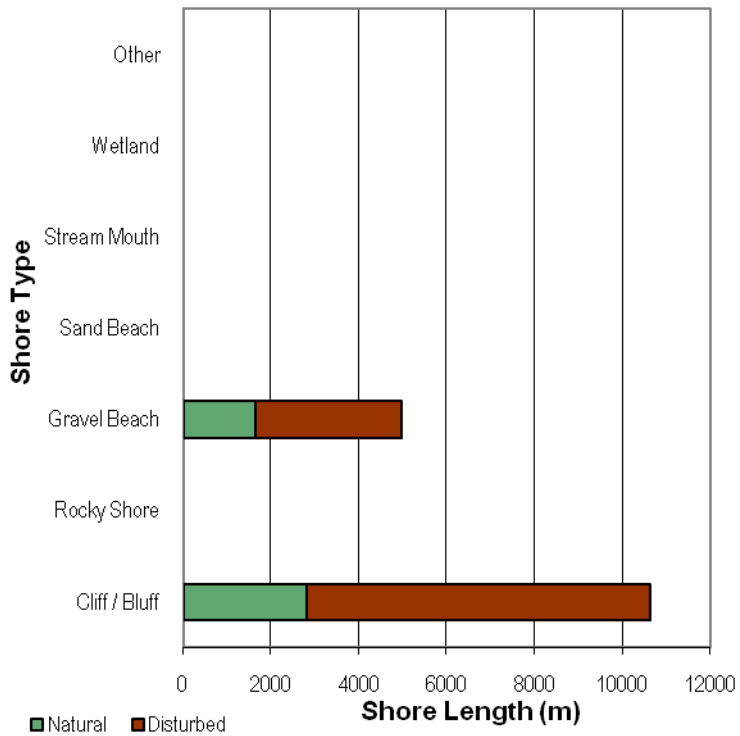

Figure 4: The total shore length that is either natural or disturbed for each different shore type category along Okanagan Lake South within RDOS Electoral Area F.

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Okanagan Lake South in RDOS Electoral Area F.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	68.2%	10630	2815	7815.5	26.5%	73.5%
Rocky Shore	0.0%	0	0	0.0	0	0
Gravel Beach	31.8%	4958	1646	3312.2	33.2%	66.8%
Sand Beach	0.0%	0	0	0.0	0	0
Stream Mouth	0.0%	0	0	0.0	0	0
Wetland	0.0%	0	0	0.0	0	0
Other	0.0%	0	0	0.0	0	0
	100.00%	15588				

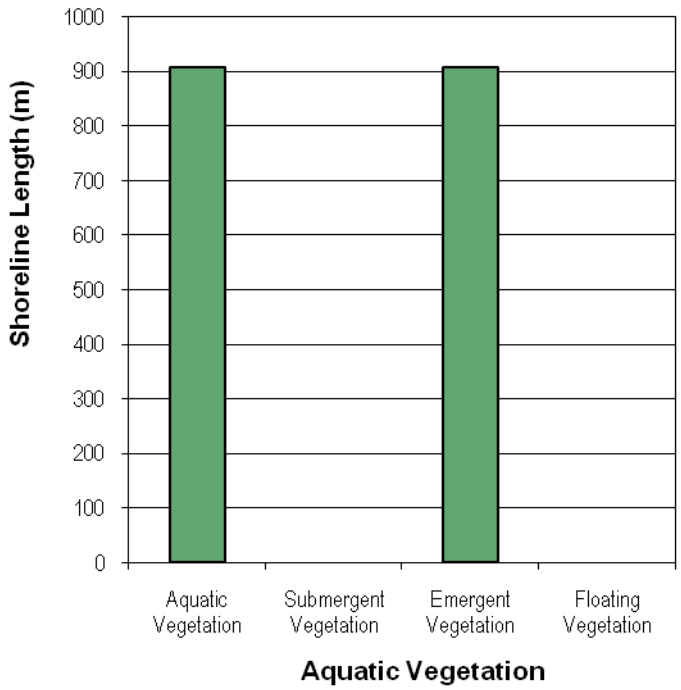

Figure 5: The total shore length where aquatic vegetation occurs along Okanagan Lake South within RDOS Electoral Area F.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake South in RDOS Electoral Area F.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	5.8%	908
Submergent Vegetation	0.0%	0
Emergent Vegetation	5.8%	908
Floating Vegetation	0.0%	0

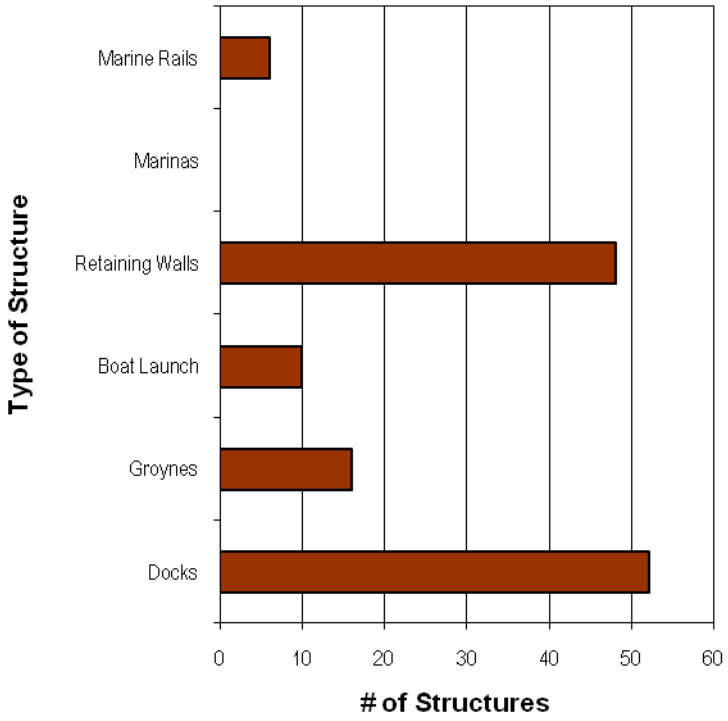

Figure 6: The total number of modifications occurring along Okanagan Lake South within RDOS Electoral Area F.

Table 6: The total number and density (# per km) of different shoreline modifications occurring around Okanagan Lake South in RDOS Electoral Area F.

Type	Total #	# Per km
Docks	52	3.34
Groynes	16	1.03
Boat Launch	10	0.64
Retaining Walls	48	3.08
Marinas	0	0.00
Marine Rails	6	0.38

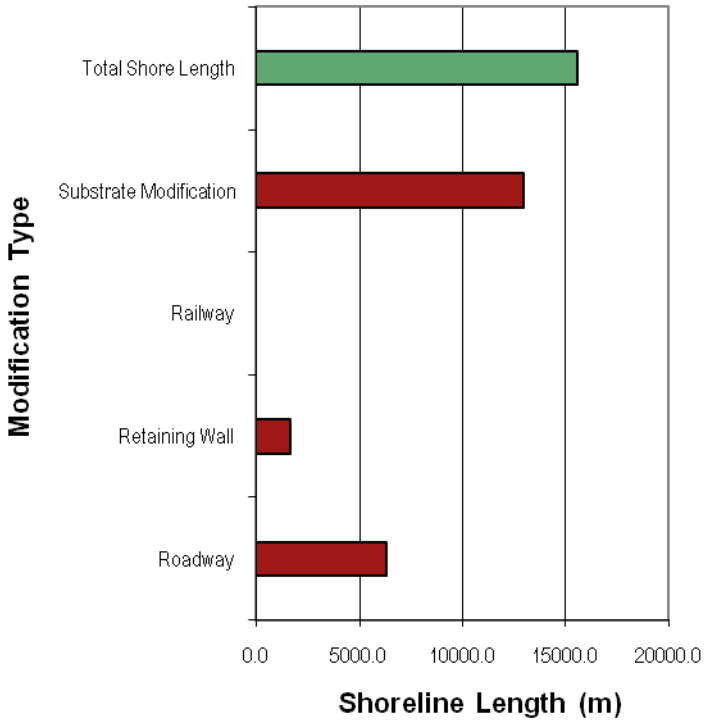

Figure 7: The total shore length that has been impacted by different modifications along Okanagan Lake South within RDOS Electoral Area F.

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake South in RDOS Electoral Area F.

Category	% of Shoreline	Shore Length (m)
Roadway	41%	6356.4
Retaining Wall	11%	1661.6
Railway	0%	0.0
Substrate Modification	83%	12970.7
Total Shore Length		15587.8

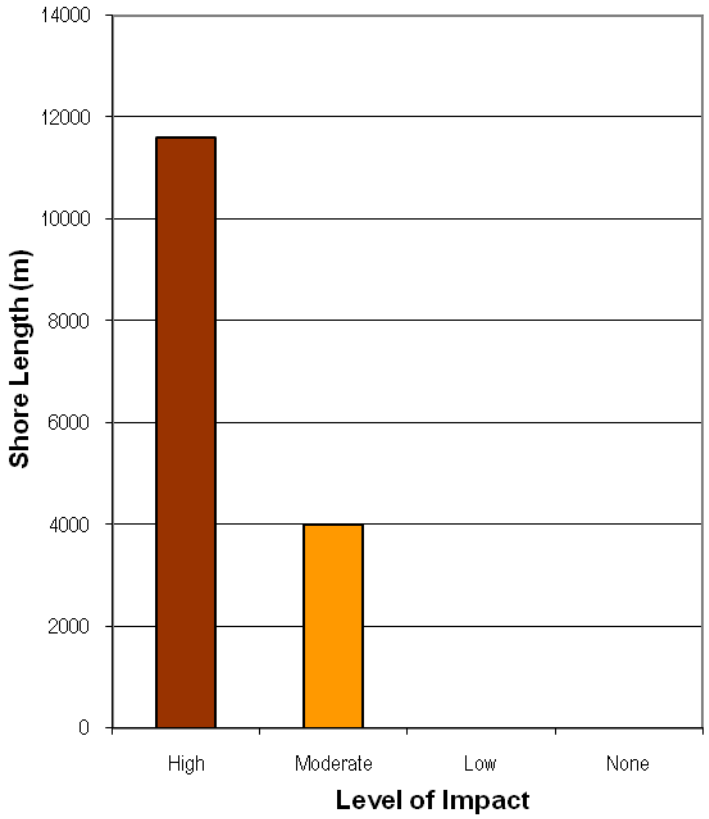

Figure 8: The total shore length that has been categorized as having a High, Moderate, or Low Level of Impact along Okanagan Lake South within RDOS Electoral Area F.

Table 8: The shore length that has been categorized as having a High, Moderate, or Low Level of Impact.

Category	Level of Impact (% of Shoreline)	Shore Length
High	74.44%	11604
Moderate	25.56%	3984
Low	0.00%	0
None	0.00%	0
Total Shore Length		15587.8

APPENDIX E
City of Peachland
Figures & Data Tables

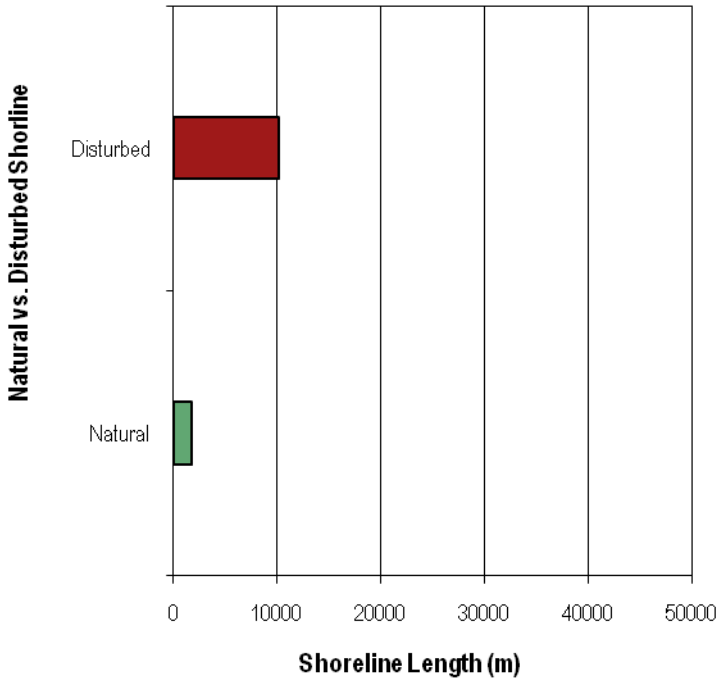

Figure 1: The total shore length that is natural and disturbed along Okanagan Lake South within the District of Peachland.

Table 1: The total shore length that is natural or disturbed along Okanagan Lake South in the District of Peachland.

	% of Shoreline	Shore Length (m)
Natural	14.98%	1788
Disturbed	85.02%	10144
	Total	11932.1

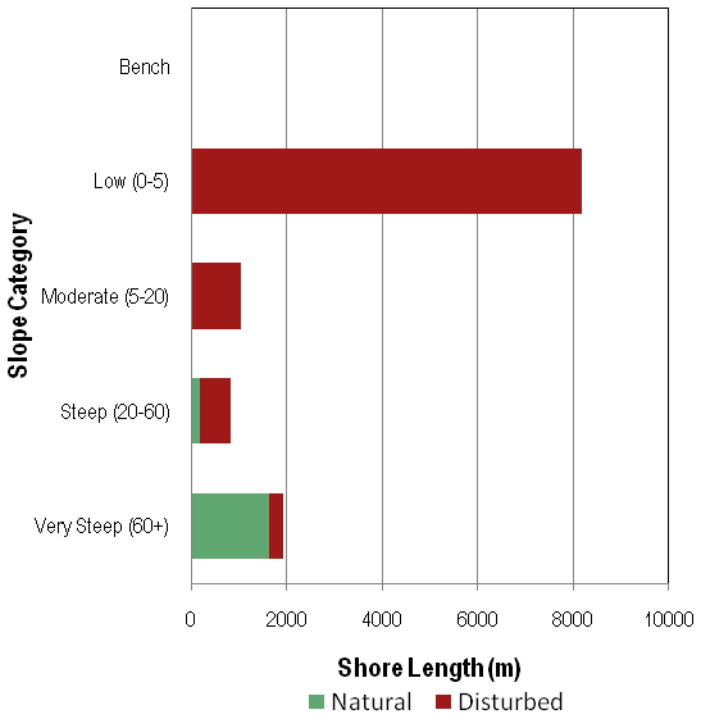

Figure 2: The total shore length that is natural and disturbed within different slope categories along Okanagan Lake South within the District of Peachland.

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

Slope	% of Total Shore Length	Total Shore Length	Shore Length Natural	Shore Length Disturbed	% Natural	% Disturbed
Very Steep (60+)	16.0	1911	1624	287	85.0	15.0
Steep (20-60)	6.9	817	163	654	20.0	80.0
Moderate (5-20)	8.6	1030	0	1030	0.0	100.0
Low (0-5)	68.5	8174	0	8174	0.0	100.0
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	11932	1788	10144	15.0	85.0

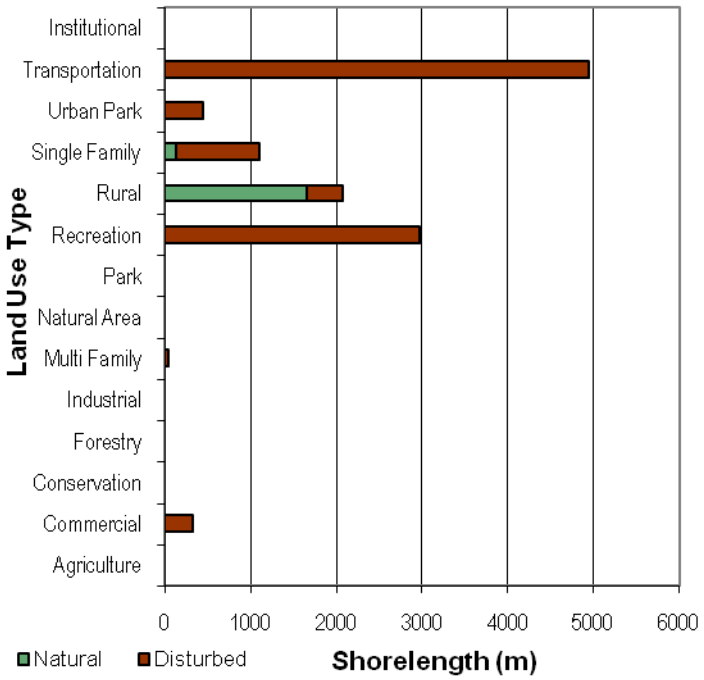

Figure 3: The total shore length that is natural and disturbed within different each land use category along Okanagan Lake South within the District of Peachland.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South within the District of Peachland.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shorelength	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	2.8%	335	0	335	0.0%	100.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.4%	49	0	49	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	24.9%	2977	0	2977	0.0%	100.0%
Rural	17.4%	2074	1657	417	79.9%	20.1%
Single Family	9.2%	1099	131	968	11.9%	88.1%
Urban Park	3.7%	447	0	447	0.0%	100.0%
Transportation	41.5%	4950	0	4950	0.0%	100.0%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	11932.1				

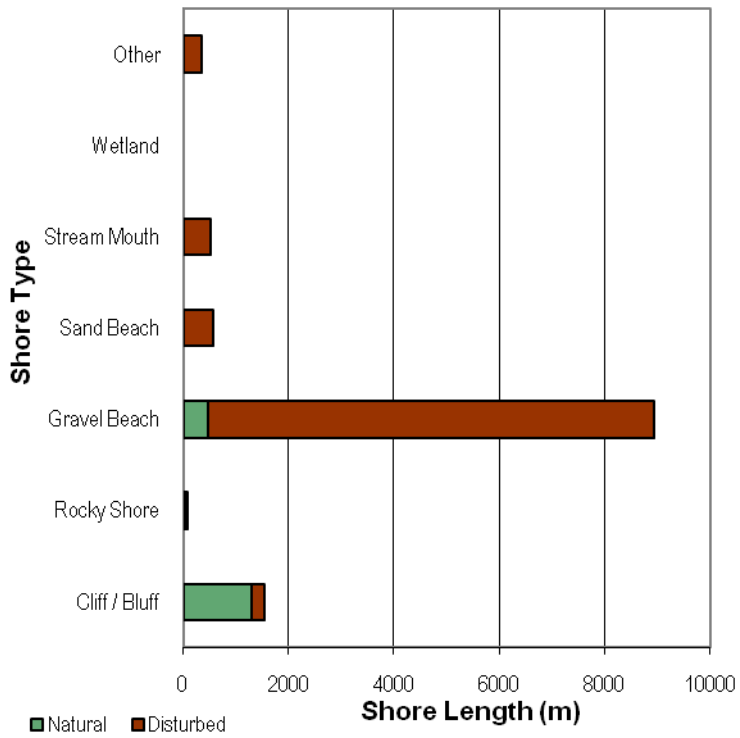

Figure 4: The total shore length that is natural and disturbed within each shore type category along Okanagan Lake South within the District of Peachland.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	12.8%	1529	1299	229.3	85.0%	15.0%
Rocky Shore	0.7%	82	16	65.4	20.0%	80.0%
Gravel Beach	74.9%	8931	472	8459.2	5.3%	94.7%
Sand Beach	4.6%	552	0	552.1	0.0%	100.0%
Stream Mouth	4.2%	503	0	503.2	0.0%	100.0%
Wetland	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Other	2.8%	335	0	335.1	0.0%	100.0%
Total	100.00%	11932				

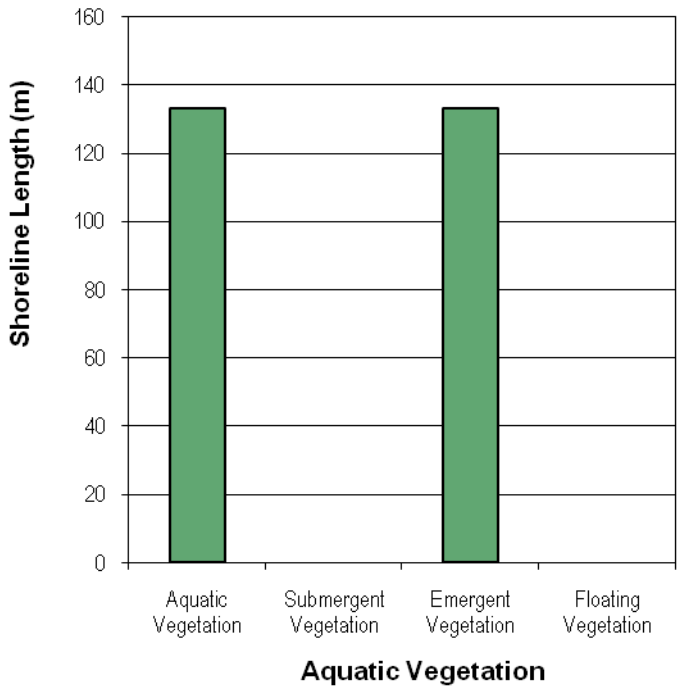

Figure 5: The total shore length that has aquatic vegetation (Total, Submergent, Emergent, and Floating) along it in Okanagan Lake South within the District of Peachland.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake South within the District of Peachland.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	1.1%	133
Submergent Vegetation	0.0%	0
Emergent Vegetation	1.1%	133
Floating Vegetation	0.0%	0

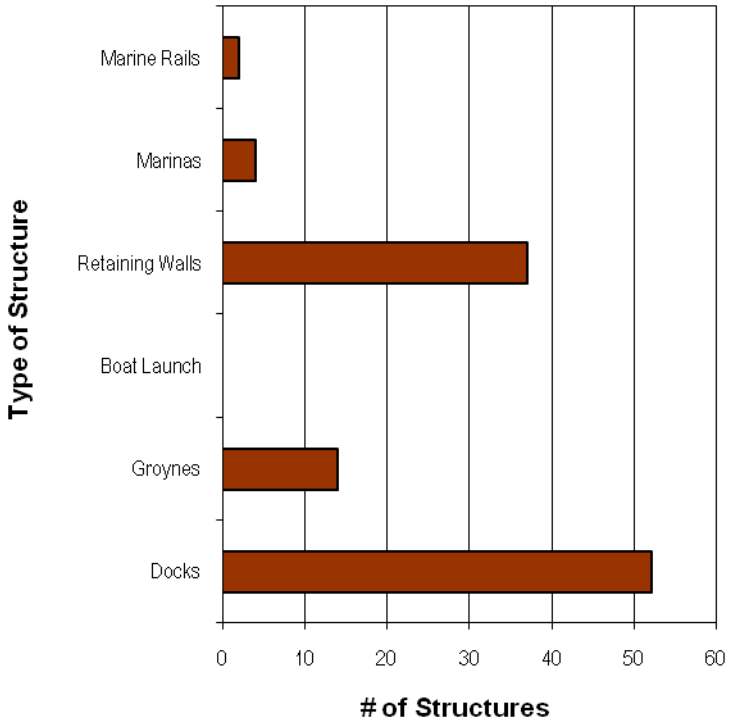

Figure 6: The number of different modifications observed in Okanagan Lake South within the District of Peachland.

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Okanagan Lake South in the District of Peachland.

Type	Total #	# Per km
Docks	52	4.36
Groynes	14	1.17
Boat Launch	0	0.00
Retaining Walls	37	3.10
Marinas	4	0.34
Marine Rails	2	0.17

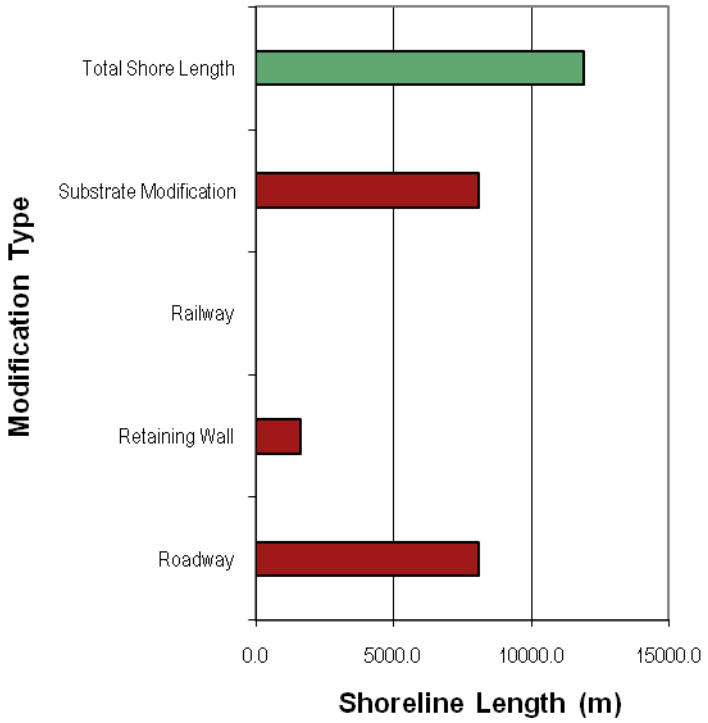

Figure 7: The total shore length that has been impacted by different activities along Okanagan Lake South within the District of Peachland.

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

Category	% of Shoreline	Shorelength (m)
Roadway	68%	8086.8
Retaining Wall	14%	1643.9
Railway	0%	0.0
Substrate Modification	68%	8120.3
Total Shore Length		11932.1

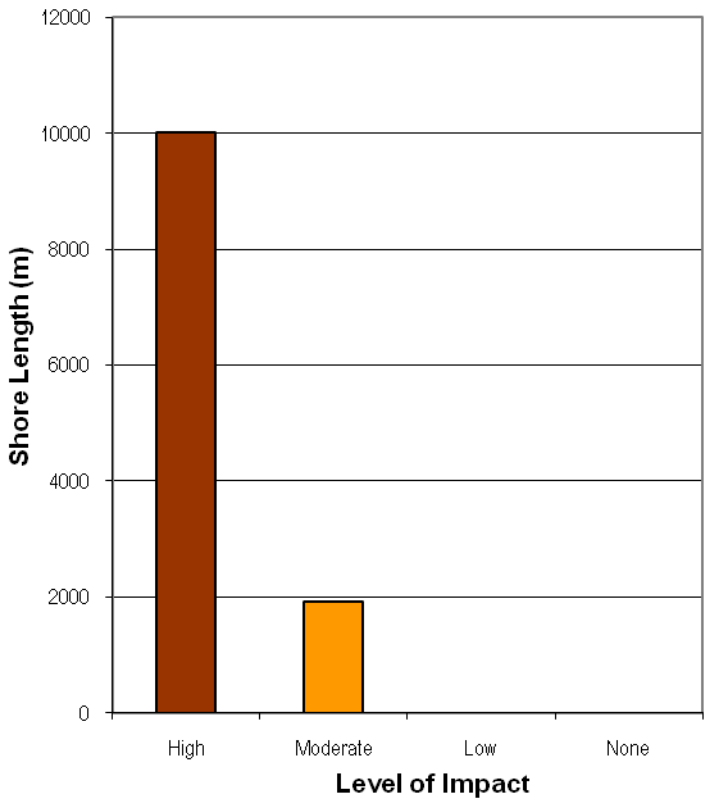

Figure 8: The total shore length that has been categorized as having a High, Moderate, or Low Level of Impact along Okanagan Lake South within the District of Peachland.

Table 8: The total shore length that has been categorized as having a High, Moderate, and Low Level of Impact along Okanagan Lake South within the District of Peachland.

Category	Level of Impact (% of Shoreline)	Shore Length
High	83.99%	10021
Moderate	16.01%	1911
Low	0.00%	0
None	0.00%	0
Total Shore Length		11932.1

APPENDIX F
District of Summerland
Figures & Data Tables

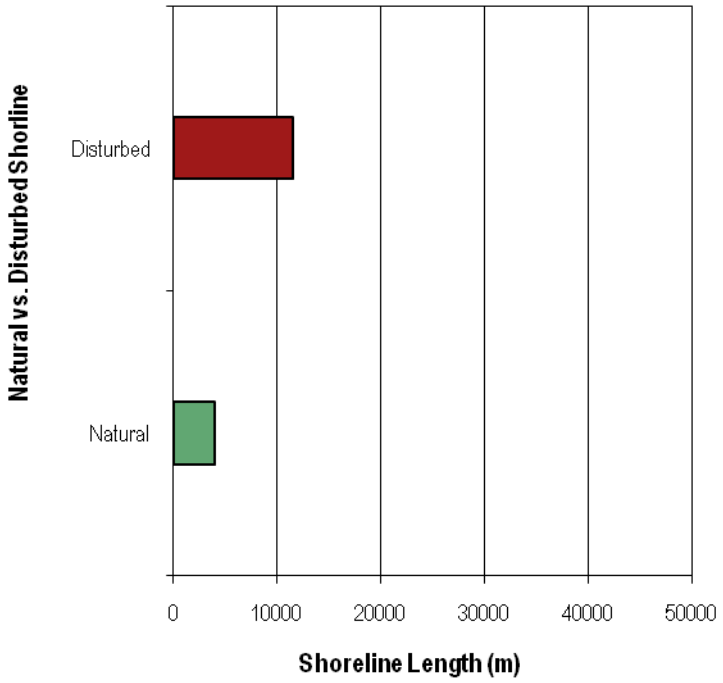

Figure 1: The total length of natural and disturbed shore shorelines along Okanagan Lake South within the District of Summerland.

Table 1: The total lenght of natural and disturbed shore lines along Okanagan Lake South in the District of Summerland.

	% of Shoreline	Shore Length (m)
Natural	25.78%	3988
Disturbed	74.22%	11485
	Total	15473.5

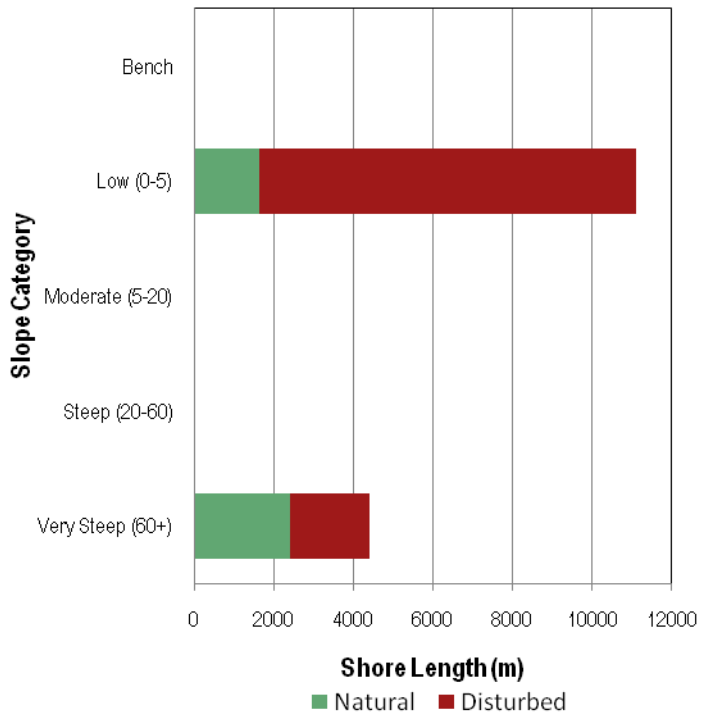

Figure 2: The total length of natural and disturbed shore shorelines within each slope category along Okanagan Lake South within the District of Summerland.

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

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	28.3	4372	2375	1998	54.3	45.7
Steep (20-60)	0.0	0	0	0	0.0	0.0
Moderate (5-20)	0.0	0	0	0	0.0	0.0
Low (0-5)	71.7	11101	1614	9487	14.5	85.5
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	15473	3988	11485	25.8	74.2

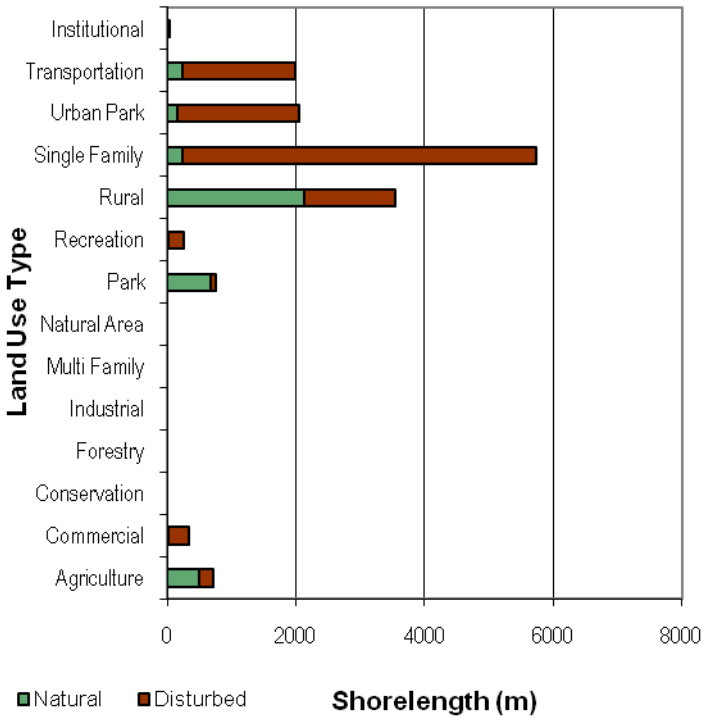

Figure 3: The total length of natural and disturbed shore shorelines within each land use category along Okanagan Lake South within the District of Summerland.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South in the District of Summerland.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shore Length	% Natural	% Disturbed
Agriculture	4.6%	714	500	214	70.0%	30.0%
Commercial	2.2%	346	15	330	4.5%	95.5%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	4.9%	763	687	76	90.0%	10.0%
Recreation	1.6%	251	15	236	5.8%	94.2%
Rural	22.9%	3543	2126	1417	60.0%	40.0%
Single Family	37.1%	5748	246	5502	4.3%	95.7%
Urban Park	13.3%	2061	151	1910	7.3%	92.7%
Transportation	12.9%	2000	249	1751	12.4%	87.6%
Institutional	0.3%	48	48	0	0.0%	0.0%
Total	100.0%	15473.5				

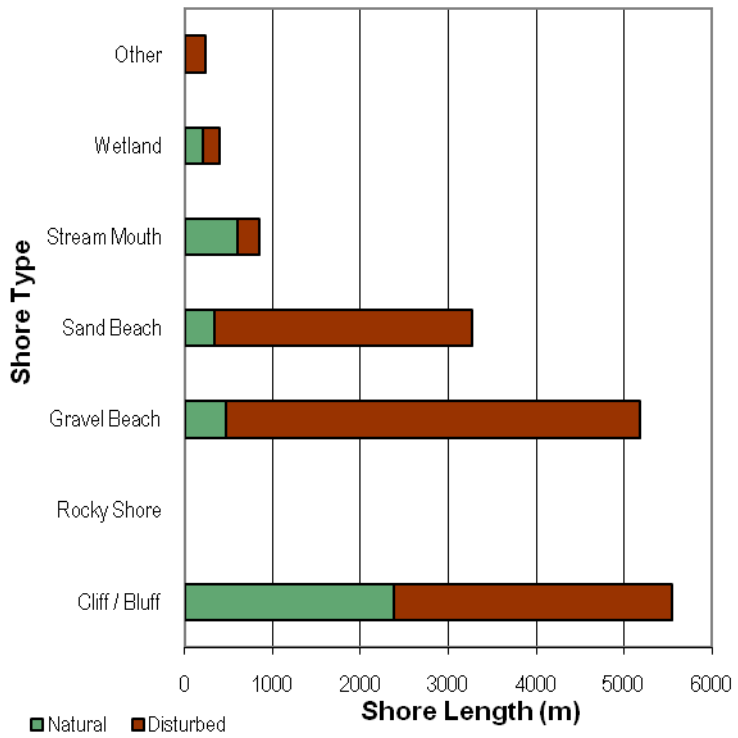

Figure 4: The total length of natural and disturbed shore shorelines within each shore type category along Okanagan Lake South within the District of Summerland.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	35.8%	5543	2375	3168.3	42.8%	57.2%
Rocky Shore	0.0%	0	0	0.0	#DIV/0!	#DIV/0!
Gravel Beach	33.5%	5180	473	4707.1	9.1%	90.9%
Sand Beach	21.2%	3273	331	2942.5	10.1%	89.9%
Stream Mouth	5.5%	844	599	244.8	71.0%	29.0%
Wetland	2.5%	393	211	182.7	53.6%	46.4%
Other	1.5%	240	0	239.6	0.0%	100.0%
Total	100.00%	15473				

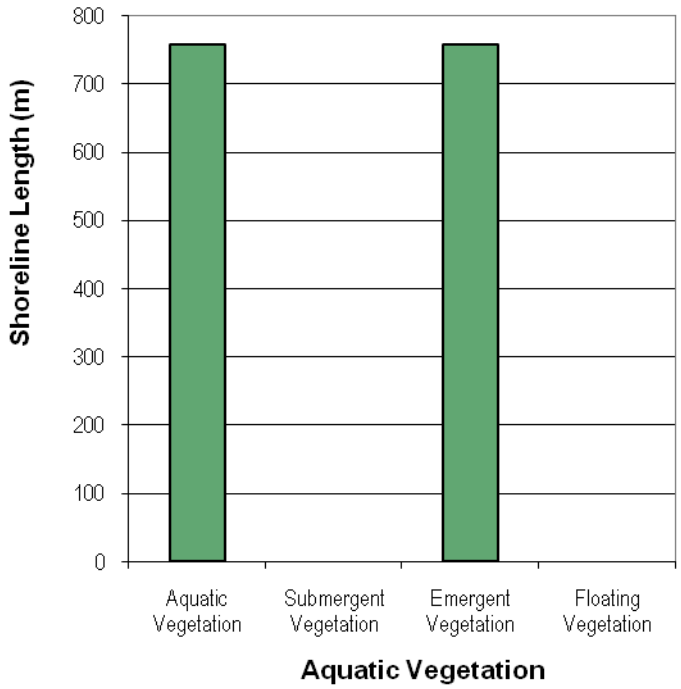

Figure 5: The total length of shoreline where aquatic vegetation is present along Okanagan Lake South within the District of Summerland.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake South within the District of Summerland.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	4.9%	758
Submergent Vegetation	0.0%	0
Emergent Vegetation	4.9%	758
Floating Vegetation	0.0%	0

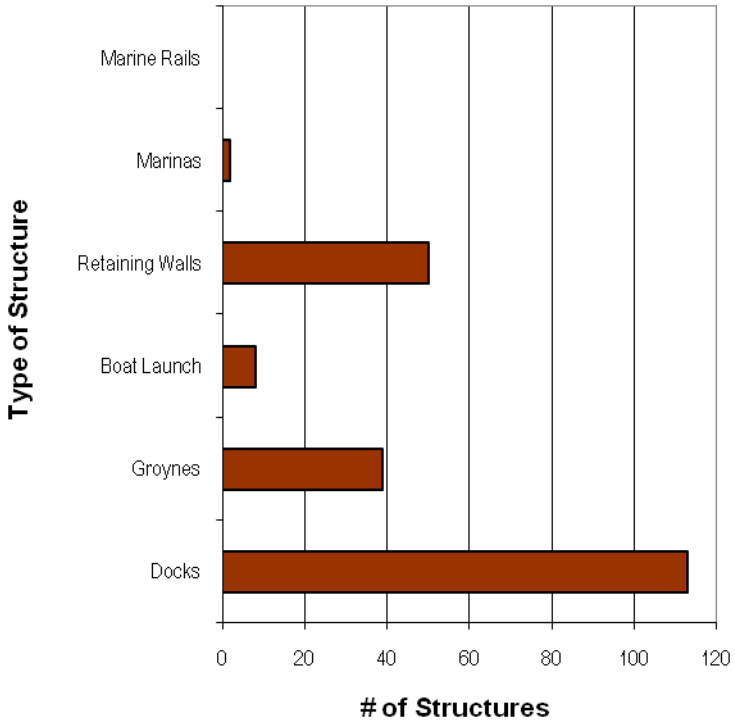

Figure 6: The total number of different modifications occurring along Okanagan Lake South within the District of Summerland.

Table 7: The total number and density (# per km) of different shoreline modifications occurring around Okanagan Lake South within the District of Summerland.

Type	Total #	# Per km
Docks	113	7.30
Groynes	39	2.52
Boat Launch	8	0.52
Retaining Walls	50	3.23
Marinas	2	0.13
Marine Rails	0	0.00

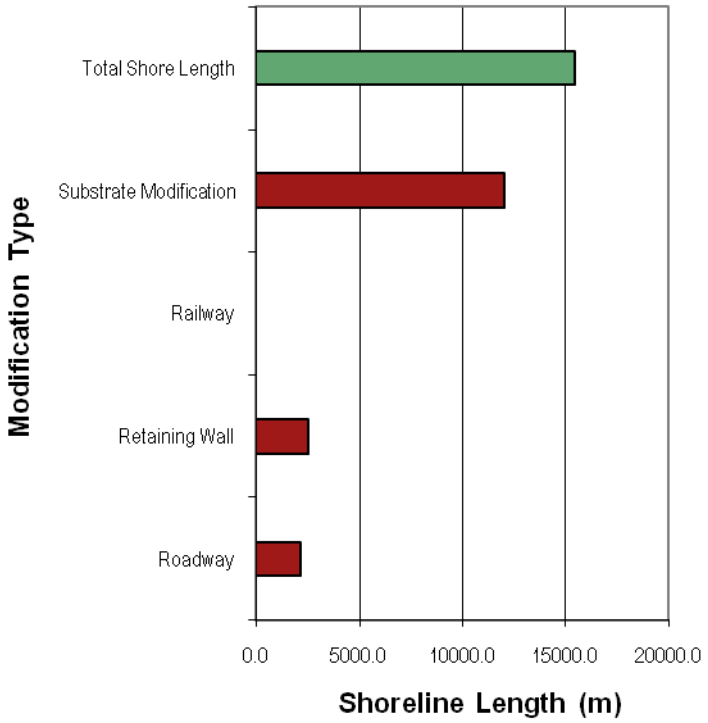

Figure 7: The total length of shoreline that has been impacted by various modifications occurring along Okanagan Lake South within the District of Summerland.

Table 8: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake South within the Disfrict of Summerland.

Category	% of Shoreline	Shorelength (m)
Roadway	14%	2159.7
Retaining Wall	16%	2518.4
Railway	0%	0.0
Substrate Modification	78%	12047.4
Total Shore Length		15473.5

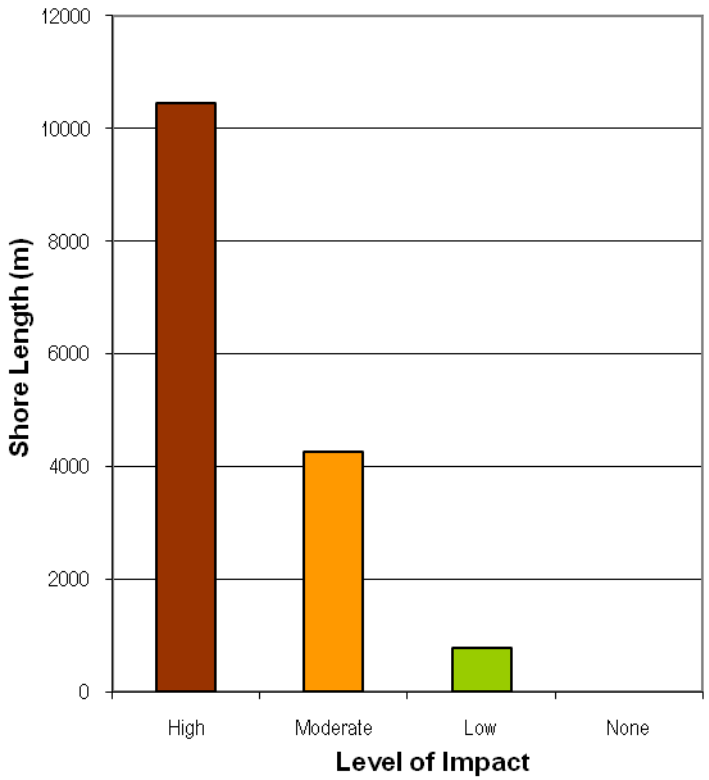

Figure 8: The total length of shoreline that has been categorized as having a High, Moderate, and Low Level of Impact along Okanagan Lake South within the District of Summerland.

Table 8: The total length of shore line that have been categorized as having a High, Moderate, or Low Level of Impact.

Category	Level of Impact (% of Shoreline)	Shore Length (m)
High	67.56%	10453
Moderate	27.51%	4257
Low	4.93%	763
None	0.00%	0
Total Shore Length		15473.5

APPENDIX G
City of Penticton
Figures & Data Tables

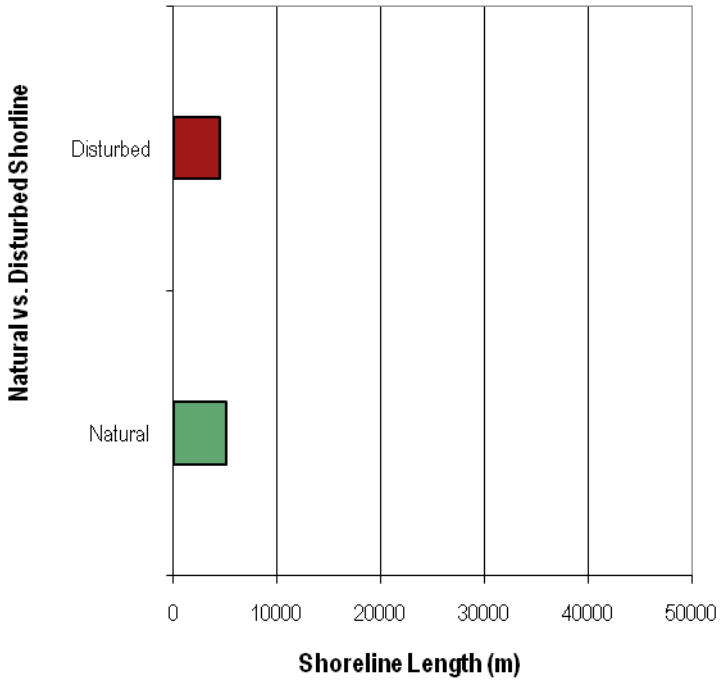

Figure 1: The total length of shoreline that is natural or disturbed along Okanagan Lake South within the City of Penticton.

Table 1: The total shore length that is natural or disturbed along Okanagan Lake South within the City of Penticton.

	% of Shoreline	Shore Length (m)
Natural	53.01%	5033
Disturbed	46.99%	4461
	Total	9493.6

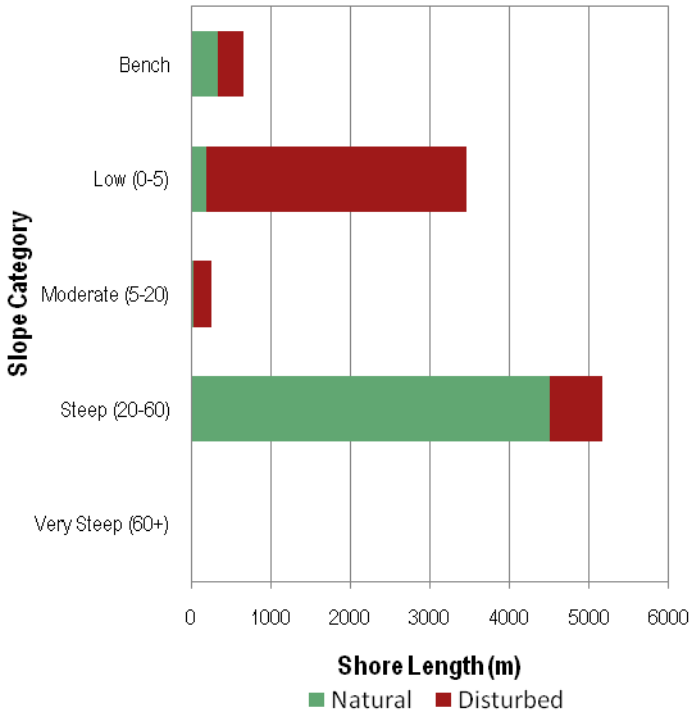

Figure 2: The total length of shoreline that is natural or disturbed in each different category of slope along Okanagan Lake South within the City of Penticton.

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

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)	54.4	5167	4505	662	87.2	12.8
Moderate (5-20)	2.5	234	23	211	10.0	90.0
Low (0-5)	36.3	3450	183	3267	5.3	94.7
Bench	6.8	642	321	321	50.0	50.0
Total	100.0	9494	5033	4461	53.0	47.0

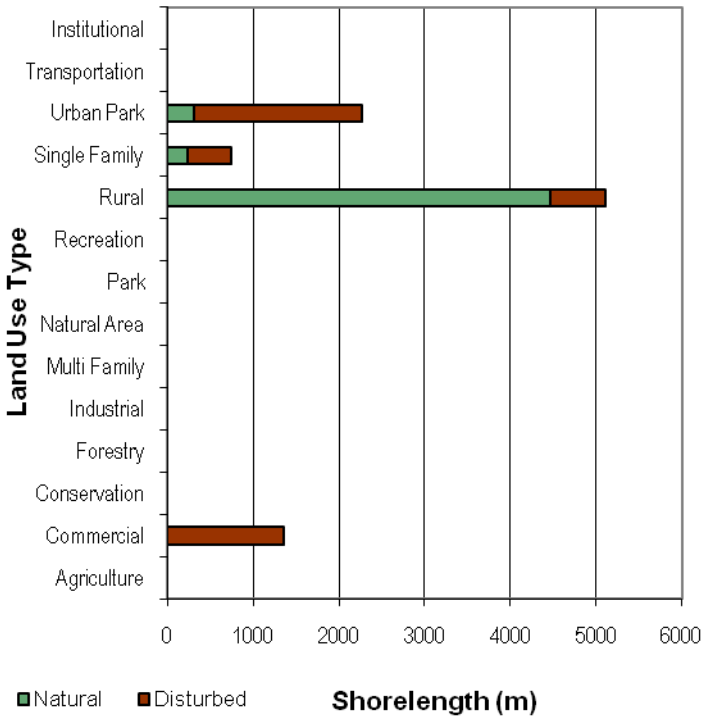

Figure 3: The total length of shoreline that is natural or disturbed in each different land use category along Okanagan Lake South within the City of Penticton.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South within the City of Penticton.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shorelength	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	14.3%	1359	0	1359	0.0%	100.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	0.0%	0	0	0	0.0%	0.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	53.8%	5105	4467	638	87.5%	12.5%
Single Family	7.9%	754	244	511	32.3%	67.7%
Urban Park	24.0%	2275	321	1953	14.1%	85.9%
Transportation	0.0%	0	0	0	0.0%	0.0%
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	9493.6				

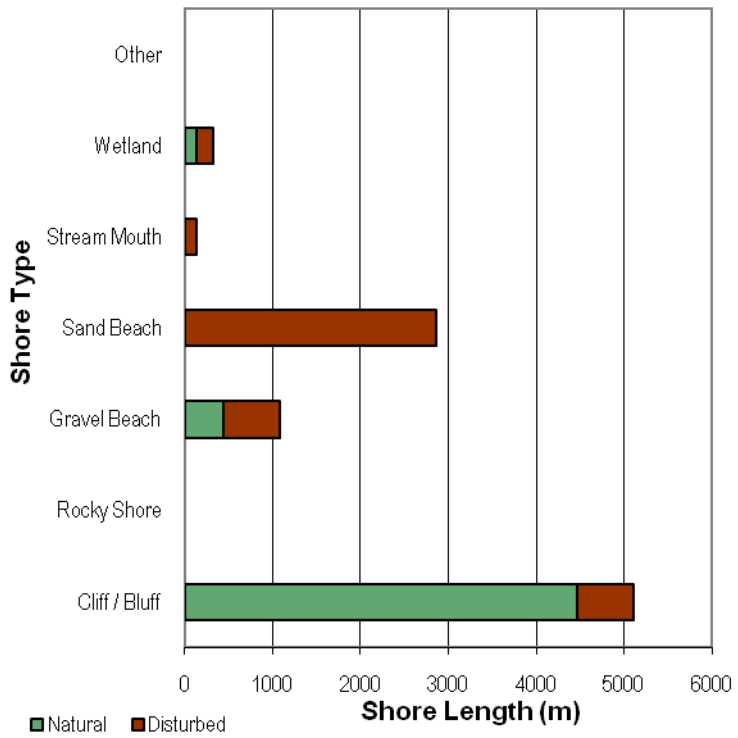

Figure 4: The total length of shoreline that is natural or disturbed in each different shore type categories along Okanagan Lake South within the City of Penticton.

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	53.8%	5105	4467	637.6	87.5%	12.5%
Rocky Shore	0.0%	0	0	0.0	0.0%	0.0%
Gravel Beach	11.3%	1076	437	639.3	40.6%	59.4%
Sand Beach	30.2%	2864	0	2864.1	0.0%	100.0%
Stream Mouth	1.3%	128	0	127.6	0.0%	100.0%
Wetland	3.4%	321	128	192.5	40.0%	60.0%
Other	0.0%	0	0	0.0	0.0%	0.0%
Total	100.00%	9494				

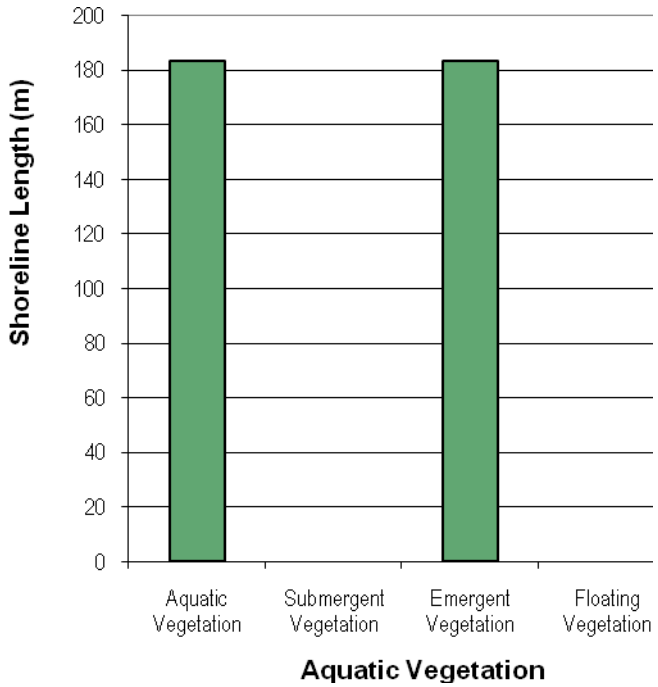

Figure 5: The total length of shoreline that has different aquatic vegetation growing along Okanagan Lake South within the City of Penticton.

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Okanagan Lake South within the City of Penticton.

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	1.9%	183
Submergent Vegetation	0.0%	0
Emergent Vegetation	1.9%	183
Floating Vegetation	0.0%	0

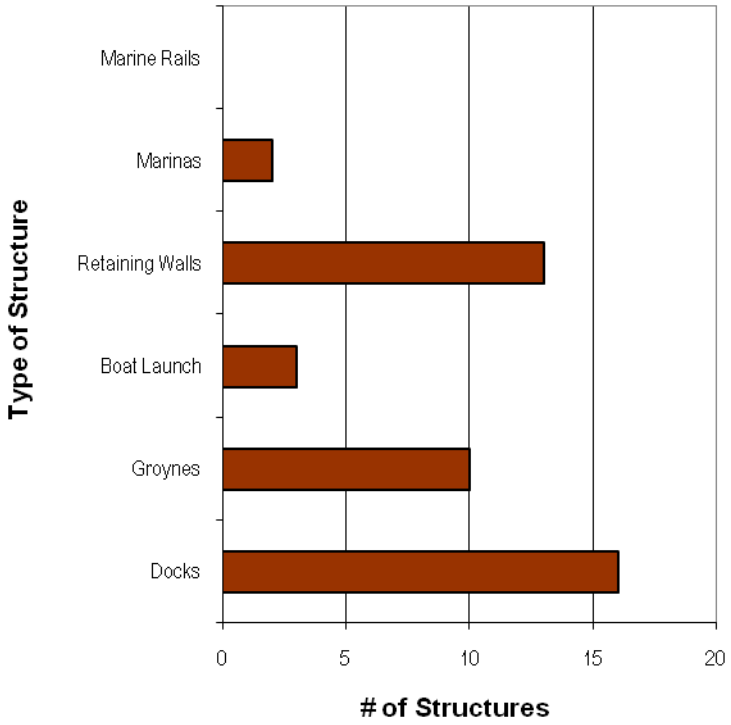

Figure 6: The total number of different modifications occurring along Okanagan Lake South within the City of Penticton.

Table 7: The total number and density (# per km) of different shoreline modifications occuring around Okanagan Lake South within the City of Penticton.

Type	Total #	# Per km
Docks	16	1.69
Groynes	10	1.05
Boat Launch	3	0.32
Retaining Walls	13	1.37
Marinas	2	0.21
Marine Rails	0	0.00

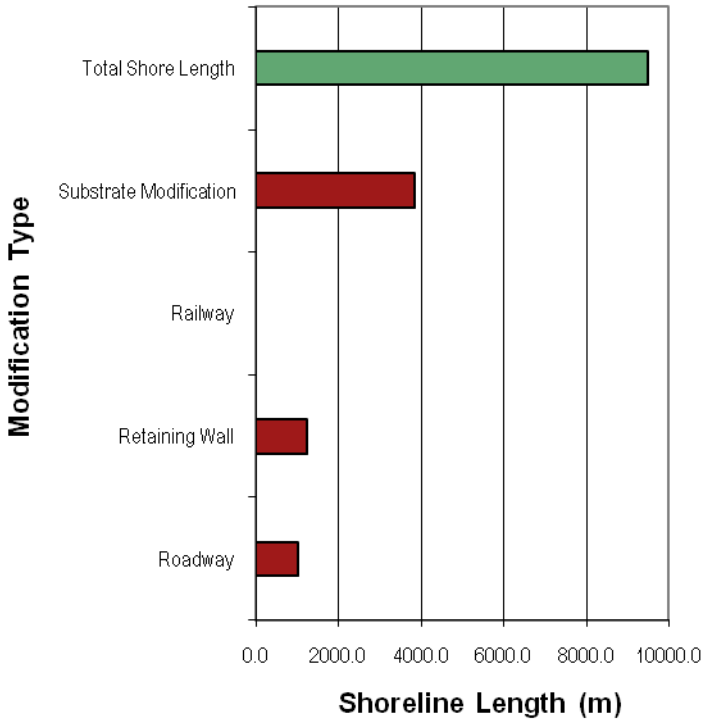

Figure 7: The total length of shoreline that has been impacted by different modifications along Okanagan Lake South within the City of Penticton.

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake South within the City of Penticton.

Category	% of Shoreline	Shore Length (m)
Roadway	11%	1034.1
Retaining Wall	13%	1254.8
Railway	0%	0.0
Substrate Modification	41%	3862.6
Total Shore Length		9493.6

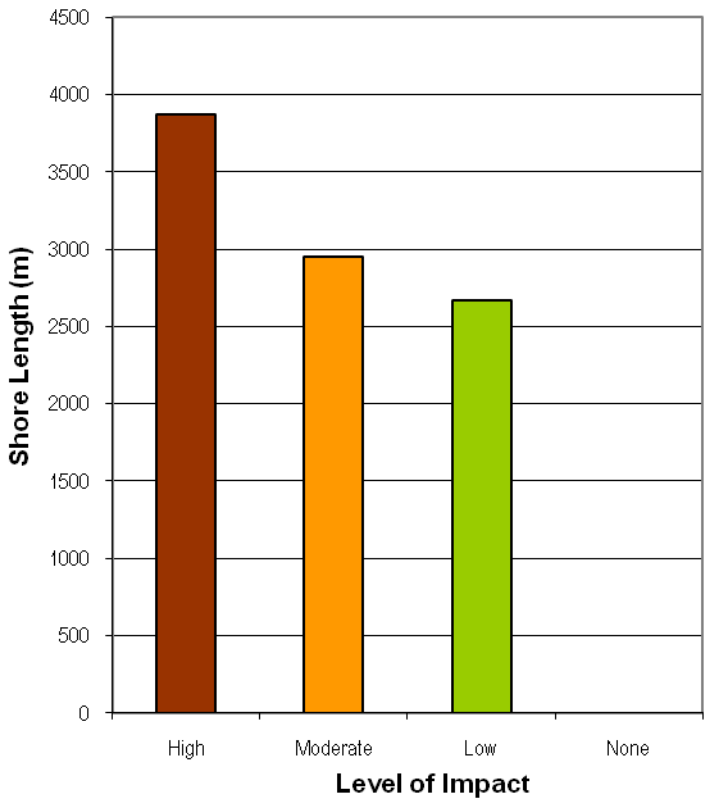

Figure 8: The total length of shoreline that has been categorized as having a High, Moderate, or Low Impact along Okanagan Lake South within the City of Penticton.

Table 8: The total lenght of shore line that has been categorized as having a High, Moderate, and Low Level of Impact along Okanagan Lake South within the City of Penticton.

Category	Level of Impact (% of Shoreline)	Shore Length (m)
High	40.75%	3868
Moderate	31.11%	2954
Low	28.14%	2672
None	0.00%	0
Total Shore Length		9493.6

APPENDIX H
Penticton Indian Band
Data Tables

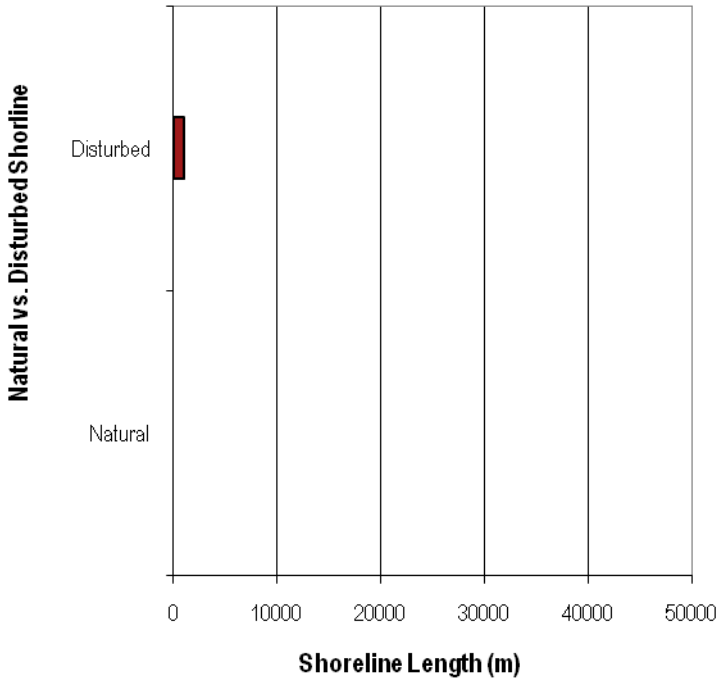

Figure 1: The total length of shoreline that is natural r disturbed along Okanagan Lake South within the Pentincton Indian Band.

Table 1: The total shore length that is natural or disturbed along Okanagan Lake South within the Penticton Indian Band.

	% of Shoreline	Shore Length (m)
Natural	0.00%	0
Disturbed	100.00%	974
	Total	974.0

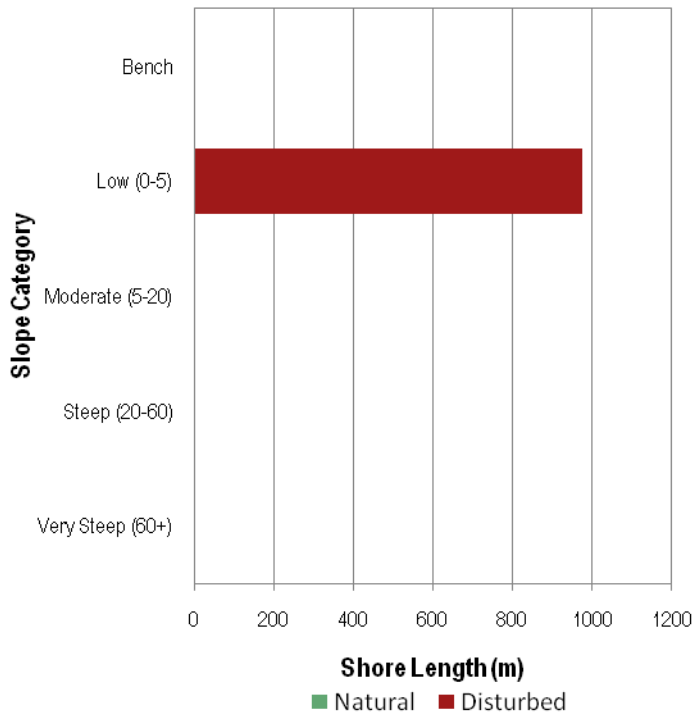

Figure 2: The total length of shoreline that is natural or disturbed within different categories of slope along Okanagan Lake South within the Pentincton Indian Band.

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

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)	0.0	0	0	0	0.0	0.0
Moderate (5-20)	0.0	0	0	0	0.0	0.0
Low (0-5)	100.0	974	0	974	0.0	100.0
Bench	0.0	0	0	0	0.0	0.0
Total	100.0	974	0	974	0.0	100.0

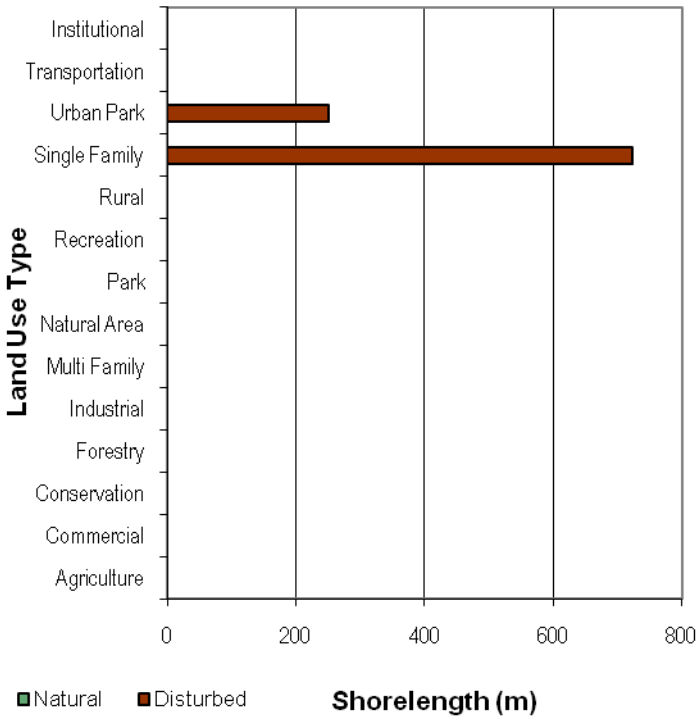

Figure 3: The total length of shoreline that is natural or disturbed within the different land use categories along Okanagan Lake South within the Pentincton Indian Band.

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Okanagan Lake South within the Penticton Indian Band.

	% of Shoreline Length	Shoreline Length	Natural Shore Length	Disturbed Shore Length	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	0.0%	0	0	0	0.0%	0.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	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	0.0%	0	0	0	0.0%	0.0%
Single Family	74.3%	724	0	724	0.0%	100.0%
Urban Park	25.7%	250	0	250	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%	974.0				

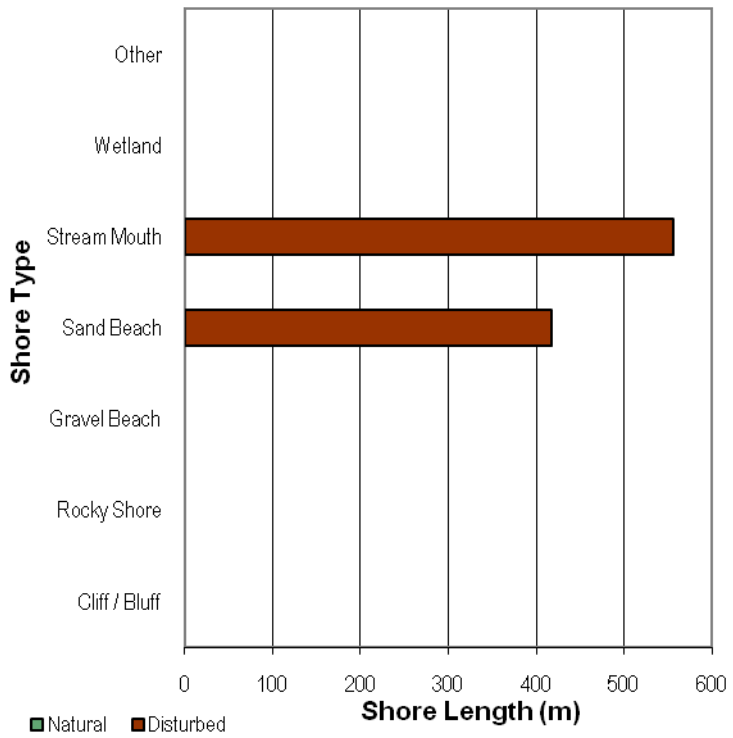

Figure 4: The total length of shoreline that is natural or disturbed within the different shore type categories along Okanagan Lake South within the Pentincton Indian Band.

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Okanagan Lake South within the Penticton Indian Band.

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.0%	0	0	0.0	0.0%	0.0%
Rocky Shore	0.0%	0	0	0.0	0.0%	0.0%
Gravel Beach	0.0%	0	0	0.0	0.0%	0.0%
Sand Beach	42.9%	418	0	417.8	0.0%	100.0%
Stream Mouth	57.1%	556	0	556.1	0.0%	100.0%
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%	974				

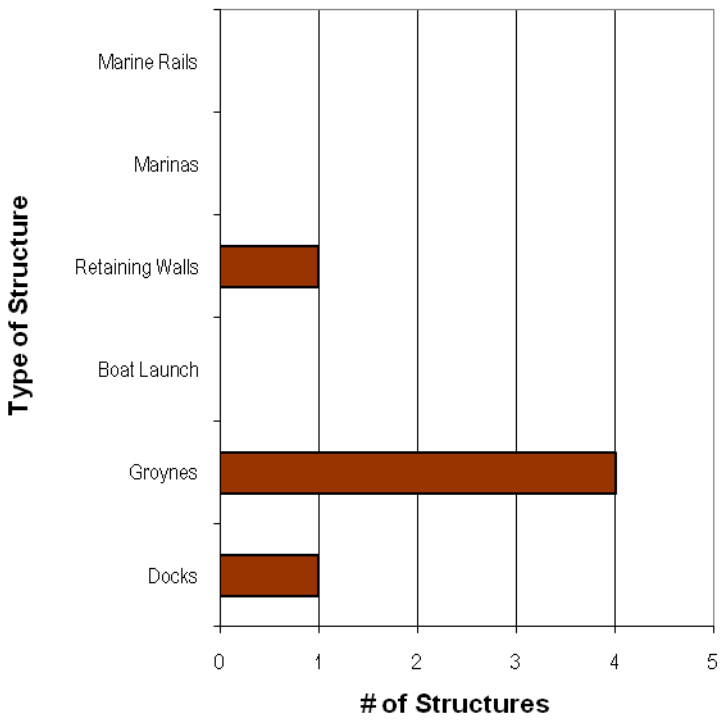

Figure 5: The total number of shoreline modifications occurring along Okanagan Lake South within the Pentincton Indian Band.

Table 5: The total number and density (# per km) of different shoreline modifications occuring around Okanagan Lake South within the Penticton Indian Band.

Type	Total #	# Per km
Docks	1	1.03
Groynes	4	4.11
Boat Launch	0	0.00
Retaining Walls	1	1.03
Marinas	0	0.00
Marine Rails	0	0.00

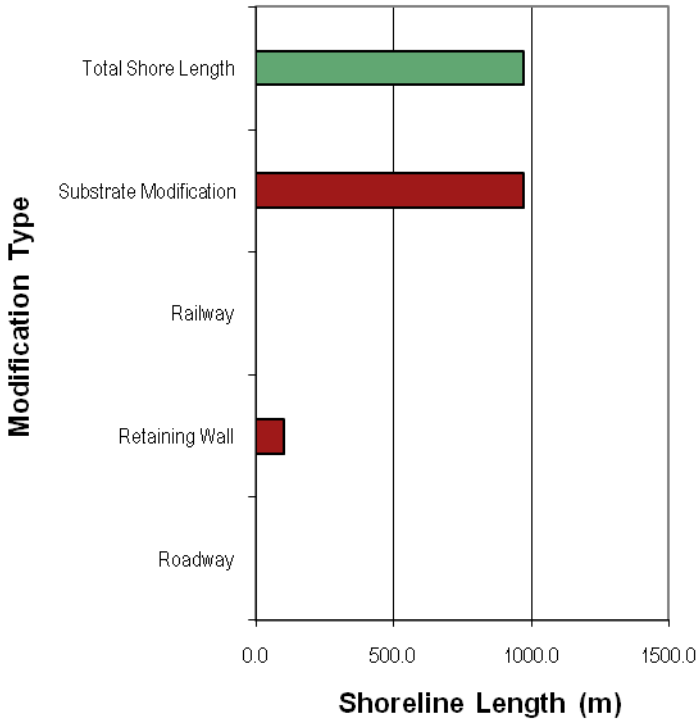

Figure 6: The total number length of shoreline that have been impacted by different modifications along Okanagan Lake South within the Pentincton Indian Band.

Table 6: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Okanagan Lake South within Pentcton Indian Band.

Category	% of Shoreline	Shorelength (m)
Roadway	0%	0.0
Retaining Wall	11%	104.5
Railway	0%	0.0
Substrate Modification	100%	974.0
Total Shore Length		974.0

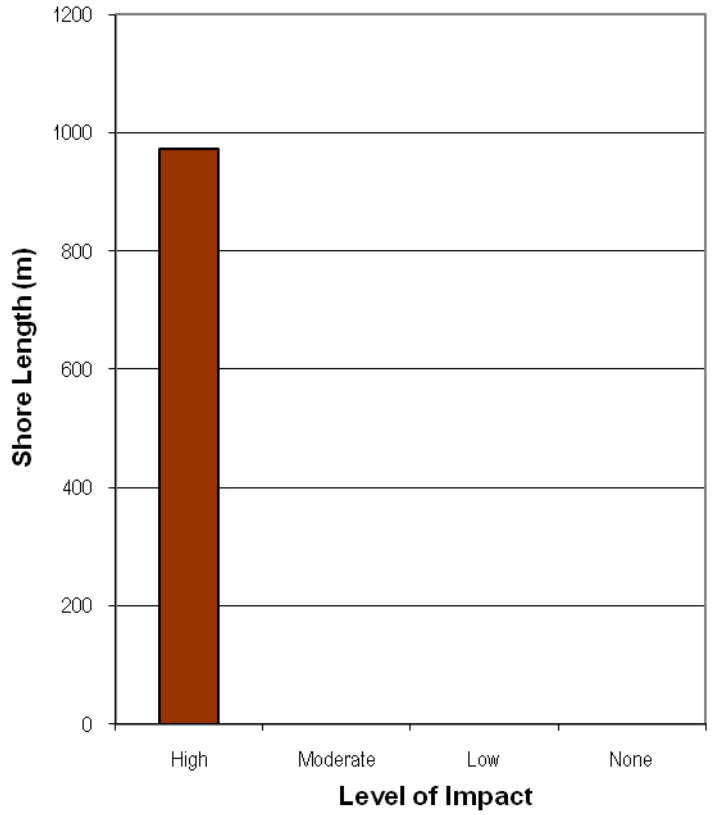

Figure 7: The total number length of shoreline that has been categorized as having a High, Moderate, and Low Level of Impact along Okanagan Lake South within the Pentincton Indian Band.

Table 7: The total length of shore line that has been categorized as having a High, Moderate, or Low Level of Impact along Okanagan Lake South within the Penticton Indian Band.

	Level of Impact (% of Shoreline)	Shore Length
High	100.00%	974
Moderate	0.00%	0
Low	0.00%	0
None	0.00%	0
Total Shore Length		974.0