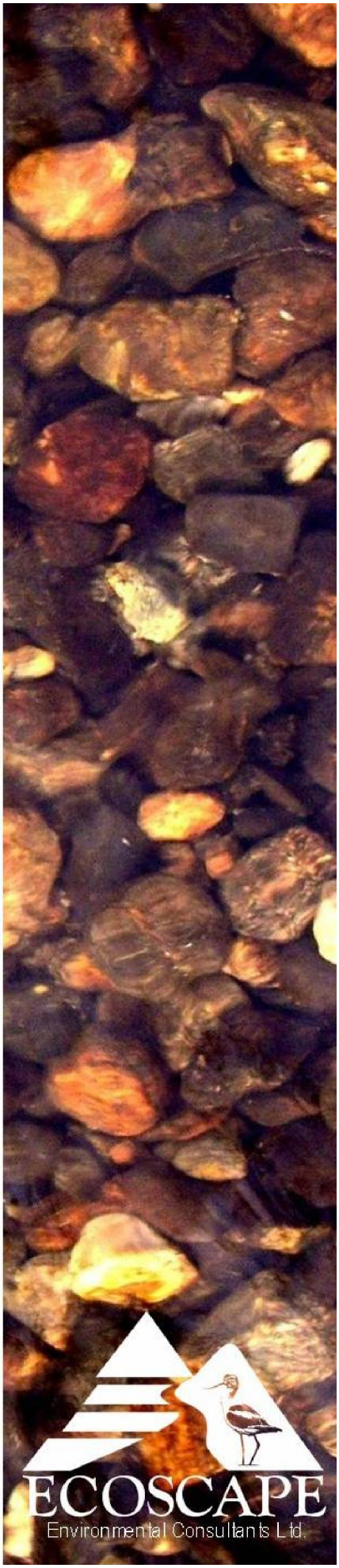

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Foreshore Inventory and Mapping

KOOTENAY LAKE MAIN ARM

Prepared For:
Regional District of Central Kootenay

Prepared By:
Ecoscape Environmental Consultants Ltd.

September, 2010
File No.: 09-513

FORESHORE INVENTORY AND MAPPING

Regional District of Central Kootenay

Kootenay Lake
Main Arm

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EXECUTIVE SUMMARY

This report has been prepared based upon the belief that it is possible to manage our watersheds and their natural surroundings in a sustainable manner. The intent of this document is to provide relevant stakeholders with pertinent environmental information to facilitate future land use planning along the Kootenay Lake Main Arm foreshore. This project is Step 1 of a general process of inventory and planning exercises that are happening around the province:

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

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

3. Step 3 - Shoreline Management Guidelines are prepared for the shorelines surveyed to allow governments to make informed land use decisions for our watersheds that are based upon the risks of potential land use change. The Shoreline Management Guidelines are intended to provide background information to stakeholders, proponents, and governmental agencies when land use changes or activities are proposed that could alter the shoreline thereby affecting fish or wildlife habitat. This step has not yet been completed for Kootenay Lake.

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

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

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

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

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

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

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

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

The following summarizes habitat modifications observed:

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

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

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

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

The findings of the FIM indicate that the foreshore areas of Kootenay Lake has been impacted by our current land use practices. The surveys indicate that in more densely developed areas, impacts are greatest. It was readily apparent that where intense development was present most habitat features had been impacted or impaired in some way. Transportation has also played a role in disturbances along the shorelines. Despite these impacts, many areas around the shoreline remain in a relatively natural condition. The lake shore still supports diverse communities in rural areas.

Also, there are many natural park land areas around Kootenay Lake that support a diverse community that is in good condition. Maintenance of the rural nature of the shore line in areas will help reduce cumulative impacts along the shoreline. Further, by limiting intense development areas along the shoreline, habitat impacts will be reduced.

REPORT DISCLAIMER

The results contained in this report are based upon data collected during a brief one year inventory completed by others. Data was provided to Ecoscape and we have assumed that the data provided is accurate. Ecoscape has reviewed and corrected data based upon the information provided from multiple sources to the best of our ability. Biological systems respond differently both in space and time. For this reason, the assumptions contained within the text are based upon field results, previously published material on the subject, and airphoto interpretation. The material in this report attempts to account for some of the variability between years and in space by using safe assumptions and a conservative approach. Due to the inherent problems of brief inventories (e.g., property access, GPS/GIS accuracies, air-photo interpretation concerns, etc.), professionals should complete their own detailed assessments of shoreline areas and shore wetlands to understand, evaluate, classify, and reach their own conclusions. Data in this assessment was not analyzed statistically and no inferences about statistical significance are made if the word significant is used. Use of or reliance upon biological conclusions made in this report is the responsibility of the party using the information. 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

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

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

2.0 PROJECT OVERVIEW

Kootenay Lake is a narrow lake with a U shaped bottom. The primary tributaries to the lake are the Kootenay River (entering in the South Arm) and the Duncan and Lardeau Rivers (entering in the North Arm). The shorelines of the North and South Arm's of Kootenay Lake are within the Regional District of Central Kootenay and Village of Kaslo. The intent of this project was to inventory the shoreline of the main arm of Kootenay Lake to understand the current condition of the shoreline and facilitate better long term management. In 2008, the West Arm of Kootenay Lake was inventoried using the same methodology (Lawrence and Porto, 2008). Without important inventory information such as this, it will not be possible to monitor whether management objectives for the lake have been met over time. The mapping protocol will allow stakeholders to understand what the current condition of the shoreline is, to set objectives for better shore management in Official Community Plans or other policy documents, and measure and monitor changes in the shoreline overtime. Data collected during this assessment should be incorporated into the Kootenay Lake Stewardship Plan.

INSERT PROJECT LOCATION FIGURE 1

2.1 Project Partners

Numerous different parties have contributed to the success of this project. Foreshore Inventory and Mapping (FIM) protocols have been developed over the last seven (7) years and have become a standardized approach to shoreline inventory. The first Foreshore Mapping effort was conducted in 2004 on Okanagan Lake. Numerous local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol since in conception. These contributing partners are recognized in Appendix A (Detailed methods).

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

1. Regional District Central Kootenay; and,
2. Fisheries and Oceans Canada;

2.2 Objectives

The project objectives were as follows:

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

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

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

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

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

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

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

3.0 FORESHORE INVENTORY & MAPPING METHODOLOGY

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

3.1 Field Surveys

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

3.2 Methodology

All of the methods outlined in Appendix A for FIM projects were carried out for this assessment. Daily information collected was downloaded to a laptop as a backup. Once downloaded, the entire database was reviewed for accuracy and corrections were made as necessary. Ecoscape has reviewed the database provided and worked with data collectors to ensure accuracy of the database. However, due to the large size of the dataset, small errors may be encountered. These errors, if found, should be identified and actions initiated to resolve the error.

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

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for *select areas* of the shoreline along Kootenay Lake. Areas selected for mapping were easily identifiable on the air photos provided for the project. Generally, these areas occurred in important floodplain areas around the lake. Due to airphoto resolution, mapping is considered to be moderately accurate and should not be relied upon exclusively for any detailed assessment. For the purposes of this assessment, aquatic vegetation included all plant forms and communities occurring below the lake highwater level. Although some of the plants are not truly aquatic, all are hydrophitic and contribute to fish habitat. Vegetation mapping was completed using air photos and site photographs. Aquatic Vegetation polygons are similar to Zones of Sensitivity identified by the Okanagan and Windermere projects. Vegetation communities were classified using the Wetlands of British Columbia – A guide to identification (Mackenzie and Moran, 2004) and were categorized as:

Marsh (Wm)

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

Swamp (Ws)

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

Low Bench Flood Ecosystems (Fl)

Low bench ecosystems occur on sites that are flooded for moderate periods (< 40 days) of the growing season, conditions that limit the canopy to tall shrubs, especially willows and alders. Annual erosion and deposition of sediment generally limit understory and humus development.

Mid Bench Flood Ecosystems (Fm)

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

Other Vegetation Areas

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

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

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

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

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

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

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

3.2.2 GIS and FIM Database Management

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

- Data and photos were backed up to a computer/laptop on a daily basis;
- Photos were taken and photo logs were used to facilitate data review and interpretation;
- Air photo interpretation was completed using moderate resolution air photos that were available. Airphoto's used during this assessment were of moderate quality and therefore, some mapping boundaries are not as accurate as desired.
- During data analysis, numerous checks were completed to ensure that all data was analyzed and accounted for.
- The TRIM shoreline file was provided by the MoE. Ecoscape did not complete shoreline mapping (i.e., digitization of the shoreline to more accurately determine the HWL) for this project due to budgetary constraints.

The following data fields were added to the FIM data dictionary

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

2. A Community Field was added to the database to allow future data analysis by community if desired. This field is currently blank.

4.0 DATA ANALYSIS

4.1 General

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

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

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

The following sections provide specific details for the biophysical analyses.

4.2 Biophysical Characteristics and Modifications Analysis

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

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

5.0 RESULTS

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

5.1 Biophysical Characteristics of the Lakes

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

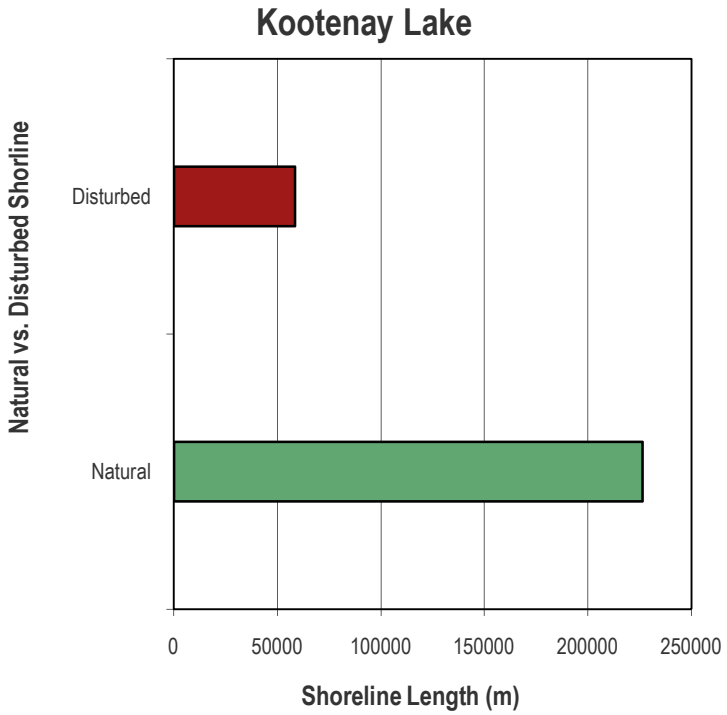

Figure 2 The total shoreline length that is either natural or disturbed on Kootenay Lake.

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

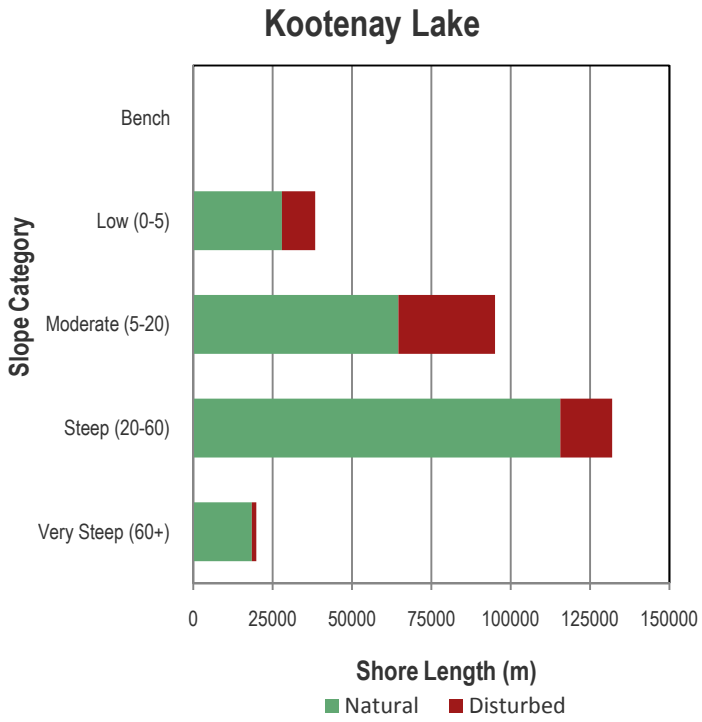

Figure 3 The total shoreline length that is either natural or disturbed within the different slope categories of Kootenay Lake.

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

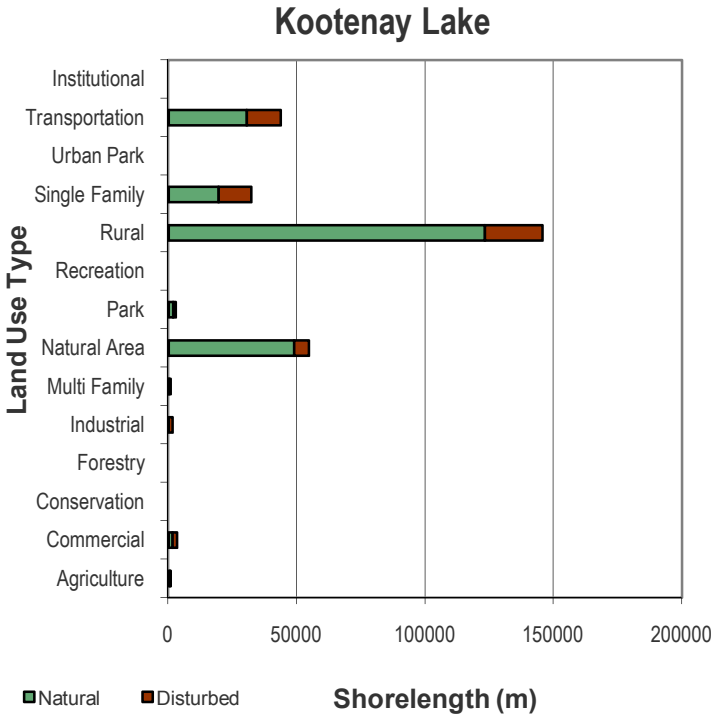

Figure 3 presents the natural and disturbed shore length by the different types of land use types occurring around Kootenay Lake.

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

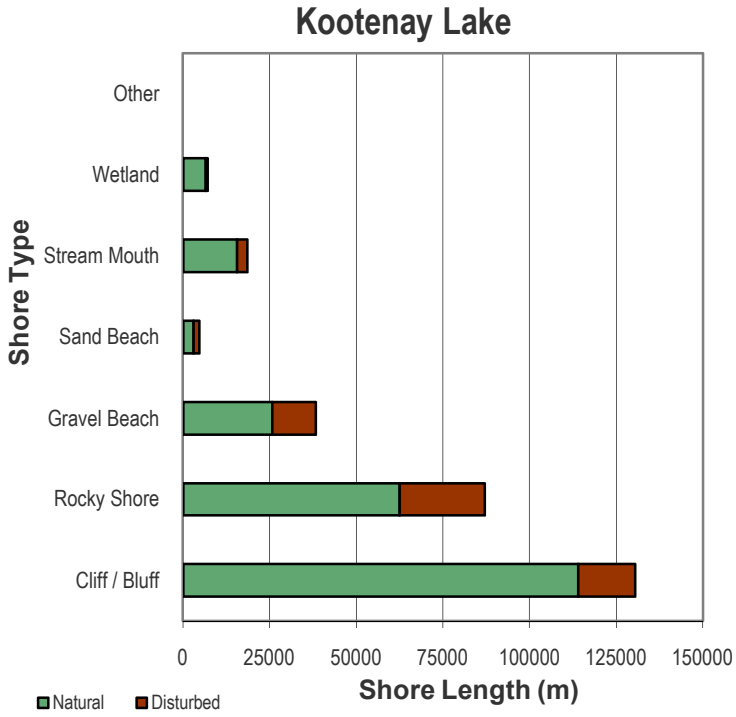

Figure 4 presents the length of natural and disturbed shoreline along each of the different shore types on Kootenay Lake.

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

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

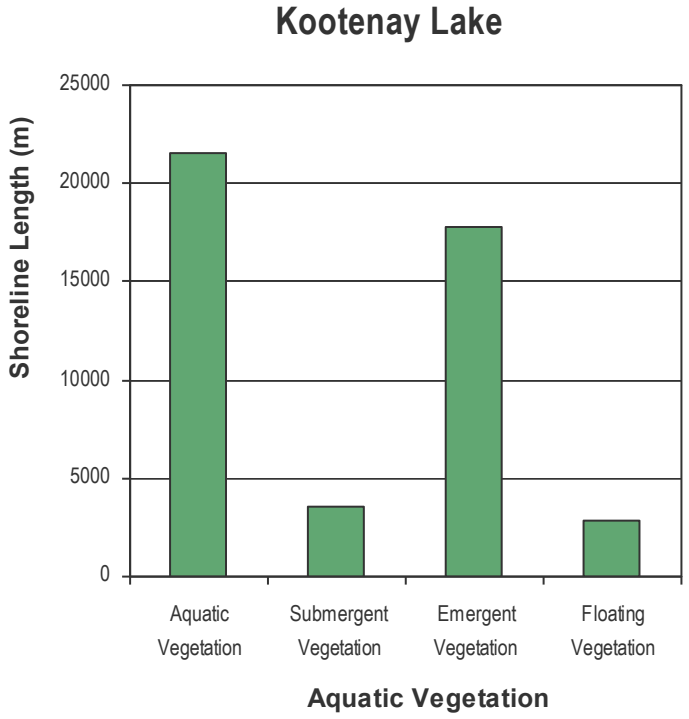

Figure 5 presents the total shoreline length that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

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

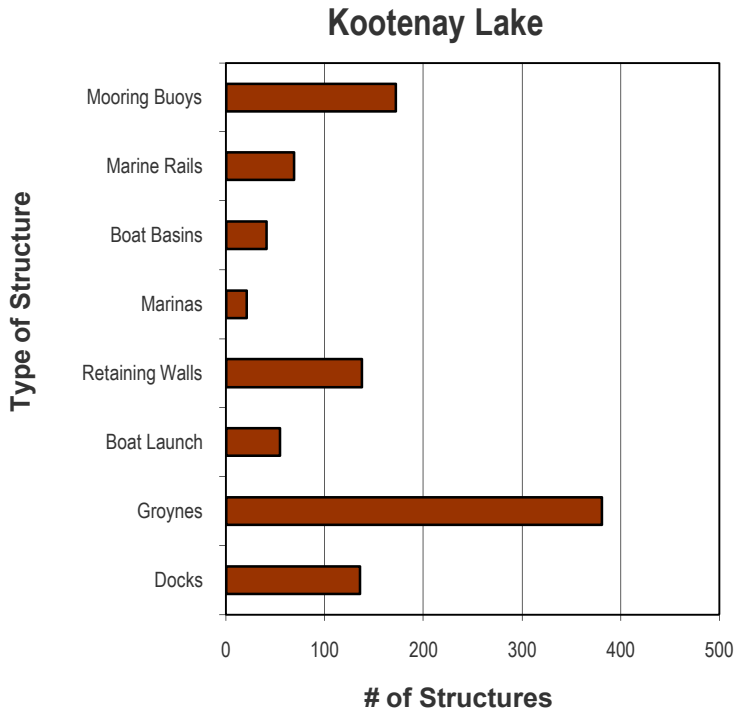

Figure 6 presents the total number of different shoreline modifications that occur around Kootenay Lake.

The percentage of the shoreline that was impacted by transportation (roads, railways), and substrate modification was recorded along Kootenay Lake to allow an estimation of the approximate shoreline length that has been affected by these different mechanisms (Figure 7). By far, substrate modification was the most substantial impact that was observed along the shoreline. In total, it is estimated that 15% or 44 km of shoreline has experienced some form of substrate modification in the form of beach grooming, highway or railway fills, and construction of groynes. Transportation impacts from railways were the next most prevalent modification and were present along 7% or 20km of shore line. Roadways having a direct impact on the foreshore of Kootenay Lake occurred along approximately 3% or 10 km of the shore length.

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

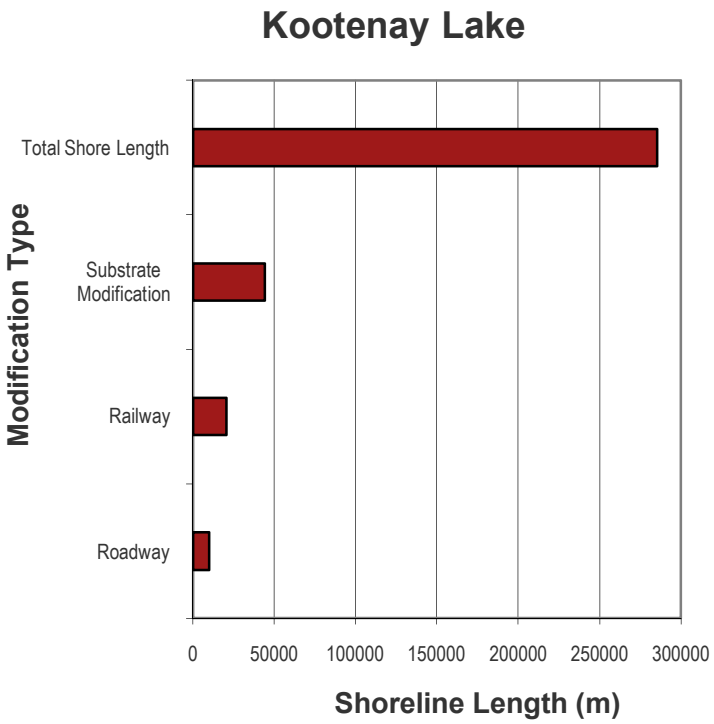

Figure 7 presents the total shoreline length that has been impacted by substrate modification, road and railways along Kootenay Lake.

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

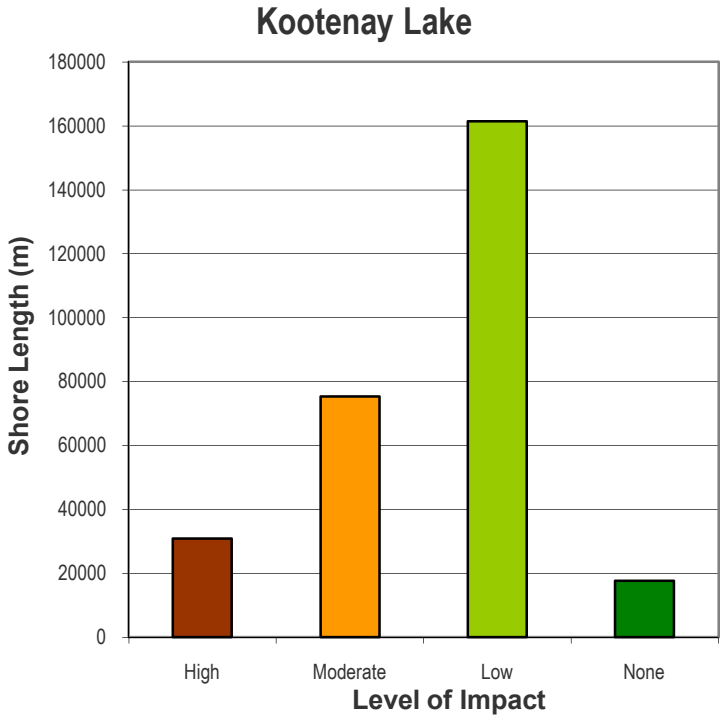

Figure 8 presents the level of impact (High, Moderate, Low, or None) observed along Kootenay Lake.

5.2 Summary of Foreshore Modifications

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

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

- Floodplain areas within Kootenay Lake have been modified since construction of the dam at the outflow for power generation. A result of this water level regulation is an increase in establishment of shrubby vegetation along the shoreline in areas that were historically more prone to flooding. In developed areas, it is apparent that emergent shrubby vegetation below the high water level (e.g., willows and cottonwoods), including grasses and sedges, and other types of aquatic vegetation has been impacted. It is believed that most of this vegetation removal is the result of groyne construction, substrate modification, or from road/rail fills. All aquatic vegetation, including establishing shrubby vegetation resulting from lake level regulation is important and continued impacts will affect juvenile fishes during high water in the spring when they are known to feed upon organisms within the vegetation (Adams and Haycock, 1989).

- Riparian vegetation disturbance has changed the vegetation type from natural broadleaf or coniferous associations to landscaped, lawn, or un-vegetated associations in more densely developed areas. The noticeable losses of riparian vegetation have not been quantified as part of this assessment, but are considered significant. There are numerous opportunities for riparian habitat enhancements along the shoreline of the lakes. Currently, an effort is underway in the Shuswap system to digitize and map all riparian vegetation to better track changes over time. This approach would provide a very accurate description of the shoreline, but may be costly to conduct.

- Private boat launches have been constructed on Kootenay Lake, resulting in a permanent loss of fish habitat in gravels that have been covered by concrete or significantly compacted / disturbed by boats and trailers. These boat launches were almost all associated with vehicular access, which has impacted riparian vegetation. It is conservatively estimated that all boat launches on Kootenay Lake have resulted in the loss of at least 990 m^2 of lost foreshore habitat (i.e., below high water level) and 1,650 m^2 of riparian habitat (assuming the average boat launch is 3 m wide and 6 m long and has vehicular access through a 10 m wide riparian zone). It is likely that most of these boat launches were constructed without a provincial *Water Act* or federal *Fisheries Act* approval.

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

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

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

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

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

6.0 KEY MANAGEMENT CONSIDERATIONS

6.1 Fisheries Overview and Considerations

Kootenay Lake has very important fisheries values because it has some of the best recreational fishing for rainbow trout and kokanee in British Columbia (Andrusak, 2006). The lake supports a variety of strains of rainbow trout, including the large Gerrard

rainbows (Andrusak, 2006). Over the past few decades, experimental fertilization programs have been carried out by the Ministry of Environment (now the Ministry of Natural Resource Operations) to help improve fisheries within the lake (Wright *et al.*, 2002). The focus of the fertilization programs has been to improve kokanee stocks, which are a key food source for the large Gerrard Rainbows. Other key food sources for Gerrard rainbows include terrestrial insects, which can account for as much as 30% of their diet during spring and summer months (Andrusak and Parkinson, 1984). The terrestrial insects rainbows forage on rely upon riparian vegetation, highlighting the importance of this lakeside vegetation. Given the dependence that the Gerrard trout stocks have on terrestrial insects, which are directly dependent upon riparian vegetation, highlights the importance of protecting of existing riparian areas.

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

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

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

6.2 Land Development Considerations

Land development activities are largely governed by the Ministry of Transportation (through subdivision), local governments (through zoning and bylaws) and through the Ministry of Natural Resource Operations (Resident fish and wildlife responsibilities) and Fisheries and Oceans Canada (Fish Habitat responsibilities). Environmental land use planning is difficult because of the inherent stochastic nature of biological systems and their interactions (i.e., it is not easy to predict the responses of living animals to changes in their environment, particularly when the environment they live in is also changing). Adjacent terrestrial areas also play a key role in a sustainable land development and maintenance of our fish and wildlife habitats. Many of these terrestrial areas rely upon the shore line areas of Kootenay Lake and visa versa.

Precautionary principles to adjust for the inherent variability of living systems as part of a sustainable approach to land use planning and management is required if we intend to ensure the long term viability of the lake system. The data set that has been developed for this project can be updated as more information becomes available as part of a long term, adaptive management response which will better integrate our communities with their natural surroundings.

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

6.3 Cumulative Impacts Considerations

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

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

7.0 RECOMMENDATIONS FOR FUTURE CONSIDERATION

7.1 General

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

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

2. **Habitat restoration opportunities should be achieved wherever possible by identifying them during the development review processes.** In more urbanized areas, examples include removal of retaining walls, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, etc. There is significant opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lake. Habitat restoration projects should focus on key goals, such as riparian restoration, fisheries enhancements, etc. Any new shoreline developments, including single family dwellings or additions, should incorporate some aspect of restoration via the development permit process mentioned above.

3. **Core habitat areas are extremely important to maintain and should be identified as early as possible in the development process.** Detailed assessments and identification of core habitat areas for conservation should be done as early in the development process as possible. Integration of lakeside sensitive areas with terrestrial areas, identified though inventory such as Sensitive Ecosystem Inventory, is required through a development permit process. Numerous different possibilities exist to preserve areas identified as sensitive, including Section 219 No Build / No Disturb Covenants registered with the Land Titles office, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), creation of Map Reserves by the Integrated Land Management Bureau, or by other mechanisms (donation to trust, etc.).

4. **Environmental information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information and air photos are an extremely important part of the environmental review process. This information should be available to the public, including all air photos, GIS files, and other electronic documents. One

agency should take the lead role in data management and any significant studies that add to this data set should be incorporated and updated accordingly.

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

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

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

   Compliance Monitoring Example
   The Ministry of Environment in the Okanagan recently assessed a 30 km segment of Okanagan Lake shoreline for compliance with the Water Act and Best Management Practices. Within that segment assessed, there were 35 properties randomly selected for assessment. Compliance assessments were completed in 3 days (May 12-14). In total 638 *Water Act* files were found for Okanagan Lake and none of those files matched the properties. All 638 files were reviewed to confirm if they matched the randomly selected properties. There was 100% non-compliance with the modifications documented on the randomly selected properties on Okanagan Lake. This highlights the necessity and requirement of better compliance and enforcement at all levels.

8. **Lake shore erosion hazard mapping should be conducted for private lands to identify areas at risk, which will stream line the review process and reverse the damaging trend of unnecessary hard armoring and construction of retaining walls along the shoreline of the lakes.** Also, this methodology would be helpful to identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some adaptation of it, would be preferred (Guthrie and Law, 2005). This mapping should be integrated with the FIM data, and be completed for each segment. Flooding,

terrain stability, alluvial fan hazard mapping should also be considered for developing areas along the lakeshore. Until lakeshore erosion hazard mapping is completed, it is advisable to only consider shoreline protection works on sites with demonstrated shoreline erosion. To accomplish this, an engineer or biologist report should accompany proposal for shoreline armoring to ensure that works are required, minimize impacts and use bioengineering techniques.

9. **Storm water management plans should be included in all development applications that alter the natural drainage patterns.** It appears that development along the lakeshore has been occurring without the benefit of comprehensive storm water management plans. Poor storm water management can alter small streams by diversion, changes in water quality, and/or changes in discharge locations to the lake. This can result in erosion of non condition foreshores and impacts to shore spawning areas. Coupled with this, storm water management of small tributary streams (even non fish bearing ones) is also important. In recent works on Okanagan Lake, Ecoscape has documented extensive impacts to water quality in Okanagan Lake as a result of poor upstream storm water management a kilometer or more away. It is recommended that storm water management plans be required as part of development processes for all developments proposing discharge to a water course. Standard best practices have been developed and current regulations do not allow development of storm water treatment systems within setback areas.

10. **Rural areas accounted for 48% of the shoreline, indicating that there are substantial risks to fish and wildlife habitats if development proceeds without appropriate Best Management Practices and appropriate shoreline planning policies.** The Kootenay Lake Stewardship Plan should incorporate analyses to determine the sensitivity of shoreline features on rural lands. Rural lands are the most prone to subdivision, and therefore are more likely to experience greater impacts as development occurs. In previous FIM projects, Single Family development areas typically had some of the highest levels of disturbance (e..g, 77% on Shuswap and 85% on Okanagan), indicating that as rural properties develop into Single Family areas, there will be an inevitable increase in shoreline disturbance. Identifying critical habitat areas for fish and wildlife on these rural lands must be completed and subsequently incorporated into the Kootenay Lake Stewardship Plan in order to protect important biological resoureces.

7.2 Future Data Management

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

1. **One agency should take the lead role in data management and upkeep**. This agency should be responsible for holding the "master data set". Although the data may be available for download from numerous locations, one agency should be tasked with keeping the master copy for reference purposes. The Community Mapping Network is currently publishing many of the data sets that have been collected. Sufficient funding must be allocated to CMN to keep up with management of the data because as there becomes more datasets costs of management will increase.

2. **A summary column(s) should be added to FIM GIS dataset that flags new GIS datasets as they become available.** Examples of this include new location maps for rare species, fish, etc. Other examples include the addition of appropriate wildlife data. Where feasible, these new data sets should reference the shore segment number (see below).

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

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

7.3 Future Inventory and Data Collection

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

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

2. **Critical habitat areas for key fish and wildlife species should be inventoried and mapped using GIS.** In order to manage biological resources, a baseline understanding of critical habitats for different species is required. Some of this

information is currently available, while much of it is still unknown. Identification and spatial mapping of this information for key species will facilitate preparation of an Aquatic Habitat Index (Step 2).

3. **The Sensitive Habitat Inventory and Mapping (SHIM) is a GIS based stream mapping protocol that provides substantial information regarding streams and watercourses and should be conducted on all watercourses around the lake**. Mapping should focus on the significant salmonid rivers and streams first, and then one smaller tributaries containing resident fish habitat, followed by non fish bearing waters. This mapping protocol provides useful information for fisheries and wildlife managers, municipal engineering departments (e.g., engineering staff responsible for drainage), and others. This information is also extremely useful for Source Water Protection initiatives because it identifies potential contaminant sources in an inventory. An inventory of streams that have been mapped within the Okanagan should be undertaken to prepare on concise SHIM GIS dataset. This will allow managers to determine which streams have been completed and which ones haven`t.

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

5. **Sensitive Ecosystem and Inventory (SEI) and Terrestrial Ecosystem Mapping (TEM) are useful terrestrial mapping tools and these inventories should be completed**. These assessments help land managers identify sensitive terrestrial zones which can be integrated into the FIM and SHIM GIS datasets. At this time, some TEM datasets may exist. There are however, many areas that have not been completed and continued efforts to find funding to complete these works should be undertaken. Integrations of the SEI and TEM with Step 2 - Aquatic Habitat Index, would help determine key shoreline areas to consider as part of an inclusive management plan.

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

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

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

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

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

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

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

12. **Future fisheries work is required.** The knowledge gaps for the different species and their habitat areas at different life stages should be addressed. Although

speculations can be made, studies aimed at identifying the important areas and life stage will facilitate more informed planning.

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

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GLOSSARY OF TERMS AND ACRONYMS

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

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

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

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

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

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

Best Management Practice (BMP) - Is a method or means by which natural resources are protected during development or construction. For example, the Ministry of Environment have been recently creating documents containing guidelines for work in and around water.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SEGMENT PHOTO PLATE SUMMARY

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Kootenay Lake

FORESHORE INVENTORY AND MAPPING
FIGURE BINDER

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APPENDIX A

Foreshore Inventory and Mapping Methodology

APPENDIX B
Kootenay Lake Data Tables

TABLE 1..... Natural versus Disturbed Shoreline Length in Kootenay Lake
TABLE 2.....Natural and Disturbed Shorelines within different slope categories in Kalamalka Lake
TABLE 3.The total length of Natural and Disturbed Shoreline within each different Slope Category along Kootenay Lake
TABLE 4.....The total length of different land uses and their disturbances around Kootenay Lake
TABLE 5..... The total length of different Shore Types around Kootenay Lake
TABLE 6..... The total length of different Aquatic Vegetation Areas around Kootenay Lake
TABLE 7..... The total number of different modifications around Kootenay Lake
TABLE 8.....The total shore length of different shore modifiers around Kootenay Lake
TABLE 9..... The Level of Impact around Kootenay Lake

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

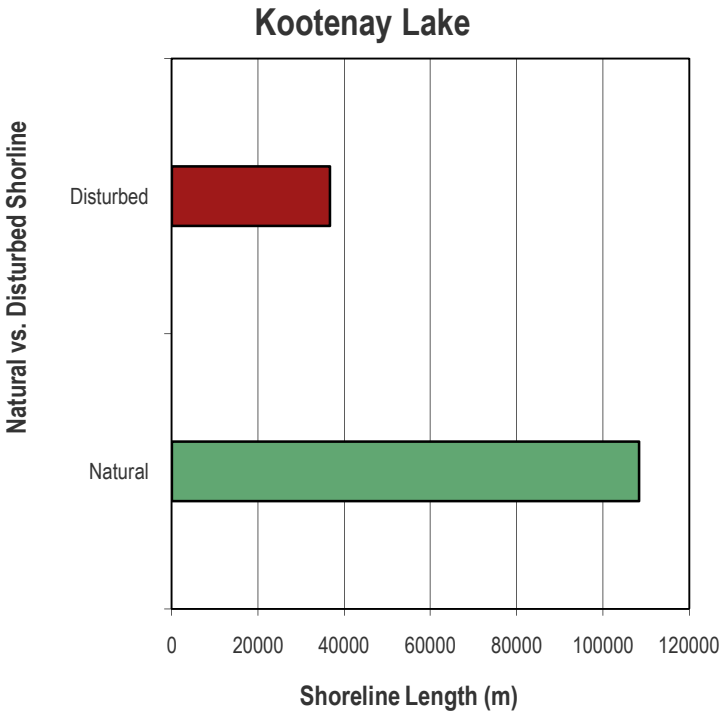

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

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

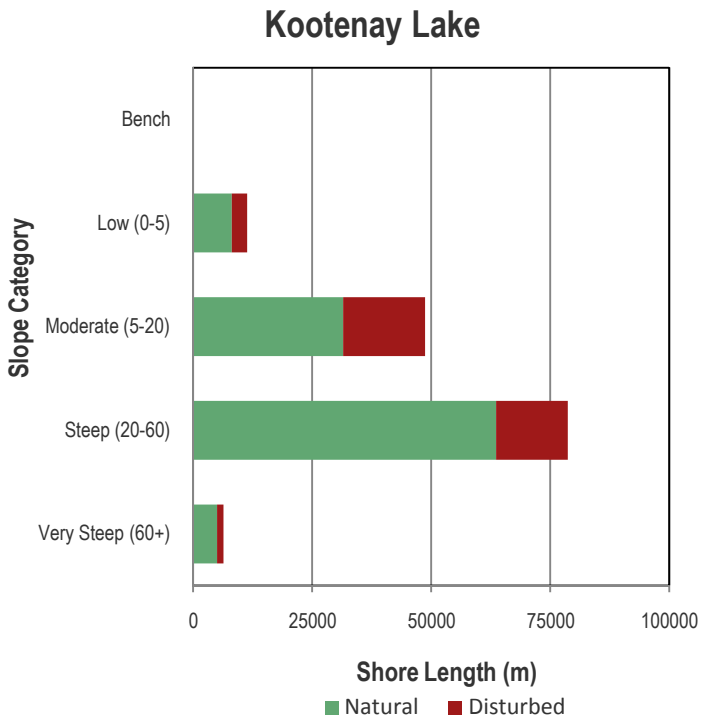

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

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

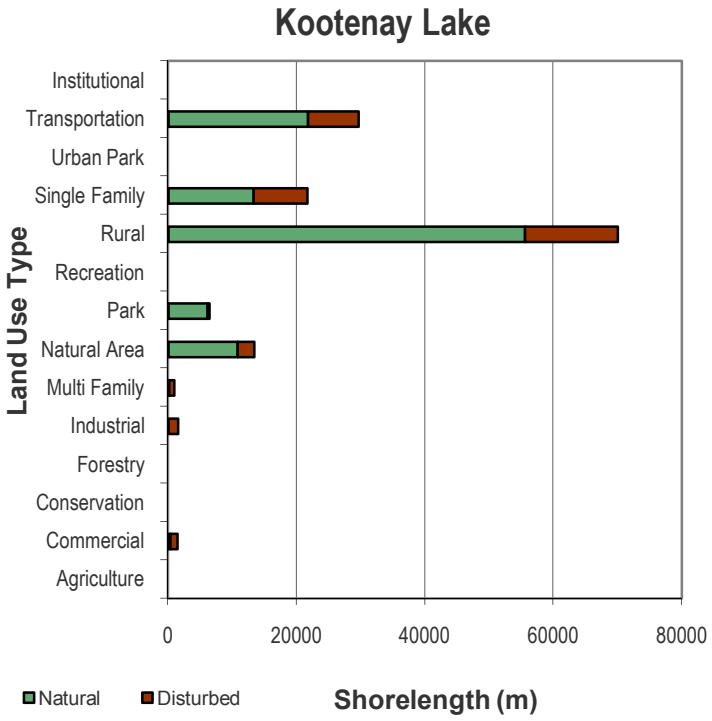

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

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

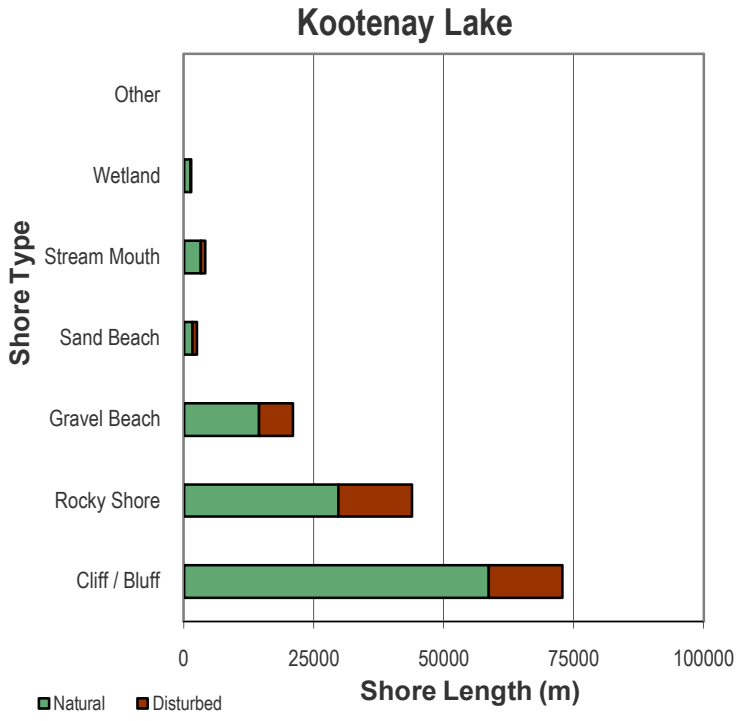

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

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

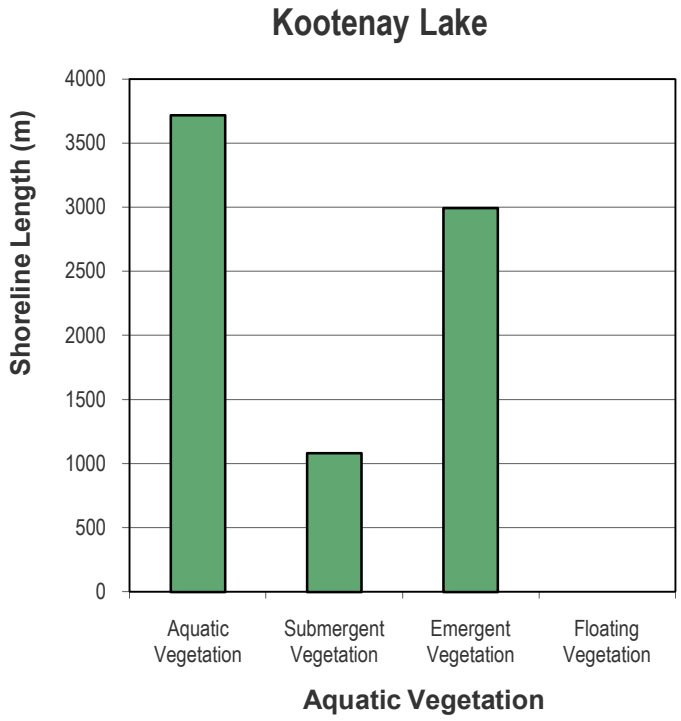

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

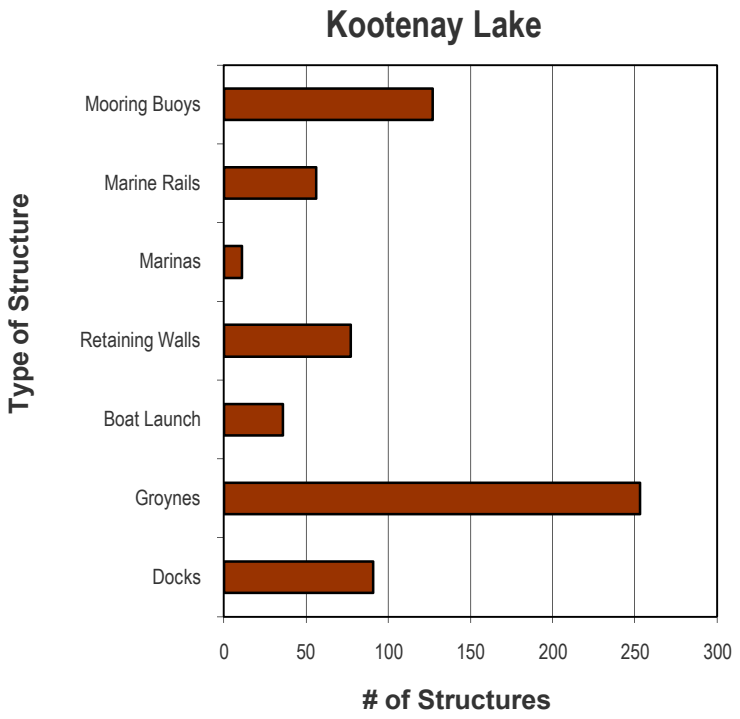

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

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

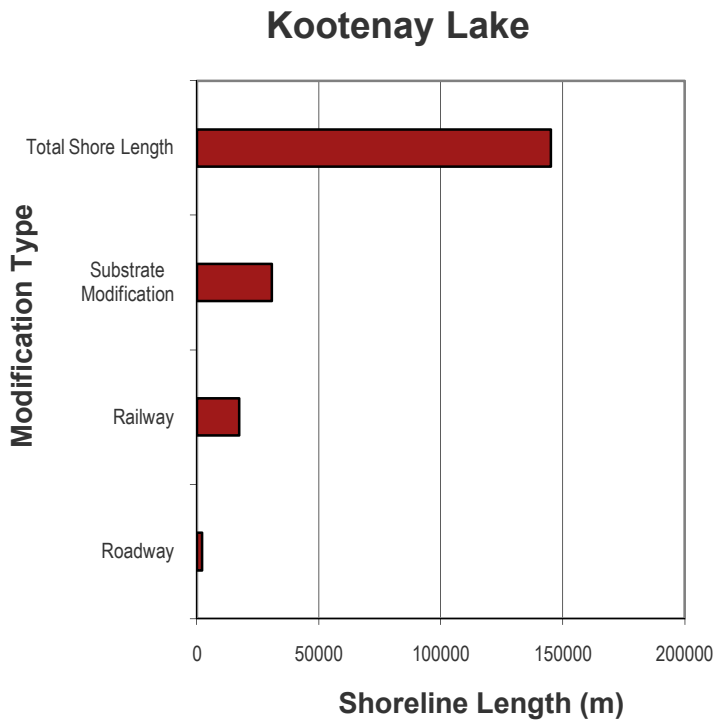

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

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

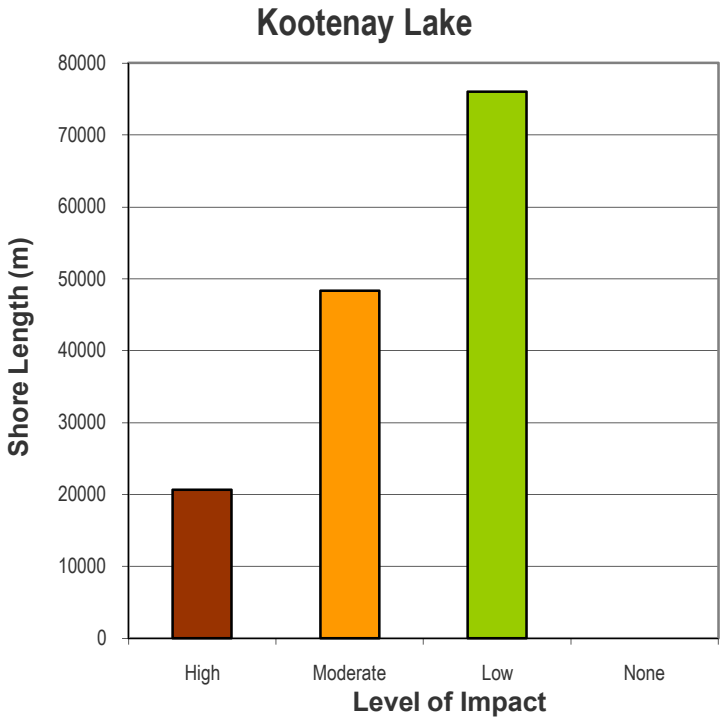

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

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

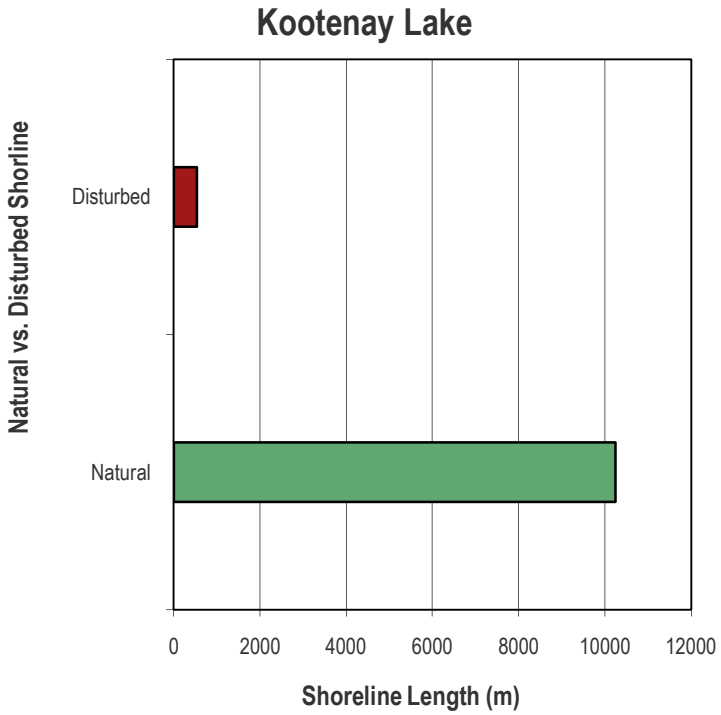

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

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

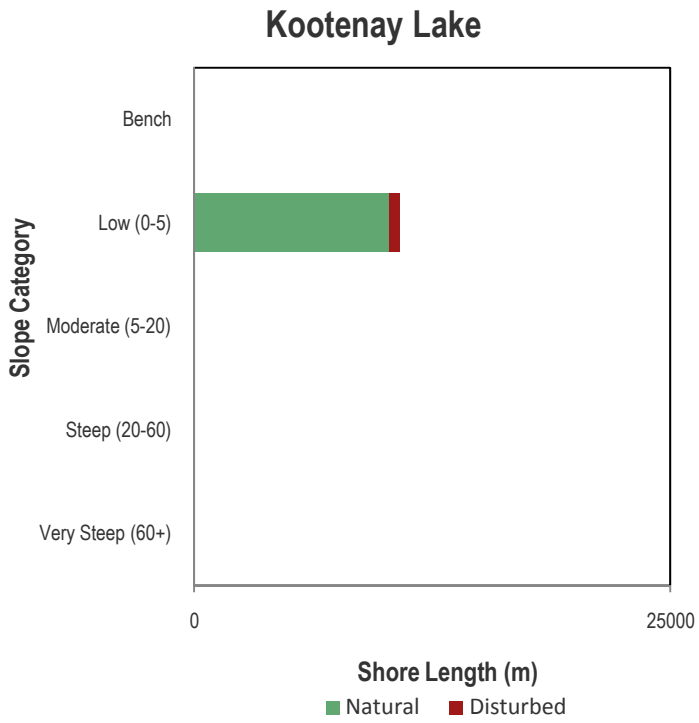

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

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

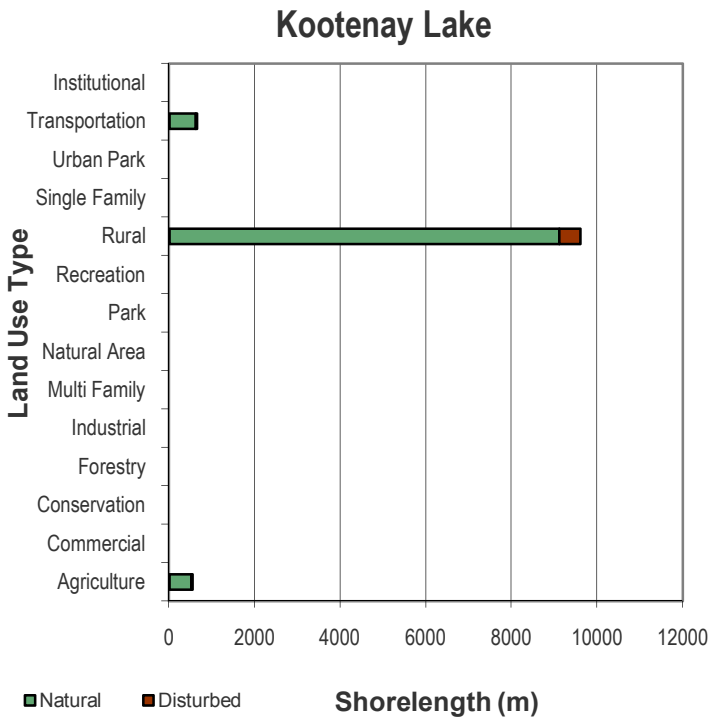

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

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

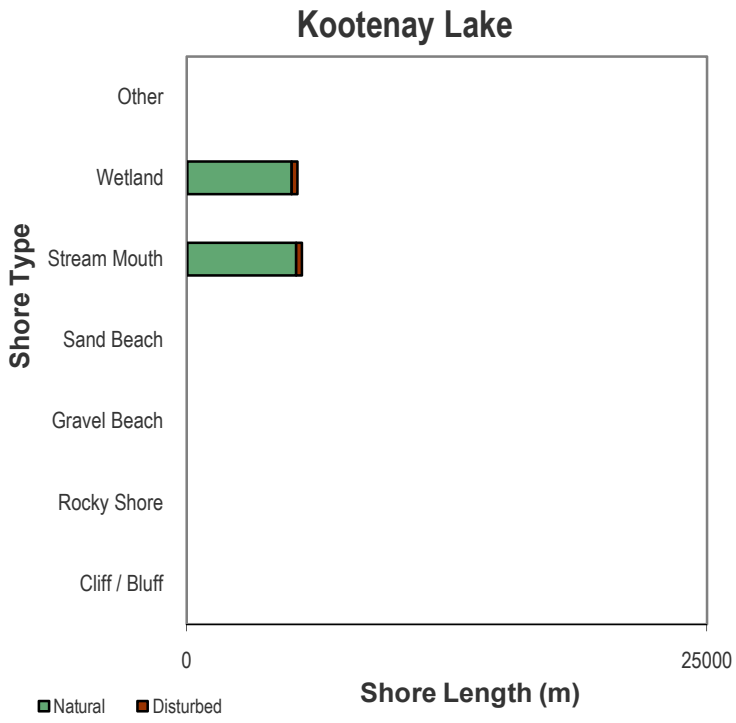

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

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

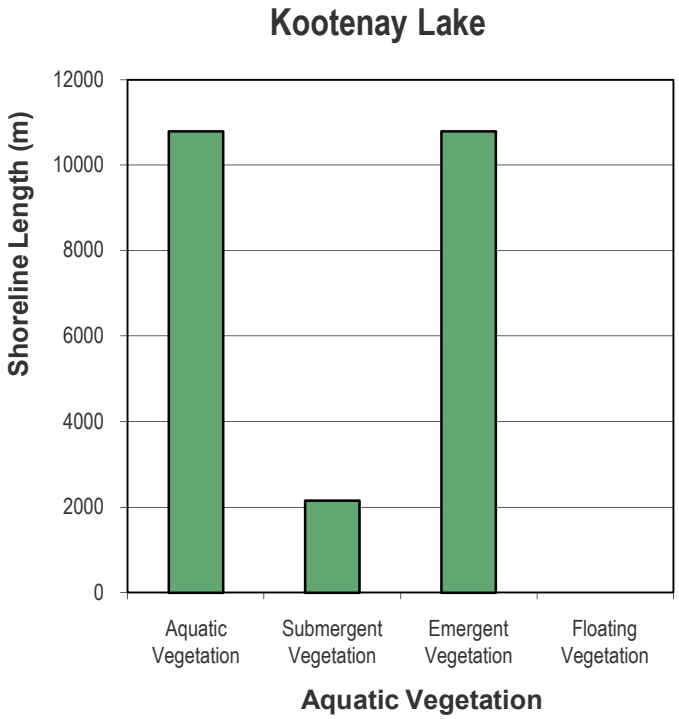

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

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

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

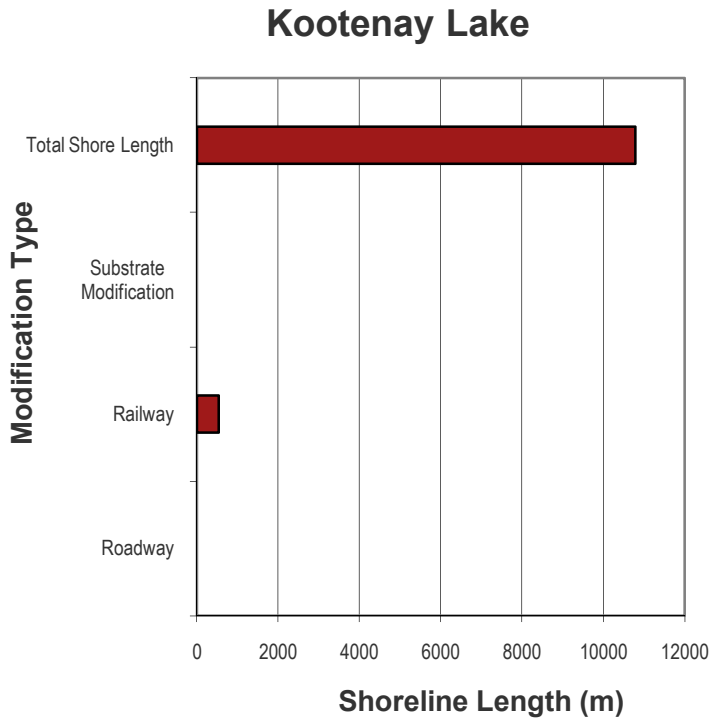

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

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

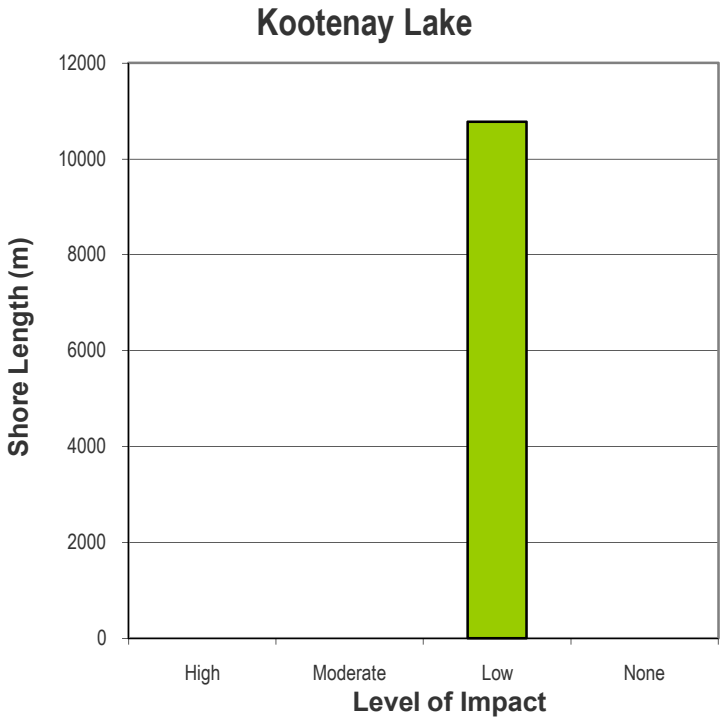

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

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

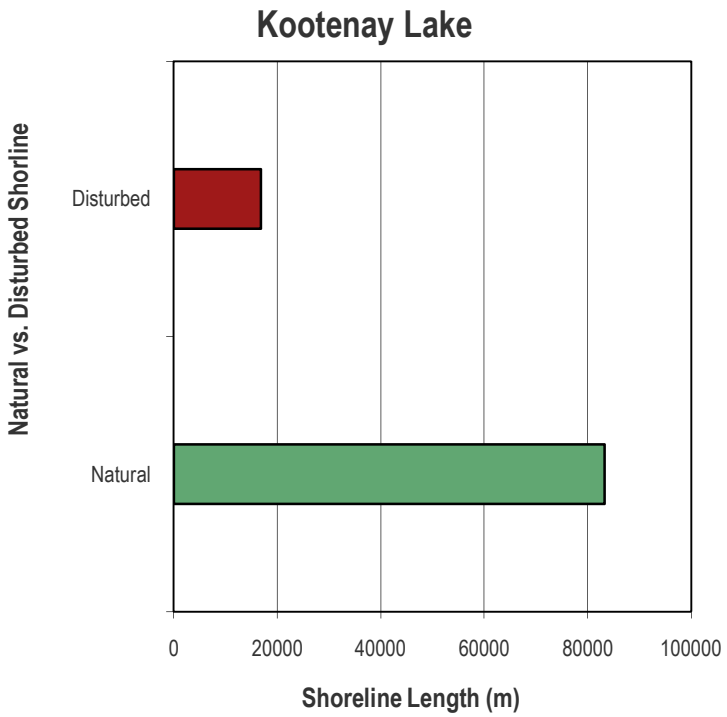

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

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

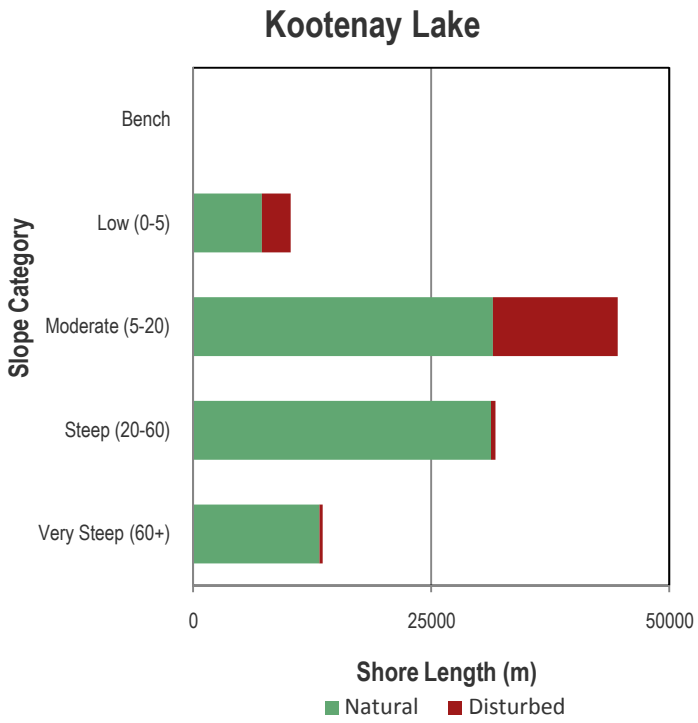

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

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

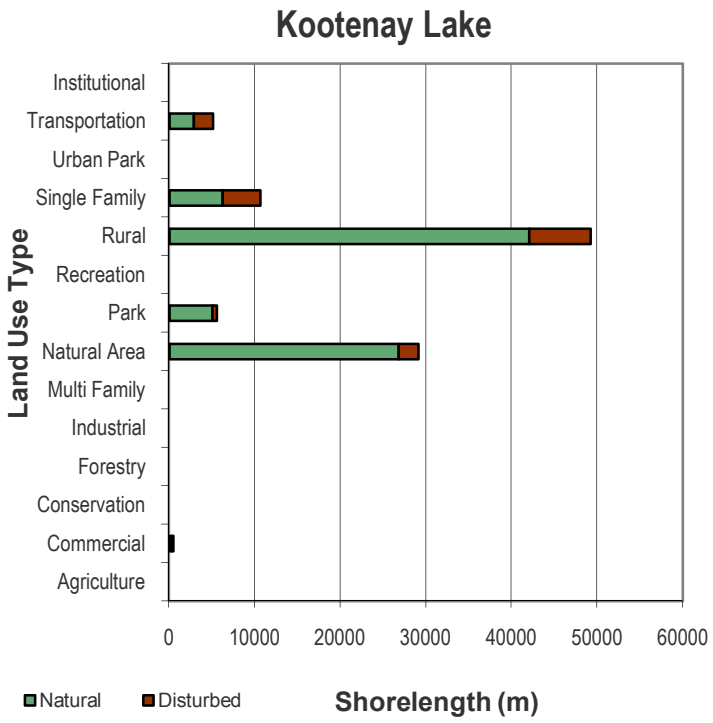

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

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

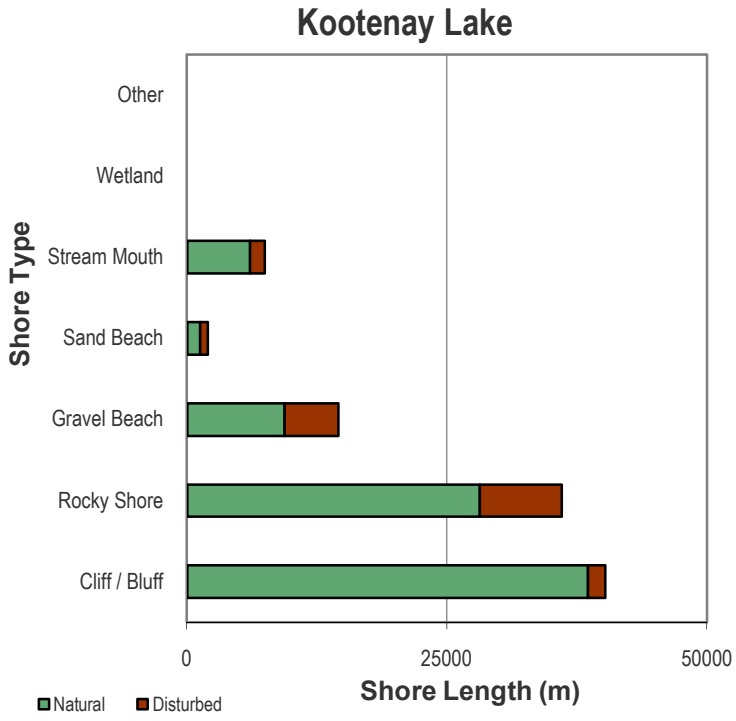

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

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

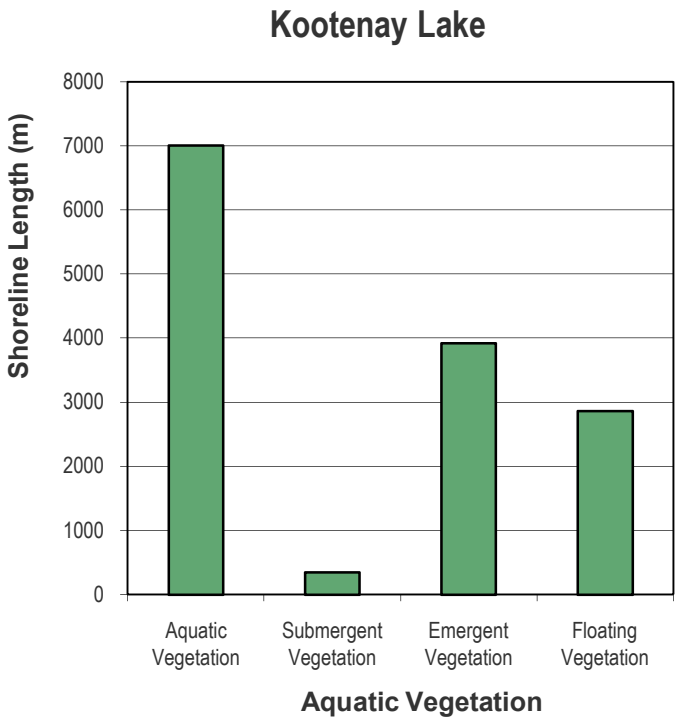

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

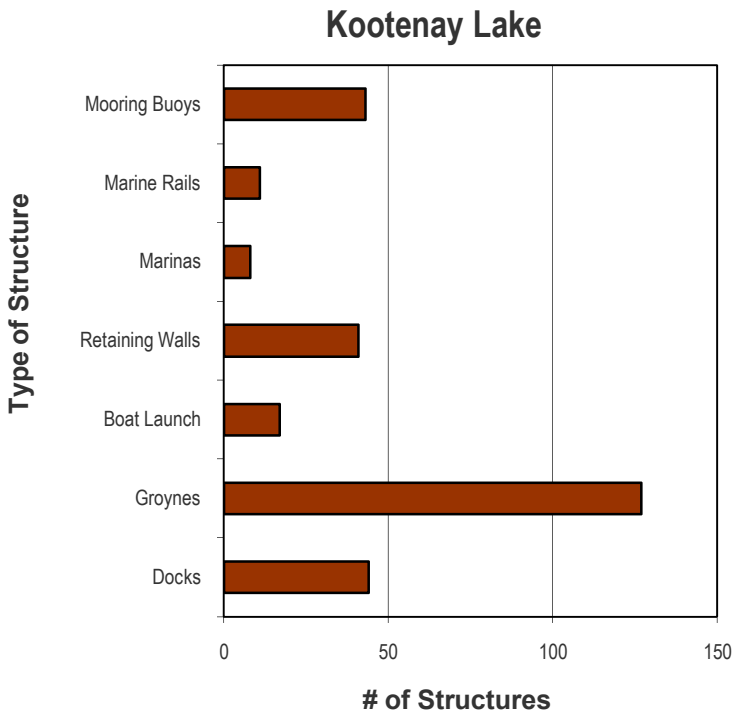

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

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

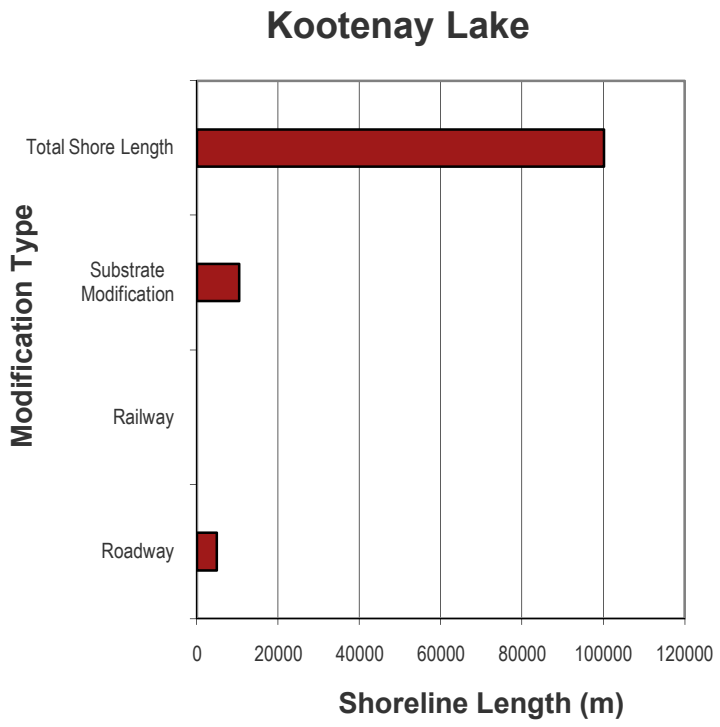

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

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

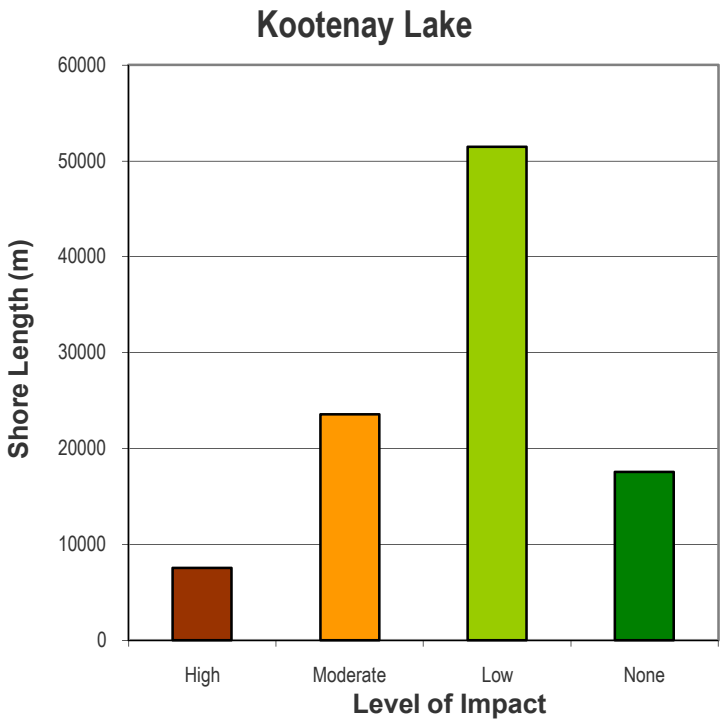

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

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

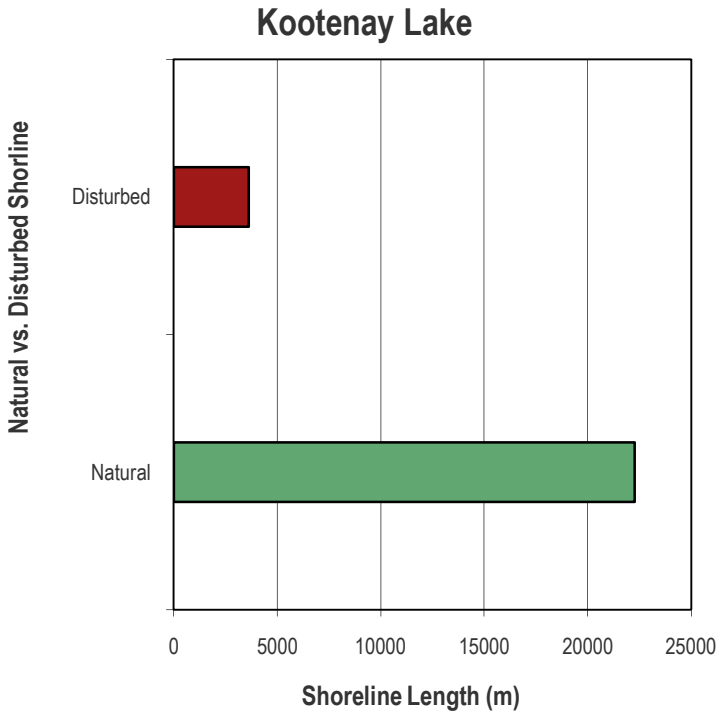

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

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

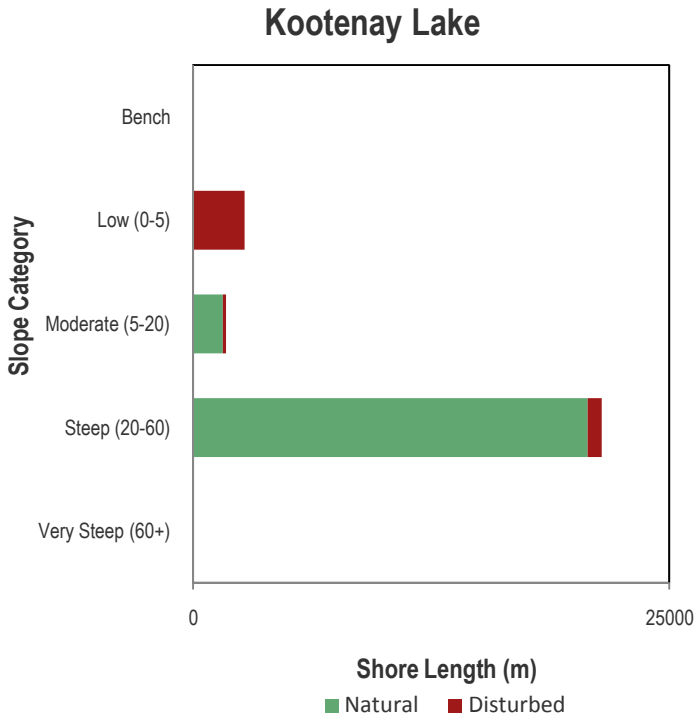

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

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

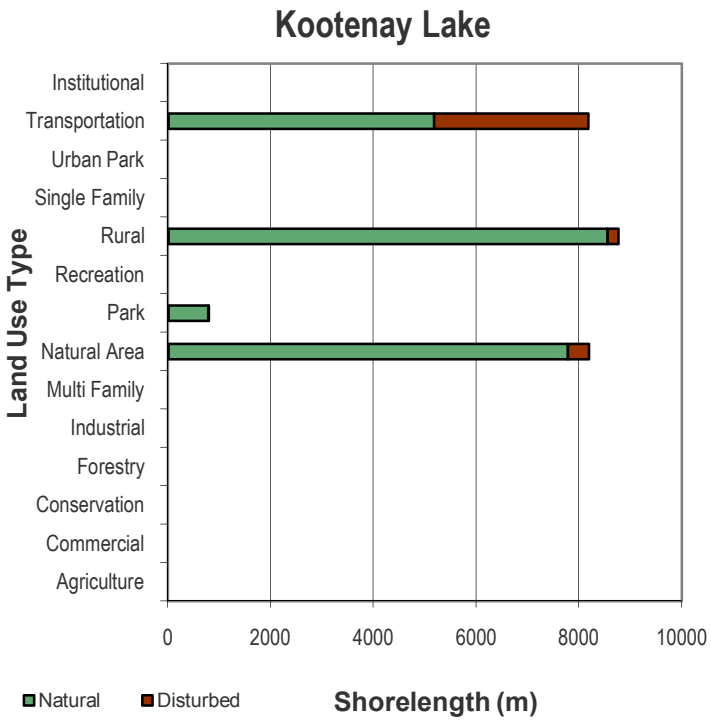

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

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

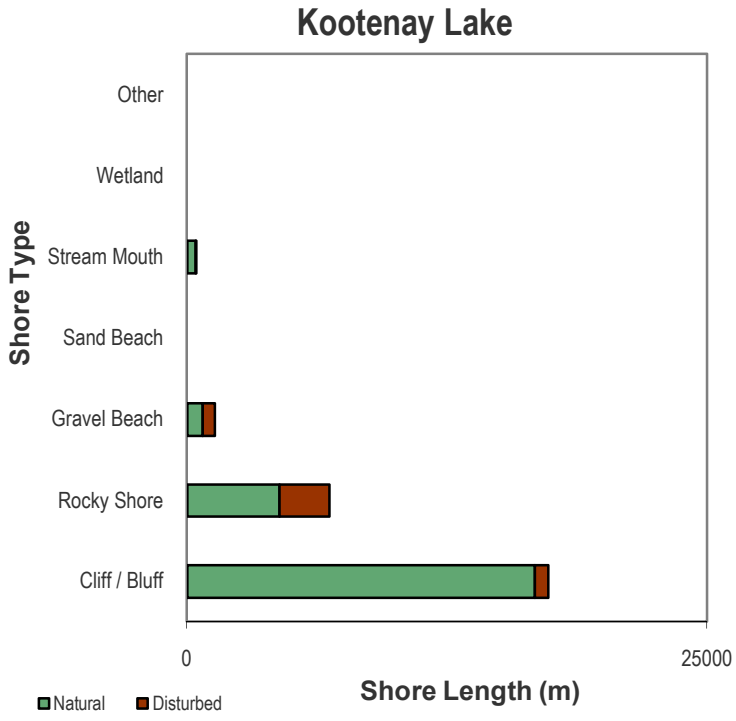

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

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

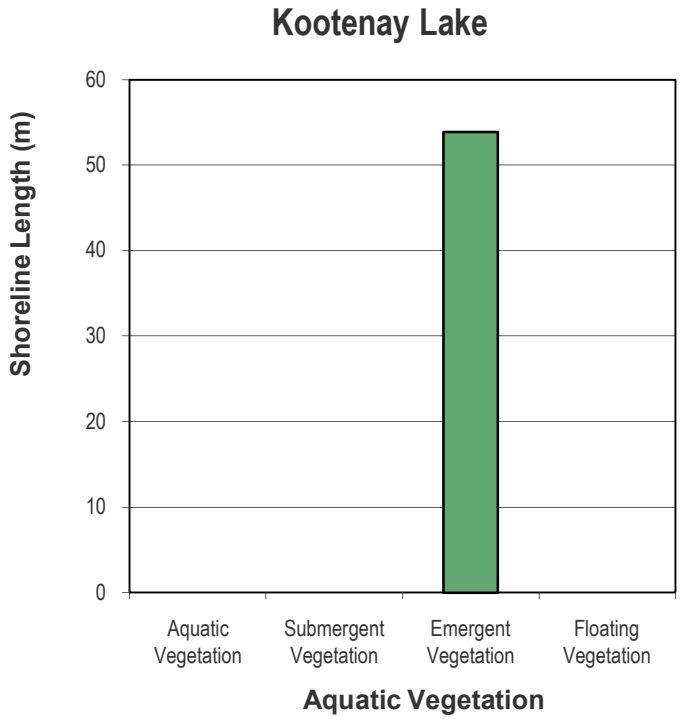

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

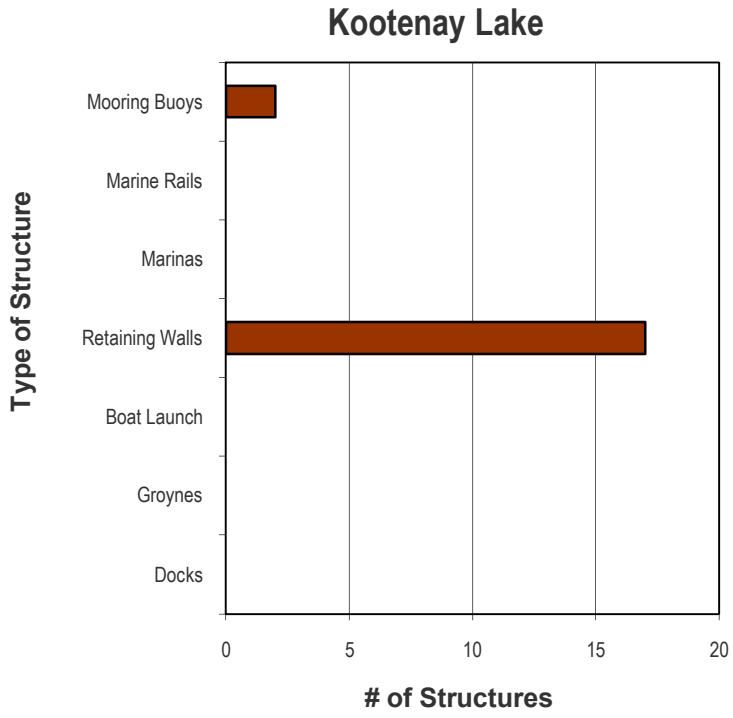

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

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

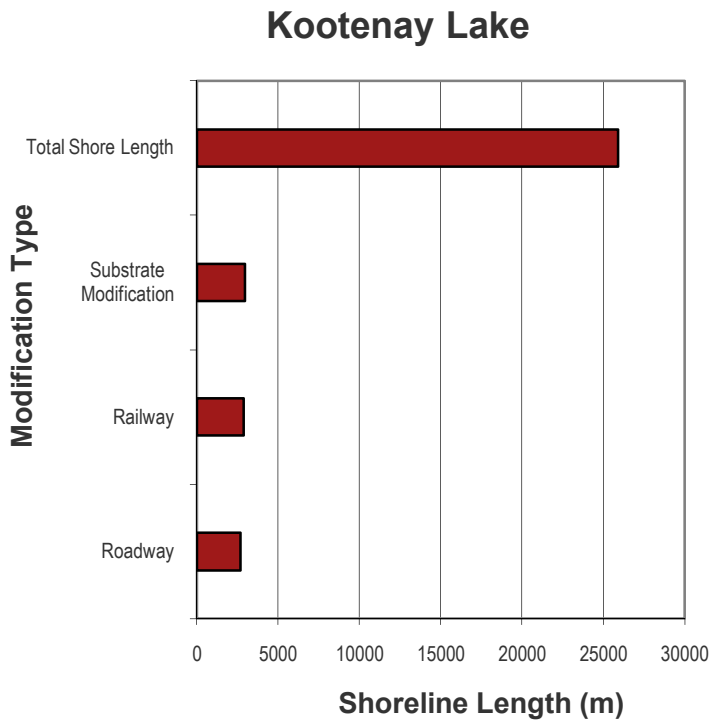

Table 7: The approximate shoreline length that has been impacted by substrate modification, road and railways, and retaining walls along Kootenay Lake.

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

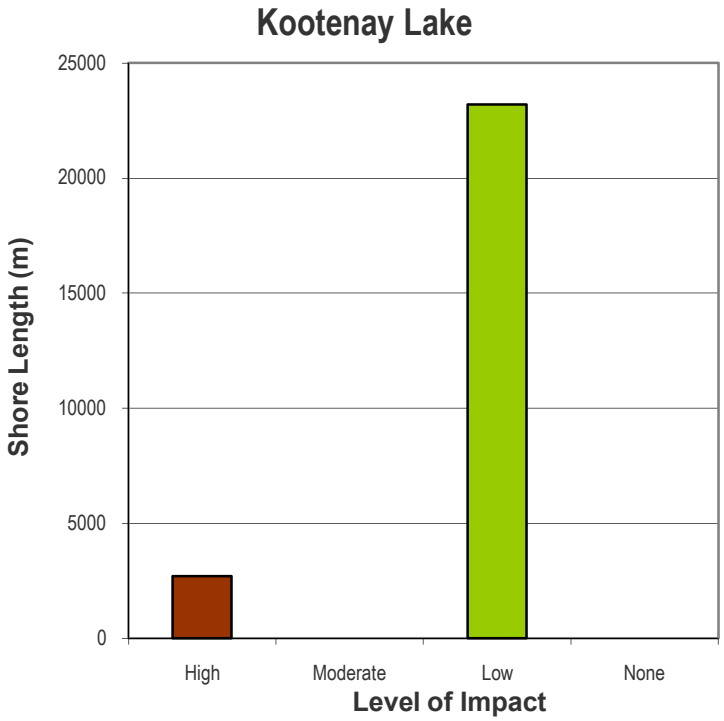

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

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

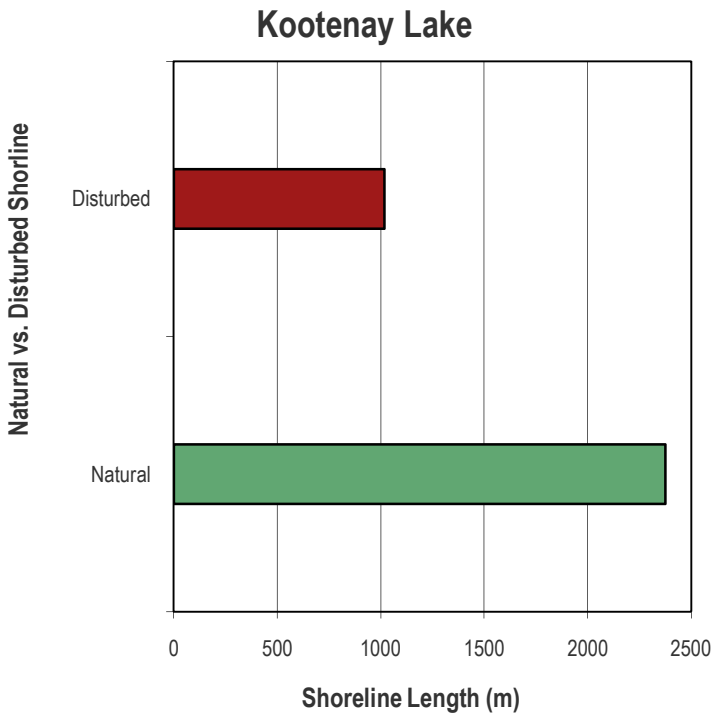

Table 1: The total shore length of natural and disturbed shorelines along Kootenay Lake.

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

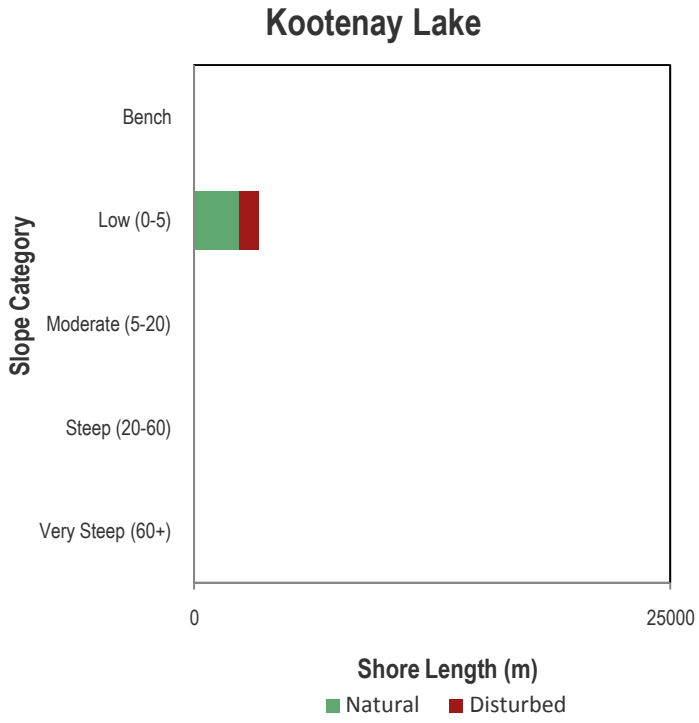

Table 2: The percentage of natural and disturbed shore lengths within each of the different slope categories in Kootenay Lake.

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

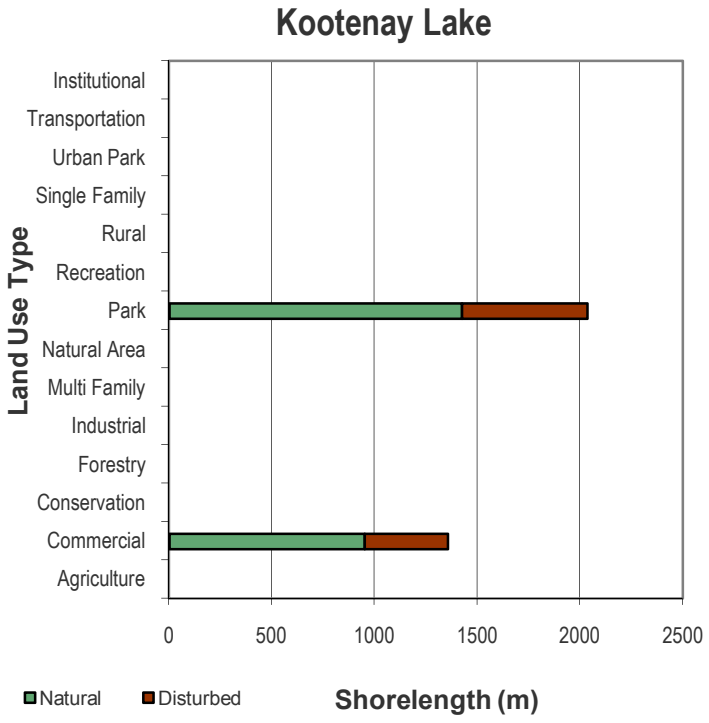

Table 3: The total length of natural and disturbed shorelines and their associated land uses around Kootenay Lake.

	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	0.0%	0	0	0	0.0%	0.0%
Commercial	40.0%	1357	950	407	70.0%	30.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	0.0%	0	0	0	0.0%	0.0%
Park	60.0%	2036	1425	611	70.0%	30.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	0.0%	0	0	0	0.0%	0.0%
Single Family	0.0%	0	0	0	0.0%	0.0%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	0.0%	0	0	0	0.0%	#DIV/0!
Institutional	0.0%	0	0	0	0.0%	0.0%
Total	100.0%	3392.8				

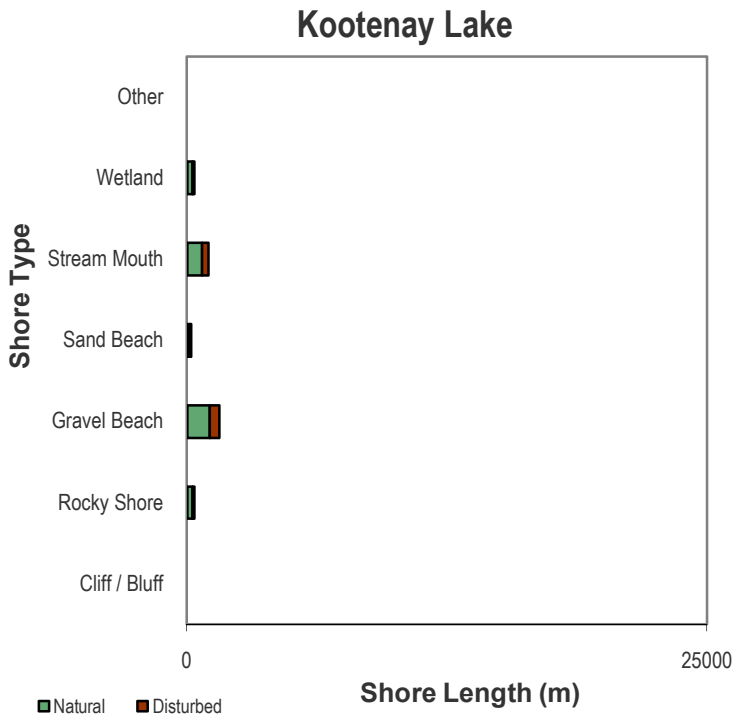

Table 4: The total length of natural and disturbed shoreline and associated percentages within the different shore types that occur around Kootenay Lake.

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

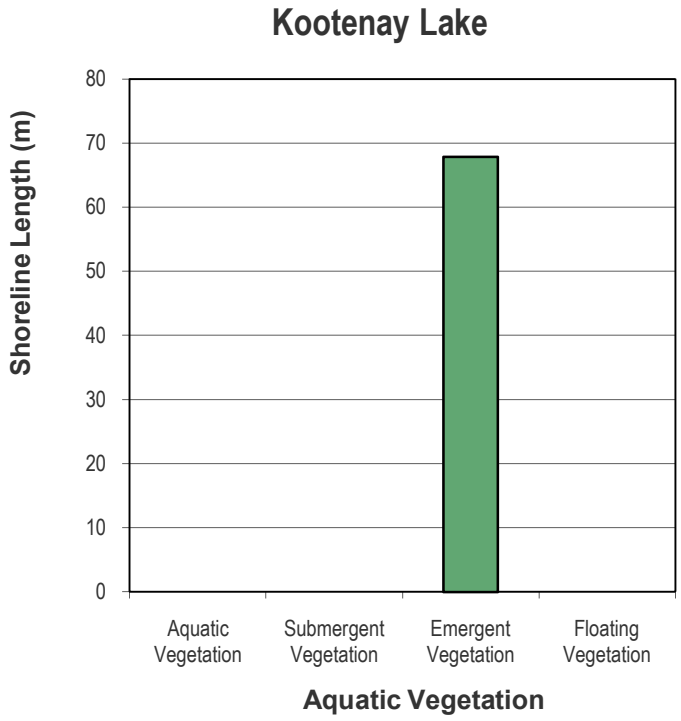

Table 5: The total shoreline length and percentage that has aquatic, submergent, emergent, and floating vegetation along Kootenay Lake.

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

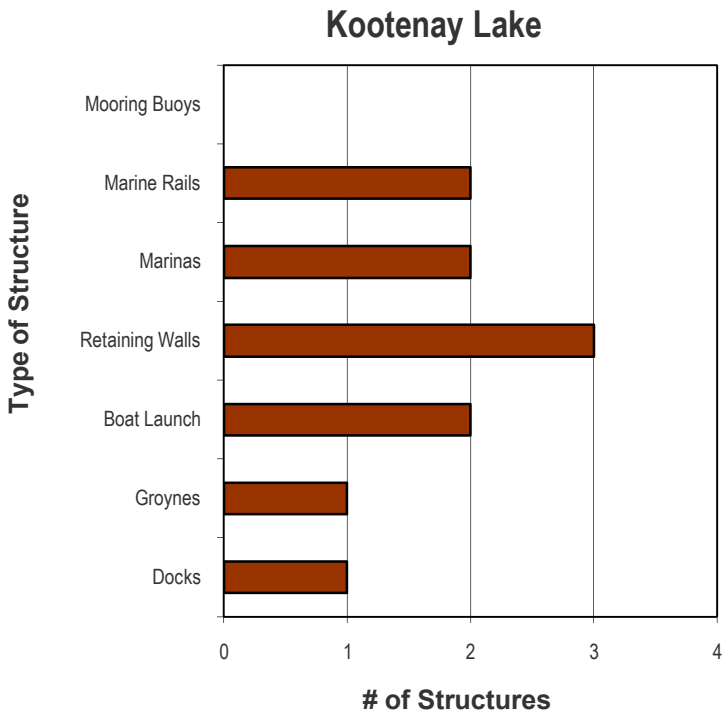

Table 6: The total number and density (# per km) of different shoreline modifications occuring around Kootenay Lake.

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

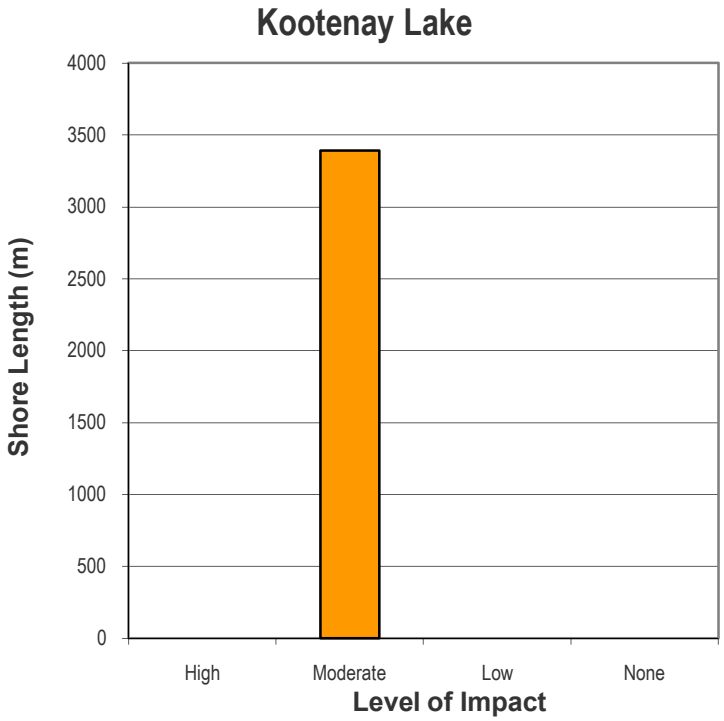

Table 8 : The total shore length that has an estimated Level of Impact of High, Moderate, Low, or None on Kootenay Lake.

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