Okanagan Lake

Foreshore Inventory and Mapping
2016 Update Report

Prepared By:

Ecoscape Environmental Consultants Ltd.

April 2017
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Prepared By:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
102 - 450 Neave Court
Kelowna, BC
V1V 2M2
Phone: 250 491-7337
Fax: 250 491-7772
ecoscape@ecoscapeltd.com

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The results contained in this report are based upon data collected during a single season inventory. Biological and lake 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. 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 are the responsibility of the party using the information. Neither Ecoscape Environmental Consultants Ltd., the authors of this report or the Regional District of Central Okanagan (or project partners) 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, analyzed, and presented.

EXECUTIVE SUMMARY OF FIM FOR OKANAGAN LAKE

Okanagan Lake is one of, if not the most important feature of our region. The lake is a significant revenue source because it supplies key services such as tourism, recreation, and agriculture, and supports our cities and rural areas in numerous ways. The lake also provides key environmental services such as fish and wildlife habitat, drinking or irrigation waters for many valley residents, and flood and drought protection. The economic and environmental value of this feature for local residents cannot be underestimated.

The foreshore – that part of the shore between the high and low water marks – and the surrounding riparian areas have significant biological and ecological values. For instance, Okanagan Lake provides critical habitat for shore spawning kokanee; wildlife, birds numerous rare plants and species, and amphibians like the western painted turtle. Riparian areas are also essential for successful ecosystem connectivity or providing corridors that help wildlife move from place to place to find forage, shelter (e.g., wintering areas) and each other. These important shoreline areas are extremely sensitive to disturbance and this report provides a summary of the current condition, observed modifications, and general disturbance of Okanagan Lake using a method called Foreshore Inventory and Mapping. (FIM)

As noted above, shoreline areas are known to provide key environmental functions and is why FIM is usually undertaken. In southern BC, FIM of shorelines has occurred on over 13 lakes and this same process is now occurring in Alberta. This assessment conducts inventories of shoreline areas using a boat and creating spatial datasets using Geographic Information Systems (GIS). This repeated exercise has been completed on the 290 km of Okanagan Lake 3 times, with the first inventory occurring during 2004. The technical data in this report contains key information regarding the status of Okanagan Lake, and particularly the rate that the lake shoreline is transitioning from natural to disturbed as a result of anthropogenic alteration. For each different jurisdiction, a graphical summary of data is provided. This process provides key information to resource managers to promote and implement better shoreline management. The focus of this brief summary is to characterize the shoreline and how fast it is changing. Understanding how, where, and what rate change is occurring around the lake ensures we can build sufficient ecological resilience in the system, such that it maintains functional habitat which is important to residents.

The information in this report indicates that the density of development associated with broad land use (e.g., Single Family, Commercial, etc.) is one of, if not the most important determinants of loss of "natural"[1] shoreline areas around Okanagan Lake, and it is almost certain that this result is applicable to all lakes in the southern interior. As the density of development increases from rural to single family, commercial, or industrial, a noticeable loss of natural shoreline occurs, with that loss occurring over a 30 to 60 year time period after the change to increased density (or landuse). Key shoreline alterations, such as the removal of native vegetation, were observed through

[1] Natural refers to a state in which the shoreline or lakebed has not been altered by anthropogenic or human related activity associated with land development, recreation, or other humans types of use (e.g., road or rail).

construction of erosion control structures (i.e., retaining walls), docks, access, or general landscaping. It was observed that the older a development, the greater the level of disturbance that occurred. As time goes on, incremental loss occurs at a slow, but steady rate. On Okanagan Lake, it is estimated that the there is a -0.2% loss of natural shoreline area per year, or approximately 588 linear meters. Over the 7 year study period (2009 – 2016), this means that 4.1 km or 1.42% of the natural area around the shoreline was lost or permanently altered. From a biological perspective, this loss is considered significant and has the potential to affect nearly all natural shoreline processes over time, which would subsequently affect many of the critical habitats surrounding the lake. Ultimately, all of these changes could have a direct effect on the quality of life for local residents.

The loss of natural shoreline results from many activities. For instance, over the 7-year study period, 165 new retaining walls were observed, that affected approximately 1.45 km of shoreline. Lakebed substrate disturbance increased by 1.4% or along 4.1 km of shoreline. Over this same period, there were 164 new docks observed and 9 new marinas. It was observed that steeper shoreline areas had the highest rates of loss, likely because many of the flatter lakeshore areas have already been developed, and the losses in these areas is slower because most of it has already been affected. All of the data suggest that change is occurring, that the effects are cumulative and that each small change adds up. While not part of this assessment, biological systems only have so much capacity for alteration, and reducing these losses will help avoid significant environmental effects, such as loss of rare or endangered species. All agencies responsible for the management of shoreline areas must consider how change affects the shoreline over the long term because while individually, small change is not considered significant, it adds up to something that is measurable and of high risks to important natural ecosystem functions around the lake. The results of the FIM summarize how loss is occurring around the lake and points to the need to appropriately consider how management of this key resource is conducted into the future.

The good news is that Okanagan Lake is still 41% natural. There are many key areas that remain and they are supporting many key species and ecosystems. If there is a true desire to protect Okanagan Lake, urgent action is necessary to ensure that we educate the public and develop regulation or policy to protect what matters. However, if careful management does not occur the risks are high that over time, key habitat functions, ecosystem services like clean water and habitat connectivity may be permanently lost. From a social and economic perspective, this loss can result in added costs and impact the local economy, health and well-being of communities and their residents.

This loss can be reduced or prevented by ensuring there is restoration during redevelopment. There is an impending need to address restoration, where key restoration targets need to be set, especially in the low lying areas that account for 36.1% of the shoreline with only 4.6% remaining natural. A few good examples of restoration were observed along re-development sites on Okanagan Lake. However, despite the few examples, it was apparent that the "good examples" were rare, relative to the quantity of ongoing re-development around the lake (i.e., restoration of a sufficient level to achieve long term gain was not observed). A summary of the status of each different jurisdiction can be found in the Appendices of this document for reference.,

The following are three key considerations that must factor into how regulatory decisions are considered moving forward on Okanagan Lake. First, shoreline planning must address and acknowledge that the entire lake is not available for development and further densification. If the entire lake is deemed available for densification, it is highly probable that many areas will transition from rural to some more dense land use type and critical areas will be lost. Second, planning initiatives need to begin to consider more than just setbacks from the lake and embark upon a more holistic, regional approach to shoreline management. Currently, nearly all shoreline planning utilizes either prescribed setbacks, or follows an explicit methodology such as the Riparian Areas Regulation. While these regulations are useful at providing site specific protection from disturbance, they do not address the overarching effects of land use change. Provincial regulation and local government policy do not typically factor in human behavior, where individuals do not envision their small actions as having a large consequence (e.g., its only two trees!) and they are unaware of the large, cumulative effect that their actions may have. Finally, the third key recommendation is to ensure ongoing education occurs. Education will help change the behavior and attitudes of lakeshore residents and reduce the rate of disturbance along the shoreline. Without a strong educational approach, ongoing cumulative losses are expected to occur even with appropriate policy or legislation.

If a more regional approach to lakeshore management and connectivity does not occur, it is probable that many, larger scale ecosystem function and connectivity concerns may not be realized, affecting the quality of life for residents. Recommendations to address these larger scale concerns have been presented, with the intent of providing a longer term, more sustainable vision for Okanagan Lake that can also be applied to other lakes in the Okanagan. The challenges facing the Okanagan are similar to other jurisdictions, but is likely of more pressing concern due to the fast rate of growth in the area. Urgent action is necessary to ensure shoreline protection and restoration, which need to be explicit in policy and consistently applied across multiple jurisdictions. Key means to address the issue is to raise the level of awareness of those that use and enjoy the shoreline of Okanagan Lake and to collaboratively develop regulation or policy to protect and restore the shoreline of Okanagan Lake.

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1.0 INTRODUCTION

Okanagan Lake is considered one of, if not, the most important natural feature of the region. Not only is it desirable to live along or in close proximity to the lake, the water body supports economic and ecological services and benefits to communities in the Okanagan. The various functions the lake provides such as recreating in the natural setting of shoreline areas, fishing, or the clean water it provides has led to the dramatic increase in development pressure observed. The foreshore – that part of the shore between the high and low water marks – has significant biological, ecological and social significance to residents in the Okanagan basin and is extremely sensitive to disturbance.

The Regional District of Central Okanagan, local governments, and project partners such as the Okanagan Collaborative Conservation Program, South Okanagan-Similkameen Conservation Program and Okanagan Basin Water Board have undertaken a number of planning initiatives to facilitate better information sharing and develop land use policies for the conservation and sustainable development of shoreline areas of Okanagan Lake. Through these planning processes and initiatives, it can be concluded that past and current development along Okanagan Lake has impacted fish and aquatic communities, wildlife, rare plants and terrestrial communities, and water quality. As a result of these impacts, project partners are working cooperatively to mitigate future impacts to the lake, foreshore and riparian areas adjacent to the lake. This FIM process provides key information to resource managers to promote and implement better shoreline management.

Foreshore Inventory and Mapping (FIM) is a mapping protocol, developed in the Okanagan, and used throughout BC and now in Alberta, to map lake shorelines and determine cumulative effects that have resulted from densification, urbanization, and growth along lake shorelines. . This shoreline mapping process was initiated in 2004 on Okanagan Lake, repeated in 2009, and has been repeated again in 2016 in this assessment. The FIM process gathers data on broad land use, shore morphology, lakebed substrates, riparian condition, and describes shoreline modifications such as docks, retaining walls, and groynes. In 2009, and Aquatic Habitat Index (AHI) was added to the FIM dataset. The AHI adds habitat related data, such as shore spawning areas or sensitive terrestrial ecosystems, to determine the environmental values of shoreline areas. This 2016 update of the FIM utilizes all the data from the previous assessments, coupled with data from other lakes to better understand the current condition of the shoreline and the connection between land uses and disturbances. The intent of this analyses is to better understand the observed rates of loss of natural areas along the shoreline of Okanagan Lake.

Of particular importance and the focus of the works from 2004 to2009, was identifying the cumulative impacts that had occurred along the shoreline of

Okanagan Lake. The past report[2] specifically identified that shoreline areas of Okanagan Lake had experienced significant impacts from development (Schleppe, 2010). Of particular interest, were initial estimates of loss of natural shoreline areas, which were expected to range from -0.5 to -2.5% per year. The report recommended that the FIM mapping process occur on a repeating interval, being undertaken every 5 to 8 years, with the intention of identifying both the rate, and areas where change was occurring.

Regulators at all levels of government and the general public are becoming increasingly aware of the importance of managing our watersheds in a sustainable manner. Land owners and the general public are often concerned and may not understand how their activities influence shoreline condition, or understand how shoreline management is being undertaken. For these reasons, an update to the FIM mapping of Okanagan Lake was undertaken as recommended. The Okanagan area has acted as a catalyst for initial shoreline mapping exercises, and continues the progressive leadership role with this inventory and report.

2.0 BACKGROUND AND OBJECTIVES

2.1 Background

Currently, many lake management projects in the province of BC follow a three step process described below. Step 1 has been completed two times, in 2004 and again in 2009/2010 for Okanagan Lake. For this project, step 1 was completed again, noting that Step 2 has already been undertaken and the results are still considered useful, relevant, and current.

1. Foreshore Inventory and Mapping (FIM) is a protocol that is used to collect baseline information regarding the current condition of a shoreline. The FIM uses a mapping based (GIS) approach to describe shorelines. These inventories provide information on shore types, substrates, land use, and habitat modifications. This new information has been combined where possible, with other mapping information such as previous fisheries inventories, recent orthophotos, and other information.
2. An Aquatic Habitat Index (AHI) is generated using the FIM data to determine the relative habitat value of the shoreline. This index follows similar methods that were developed for Shuswap Lake and is similar to other ongoing assessments along lakes in the Kootenay's. The Aquatic Habitat Index uses many different factors such as biophysical criteria (e.g., shore type, substrate information, etc.) fisheries information (e.g., juvenile rearing suitability, migration and staging

[2] Foreshore Inventory & Mapping / Aquatic Habitat Index. Okanagan Lake: A Compilation of North, South and Central Okanagan Lake, 2011 (Schleppe, 2010)

areas), shoreline vegetation conditions (e.g., width and type of riparian area), terrestrial ecosystem information (Sensitive Ecosystem Inventory), and modifications (e.g., docks, retaining walls, etc.) to estimate the relative habitat value of a shoreline segment. This assessment was the first known to the author to incorporate areas identified to be important terrestrial habitats. The Habitat Index classifies this information in a 5-Class system from Very High to Very Low and describes the relative value of the different shorelines areas to one another (i.e., describes shorelines areas within Okanagan Lake to each other and not to other lakes (e.g., Shuswap or Mabel).

3. Shoreline Management Guidelines are prepared to identify the Shoreline Vulnerability or sensitivity to changes in land use or habitat modification. Shoreline Vulnerability zones are based upon the Aquatic Habitat Index described above. The Shoreline Vulnerability Zone uses a risk based approach to shoreline management, assessing the potential risks of different activities (e.g., construction of docks, groynes, marines, etc.) in the different shore segments. The Shore Line Management Guidelines document is 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. *It is noted here that Step 3 for Okanagan Lake has not been undertaken, but would be a very useful planning process to complete. The Kootenay Lake Partnership is currently finalizing the Kootenay Lake Shoreline Guidance Document, and is an active group of all levels of government working collaboratively at shoreline management. Currently, the Province is utilizing the Okanagan Large Lakes Protocol for development below the high water mark which generally considers Rocky Mountain Ridged Mussels and Kokanee. Each local government operates generally within their own jurisdiction, operating somewhat independent of the others, at least from a regulatory perspective.*

2.2 Objectives

The update of the FIM information allows for a comparison over time and the identification of trends into the future. This information will be useful in assessing the current status of Okanagan Lake. It will also serve as an aid in developing land use policies, regulations and standards to increase long term environmental planning capabilities for the protection of aquatic and riparian habitat. The scope of work for the 2016 FIM update was expanded to incorporate milfoil mapping for the OBWB and incorporate into the mapping water intakes and zone locations to better address water quality issues and concerns.

The main objective for this project is to update the 2009 FIM data for Okanagan Lake and compare the 2009 and 2016 data to determine change over time. FIM is considered to be an indicator for the health of the lake, foreshore and riparian areas of Okanagan Lake.

The following objectives of the original FIM project are still relevant to this work:

1. Compile existing resource information for Okanagan Lake;
2. Foster collaboration among the local governments, DFO local staff, Ministries of Forests, Lands and Natural Resource Operations, and Environment, First Nations bands, and the local communities;
3. Provide an overview of foreshore habitat condition on the lake;
4. Inventory foreshore, land use, riparian condition and anthropogenic alterations and illustrate foreshore morphology;
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, elected officials and other key referring agencies that review applications for land development approval;
7. Provide a framework and common understanding of sensitive areas of Okanagan Lake as a whole to facilitate improved resource management;
8. Provide a baseline data set for Okanagan Lake as a whole that can be utilized to develop long term objectives, conservation and protection areas, and allow for monitoring of any objectives prepared; and
9. Provide a summary of potential locations where habitat improvements are possible along the shoreline based on habitat potential.

2016 Foreshore Inventory and Mapping Update Objectives

The following are the objectives of the update of the FIM project undertaken as part of this work:

1. Update the FIM dataset so that it is more current;
2. Update the regional summaries of information for each different municipality, or electoral area surrounding Okanagan Lake;
3. Complete an analysis to understand the current rates of loss of natural shoreline around Okanagan Lake;
4. Summarize data from FIM initiatives to better understand the effects of different land use types on shoreline areas to facilitate regional planning processes;
5. Collect spatial information regarding milfoil, densities, and locations to facility Okanagan Basin Water Board milfoil management objectives, planning, and permitting; and

6. Obtain and incorporate into the FIM mapping water intakes and zone locations to enable a better understanding of water quality issue.

3.0 METHODS

3.1 Methods Overview

Foreshore Inventory and Mapping is a field inventory that is conducted from a vessel, viewing the shoreline from the water. The lake is initially broken into segments, or regions of similar land form, land use, riparian condition, and substrate. For each segment, data is collection in the following general categories:

1. Land Use
2. Shoreline Type and Slope
3. Lakebed Substrates
4. Riparian Condition and Aquatic Vegetation
5. Shoreline Modifications

Data is collected by observing the shoreline, where the field crew is each assigned a piece of information to collect. The boat travels from the start to the finish of the segment, and data is then entered into a data logger (typically a GPS). Once the data is collected, it is processed, reviewed, and quality assurance/control measures are undertaken to finalize the GIS database.

3.2 Field Methods

The full inventory methodology is found in Appendix A and summarized in the 2010 FIM report. In addition to the data collection, photos were taken of the shoreline in order to enable a comparison to photos taken in 2009. The following provides a brief summary of alterations made to the 2009 dataset that were collected or amended during the 2016 inventory of Okanagan Lake.

- Historically, docks have been considered any floating or pile supported structure in front of a property. This means that swim floats were considered "1 dock" in 2009. To better account for the differences between a swim platforms and a dock, which are typically pile supported on Okanagan Lake, these items were counted separately. Data from 2009 was also reviewed, and the total number of swim platforms was estimated using air photos, and still photos taken during the inventory.
- Historically, boat houses were considered pile supported or floating structures that had 4 walls. Since this type of covered structure is not as common on Okanagan Lake, when compared to lakes like Shuswap, it was amended such that covered boat lifts were treated as separate entities from more traditional 4 walled boat houses.

Similar to docks, these were estimated in the 2009 dataset using airphoto and still photo documentation.

- During the field inventory, it was very apparent that different observers have a bias. In other words, when one person may observe a retaining wall, another may only observe a line of rock, and consider the vertical element of insufficient height to be considered a retaining wall. To address observer bias, and difference between the field crews in 2009 and 2016, all data in the database was revisited to ensure that counts of different modifications were accurate. The two primary items where differences were most apparent were retaining walls and groynes, which are perpendicular structures to the shoreline that affect sediment movement. The final datasets from both 2009 and 2016 were reviewed by both Jason Schleppe, M.Sc., R.P.Bio and Lauren Bevendick, who both participated in the field inventory in 2016, noting that Jason also participated in the full inventory in 2009. A significant effort in quality assurance and control was made to increase the accuracy of the data collected.

3.3 Analytical Methods - Current Rates of Change

In 2004, the original FIM mapping was conducted for only a portion of Okanagan Lake. The premise of this initial work was to inventory the shoreline of the lake and provide a basis to measure change along the shoreline. In 2009 and 2016 the entire shoreline of Okanagan Lake was inventoried using the same methodology. It has been approximately 7 years since the lake was last surveyed and an analysis of change has been complete for all jurisdictions on Okanagan Lake.

The analysis focused on the comparing the following factors:

- Percentage of Natural and Disturbed Shoreline;
- The percentage of natural and disturbed shorelines in areas of different broad land use categories
- The percentages of natural and disturbed shorelines of different shore types
- The percentage of natural shoreline along different slope categories
- The density of shoreline modifications

3.4 Analytical Methods – Land Use

To ascertain the effects of broad land use categories on the shoreline, data from 10 lakes inventoried using the FIM methods were pooled from the Okanagan and Shuswap regions. Data from Kootenay Lake was also considered. More than thirteen lakes were initially considered, but three smaller lakes from the Kootenay’s were removed because their small size made it hard to accurately compare them with the other, larger interior lakes from the other areas. Thus, the suite of lakes chosen is best for considering multi regional, land use issues. For the pooled dataset of 10 lakes[3], the percent disturbance was determined. In cases where multiple land uses were observed in a single segment, the percentage of the disturbed shoreline was split relatively between the different land use types. Typically, these scenarios were most commonly observed in areas of commercial, and multi-family development, with high levels of disturbance or in long stretches of rural with short stretches of single family intermixed. For these reasons, it is not likely that they had a significant "skewing" effect on the data because in either scenario, disturbance was mostly attributable to shore length affected. These data were then graphed using boxplots.

Shoreline development has both positive economic benefits and potential environmental impacts. Quantifying the rate of shoreline development can assist in making informed decisions for future land use planning and conservation initiatives. FIM assessments quantify the percent of disturbance of each shoreline segment. The percent of disturbance can be used to estimate the effects of shoreline development and subsequently consider different broad land use types.

To estimate historical percent disturbances of the shoreline of Okanagan Lake, historical air photos were used for 1959, 1973, 1976 and 1984 for select shoreline segments. Shoreline segments were selected if they had adequate historical imagery coverage and experienced considerable growth from 1959-2016. All selected shoreline segments were Single Family and considered representative of the observed buildout trends.

These estimated percent disturbances from historical airphotos and percent disturbance from FIM assessments in 2004, 2009 and 2016, were used to construct a generalized logistic curve. A logistic curve is S-shaped and is often used to model population growth in ecological communities. A logistic curve assumes that shoreline development starts slowly (i.e., when the shoreline is more rural for instance) but then starts to increase at an exponential rate as development density increases to single family. The exponential rate of growth is a rapid rate phase of development. At the tail end of the curve, this rate of development slows when the shoreline becomes close to it's asymptote, or peak disturbance. A logistic curve was chosen because it is typically bound by 0 and 1, which is useful, because disturbance will range from 0 to 100% (or 1).

To generate the logistic curve, the average rate of shoreline disturbances (as a percent) from 1959 to-2016 was used as the endpoint, or place where the curve flattens to an asymptote. An asymptote is where the curve flattens and achieves the endpoint, or maximum observable disturbance along the curve.

[3] Kalamalka Lake, Wood Lake, Osoyoos Lake, Okanagan Lake, Kootenay Lake, Mabel Lake, Shuswap Lake, Little Shuswap, Mara Lake

3.5 Analytical Methods – Jurisdictional Summary

To understand the relative habitat values, and levels of disturbance within each jurisdiction, the data was summarized using the AHI and level of disturbance. For each different AHI ranking of Very High, High, Moderate, Low, and Very Low, the percentage of shoreline that was natural and disturbed was plotted for 2009 and 2016 data. This was done to help each jurisdiction understand the habitat values present along the shoreline, and the current levels of disturbance that were observed.

3.6 Milfoil Mapping

Since this inventory collects aquatic vegetation data, additional mapping was conducted during the field inventory to improve understanding of the densities and locations of milfoil. To map milfoil on Okanagan Lake, polygons of aquatic vegetation coverage were digitized on field maps, and then subsequently digitized using GIS and air photo interpretation. In cases where the littoral zone, or areas of the lake with depths less than 6 m were large, the boat used a "zig zap" pattern to ensure the majority of the area was visually observed. The data was collected by Monique Stone, of the Okanagan Basin Water Board, which improved accuracy because of her knowledge of previous milfol control works, densities, and locations. The data collected included:

- Type – This was either milfoil, *Potamogeton* spp. (native pondweeds), bulrush species, or cattail.
- Percent Coverage
- A categorical ranking or Dense, Moderate, or Sparse

The data allowed up to three different species groups to be collected during the inventory.

4.0 RESULTS

4.1 Lake Overview

4.1.1 Natural and Disturbed Shorelines:

Okanagan Lake has a shoreline of length of approximately 290,073 m or 290 km. Data in this report has been presented as a percentage of the shoreline length, to help make figures easier to interpret. When the whole lake is considered, approximately 1.42 percent of the lake transitioned from a relatively natural state to a state or urbanization between 2009 to 2016. This rate fits within previous estimates made in 2009, but on the lower end, since it represents approximately -0.3% per year.

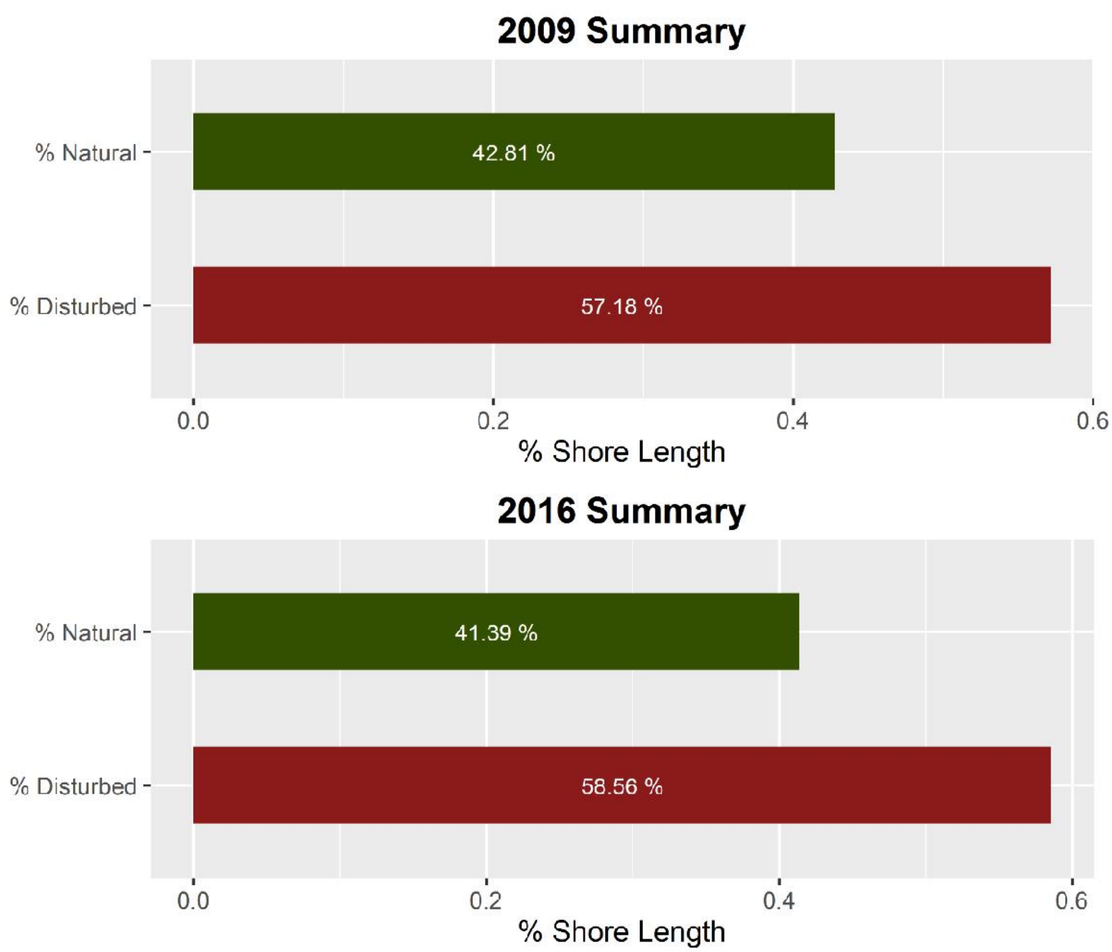
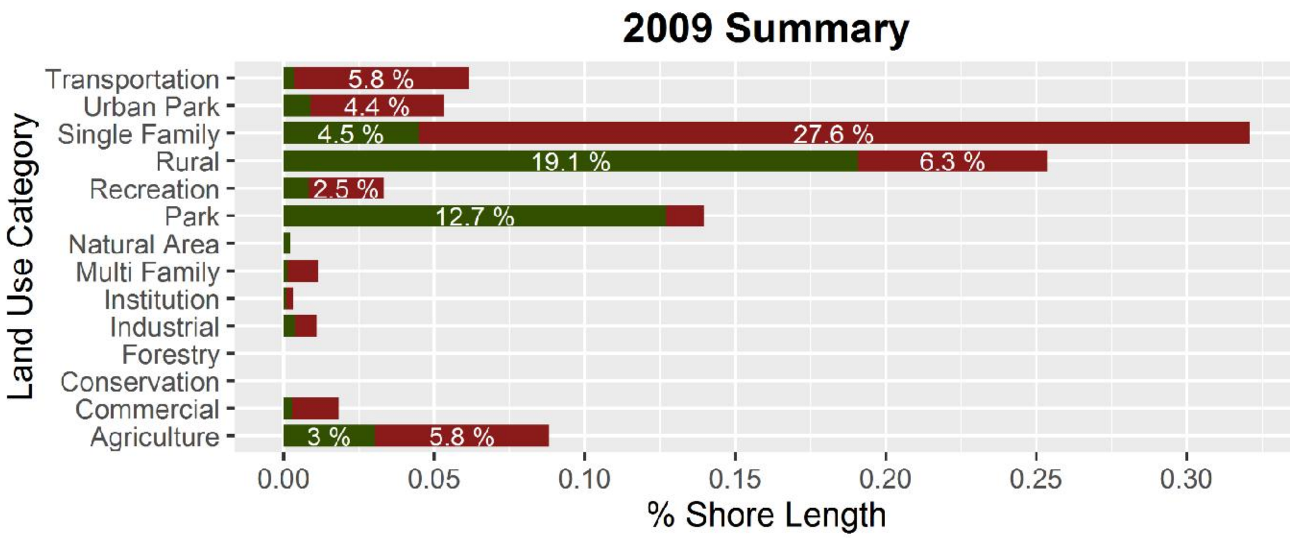


Figure 1: The percentages of natural (green) and disturbed (red) shorelines on Okanagan Lake in 2009 and 2016.

To put this in perspective, this is approximately 588 linear meters of shoreline that is altered on an annual basis, or 4.1 km over the last 7 years. Thus, while the percentage may seem small, the resultant length of shoreline is considered measurable and significant. This highlights that all actions matter, even at a lot by lot scale, and the impacts from the cumulative effects can have significant effects.

4.1.2 Broad Land Use Categories:

Land uses have varying levels of disturbance along the shoreline, with increases in density increasing the overall level of disturbance. Single family residential areas account for the largest portion of shoreline, followed by Rural Areas, Natural Area parks, agricultural areas, and areas primarily used for transportation. Areas of rural residential lost 6% of their natural areas, the largest of any land use type. Single Family residential lost 0.2% of their natural areas, although the total area of single family increased by 0.6% and the total disturbance increased by 0.8%.



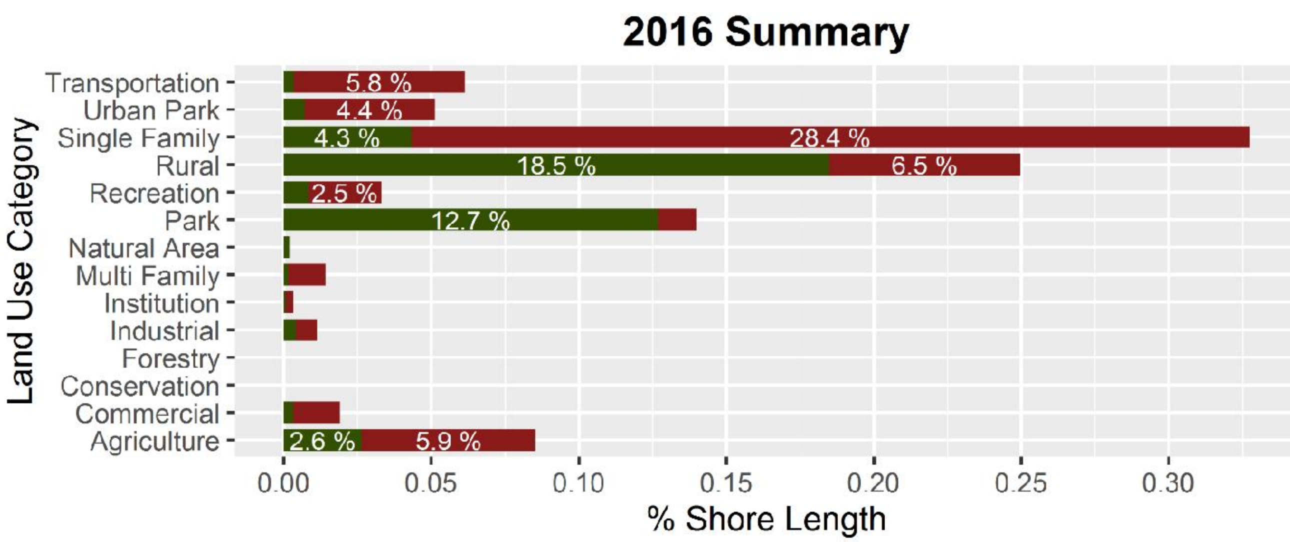


Figure 2: The percentage of natural (green) and disturbed (red) shorelines in areas of different broad land use categories along Okanagan Lake in 2009 and 2016. * **values less than 2% have not been labelled for clarity**

4.1.3 Shore Types:

Gravel beaches are the most common shoreline observed on Okanagan Lake, accounting for 43% of the shoreline. The total length of disturbance increased by 1% along gravel beach areas. Disturbance levels increased by 0.2% along wetland areas, a highly important shoreline area that decreased from 8.3 to 8.1% of the shoreline length. It is noted here that losses of this size are challenging to predict with extreme accuracy, but the data still suggests losses of wetland areas may be occurring. Cliff bluff areas lost approximately 0.2% of their natural shoreline length, which amounts to 580 linear metres. Rocky shorelines decreased in size by 0.4%, because disturbance increased by 0.4% and they likely transitioned from rocky areas to gravel beaches.

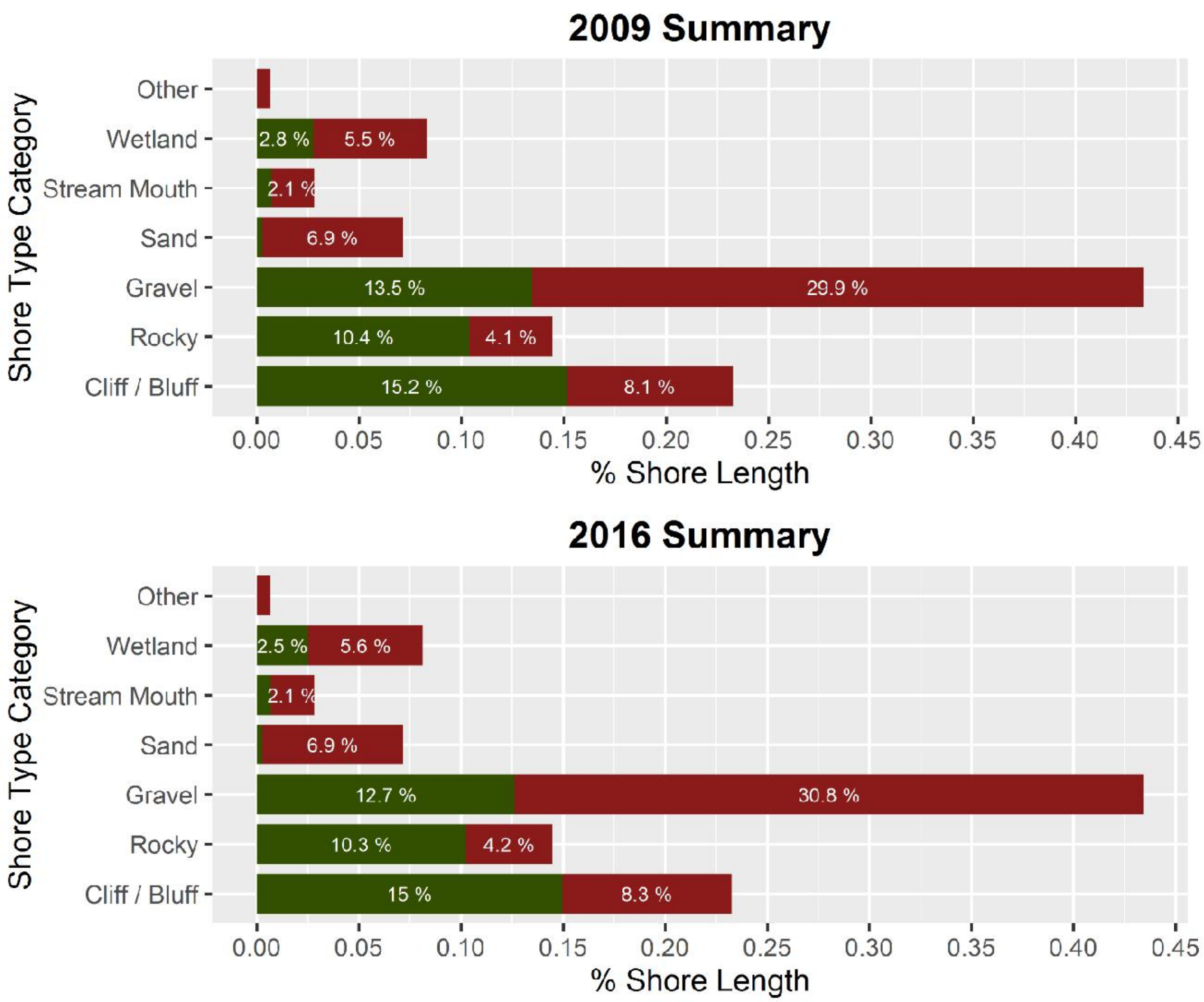


Figure 3: The percentages of natural and disturbed shorelines of different shore types on Okanagan Lake in 2009 and 2016. * **values less than 2% have not been labelled for clarity**

4.1.4 Slope Gradients:

The data suggest that change is occurring on slope types that occur on Okanagan Lake. The biggest losses of natural shoreline occurred on Steep and Moderate gradient areas, with Very Steep and Low gradient areas also being impacted. It is not surprising that Steep and Moderate gradient areas had the highest rate of loss of natural shoreline, given that these areas are less disturbed, and currently experiencing a higher rate of development than other areas.

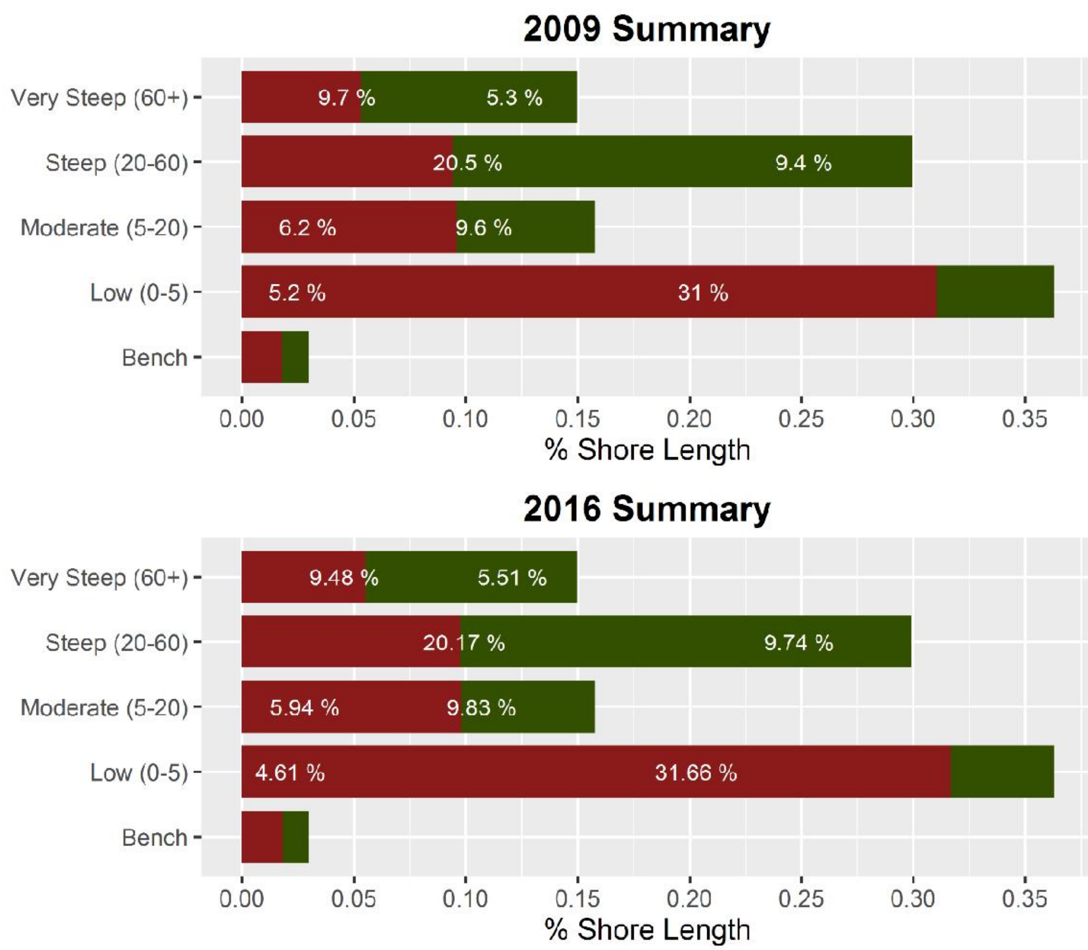


Figure 4: The percentages of natural and disturbed shorelines of slope gradients on Okanagan Lake in 2009 and 2016.

*** values less than 2% have not been labelled for clarity**

4.1.5 Number of Modifications:

There was a total of 9 new marinas observed on Okanagan Lake, with most of these associated with densification as rural or single family areas transitioned to multifamily. There was a reduction in marine rails, but an increase of 164 dock structures. This rate of dock growth suggests that dock buildout may lag behind initial home construction. Boat houses appeared unchanged, and there was a reduction of 9 covered boat lifts. Only 1 new boat launch was observed. There was also a total of 165 new retaining walls observed.

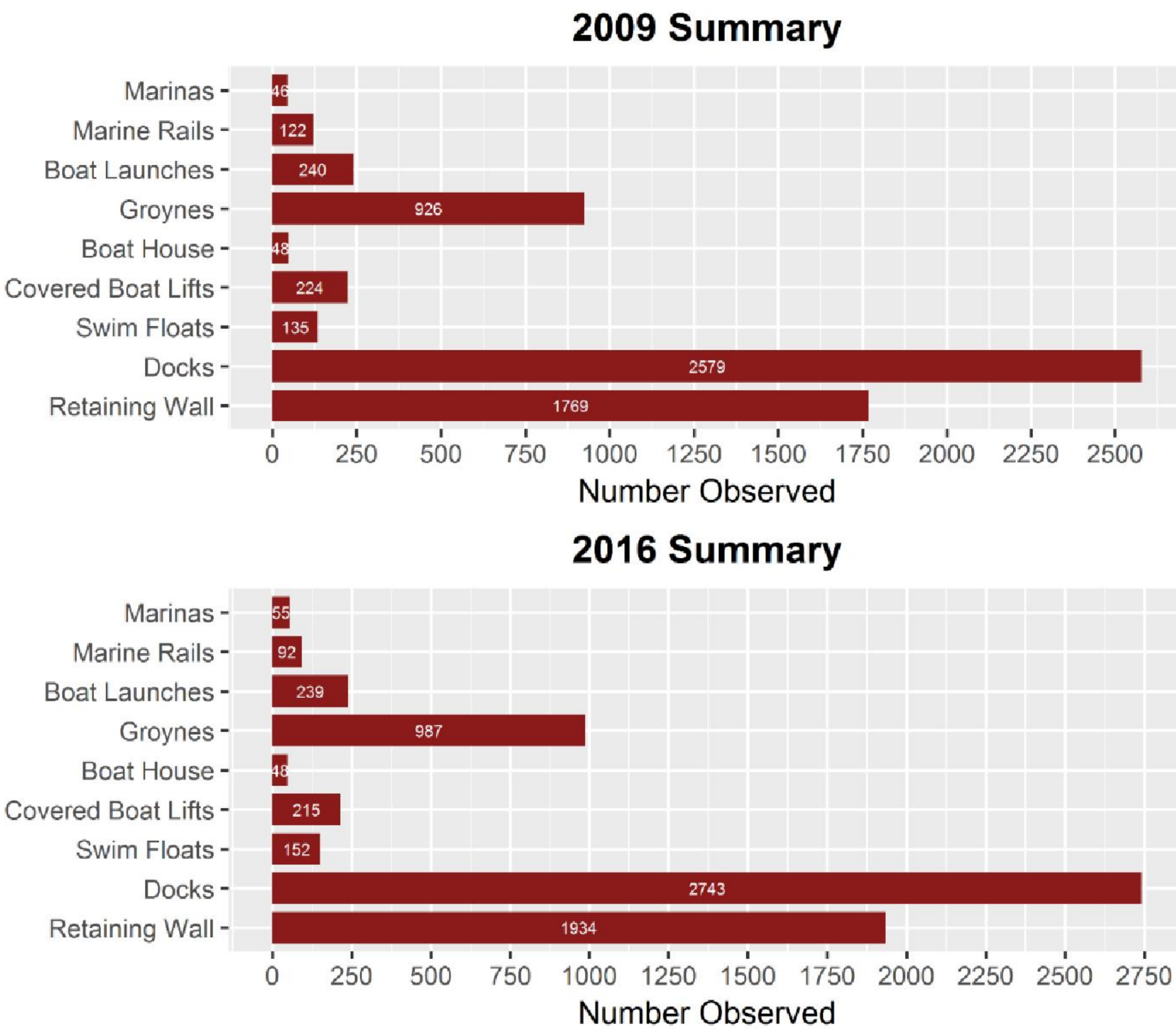


Figure 5: The number of modifications observed along shorelines of Okanagan Lake in 2009 and 2016.

4.1.6 Relative Shoreline Length Modifications Disturbed

The increase of 165 new retaining walls increased the linear length of shoreline with retaining walls by 0.5%, or an increase of 1,450 m of shore. This also corresponded with an increase in shoreline substrate alteration of 1.4% or 4,060 m. Substrate modification of the shoreline is important because substrate provides important habitat for fish, such as shores spawning Kokanee. When substrate modification occurs in these shore spawning areas, it can significantly reduce the total area available for spawning or reduce the success of shore spawning even if it still occurs in these altered areas.

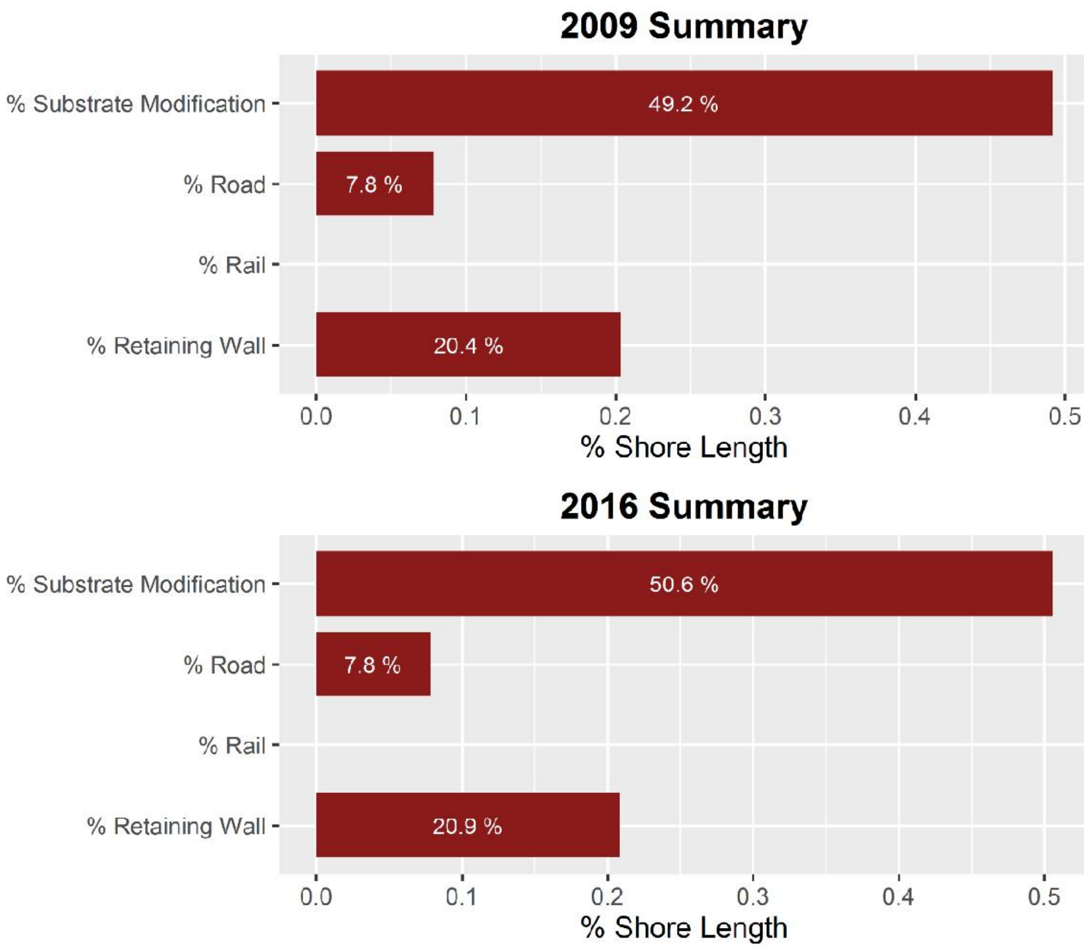


Figure 6: The percentage of shoreline length of different modifications that occur along Okanagan Lake in 2009 and 2016.

4.2 Summary of Land Use Effects

Foreshore Inventory and Mapping has been completed on at least 13 lakes in southern BC and the following is a comparison of data pooled between 10 of these lakes that are most similar. To better understand land use trends across all lakes in BC, data were pooled and graphed using boxplots. The following figure describes the information contained in a boxplot, which summarized numerous different pieces of information, such as where most data fall, and the distribution of the data.

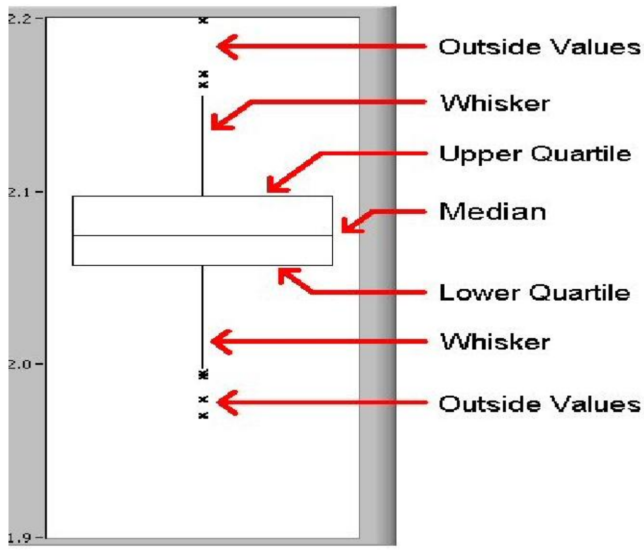


Figure 7: Summary of how to interpret a boxplot diagram.

4.2.1 Land Use Density

It is clear from the data that as density of development increases, so does the percentage of the shoreline that is disturbed. The biggest jump occurs when lands transition from rural areas to a more dense land use, such as single family or multifamily. Nearly all types of land use associated with an urban environment ultimately result in a high level of disturbance, that typically exceeds 75%. For instance, single family residential areas had an average disturbance of 87 ± 8 %, when compared to rural areas, which had a disturbance of 33 ± 10%. Since these data are pooled across 10 lakes, each with different local policy, it is probable that they are reflective of trends that are somewhat independent of policy. The median, or black line in the plots below is the best to consider as the "average".

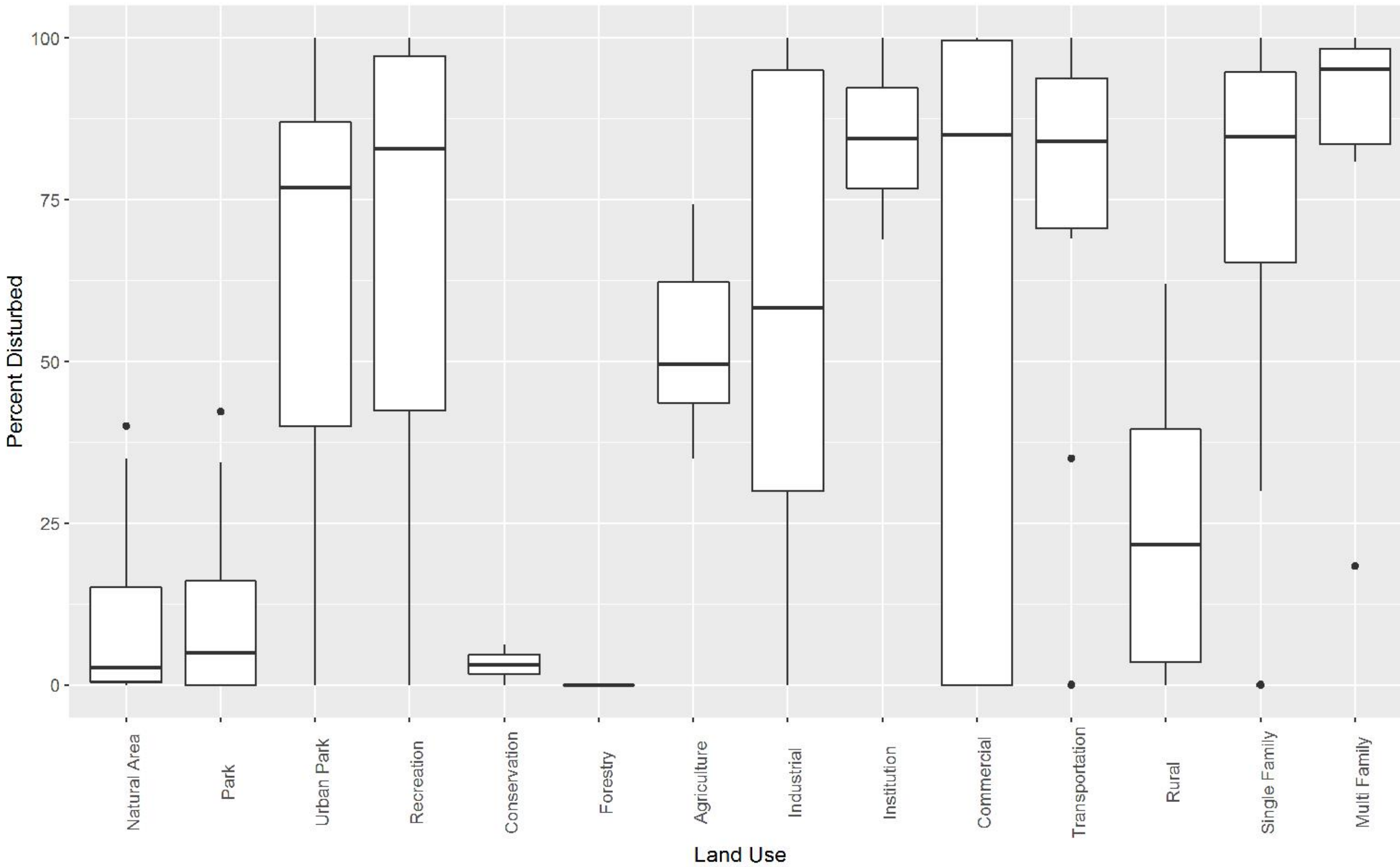


Figure 8: The percentage of disturbed shoreline across 10 lakes in the southern interior of British Columbia.

4.2.2 Density and Slope

When given land uses and their corresponding slopes are considered, a very specific trend emerges. The data indicates that the intensity of disturbance resulting from different types of development consistently decrease as the slopes increase. This can be explained by two likely factors. First, low gradient sites typically occur at stream confluences, or other types of fans, and these areas are usually the first to develop. Thus, these areas have experienced development pressure for a longer period of time (i.e., circa 1900), and the incremental, cumulative losses are more observable. Second, it suggests that areas of steeper slope may remain more natural because the grade makes intense development more challenging. However, since many of the steeper areas have not experienced development for the same period of time on most lakes, it is not possible to conclusively determine whether insufficient time has passed to observe a similar level of disturbance or whether these areas are more challenging to develop. Given that access to heavy machinery and blasting contractors is typically within the means of most lakefront owners in the Okanagan, it is probable that as time goes on, the effects of disturbance will continue in these areas but the average level will still remain somewhat less than that of low gradient areas.

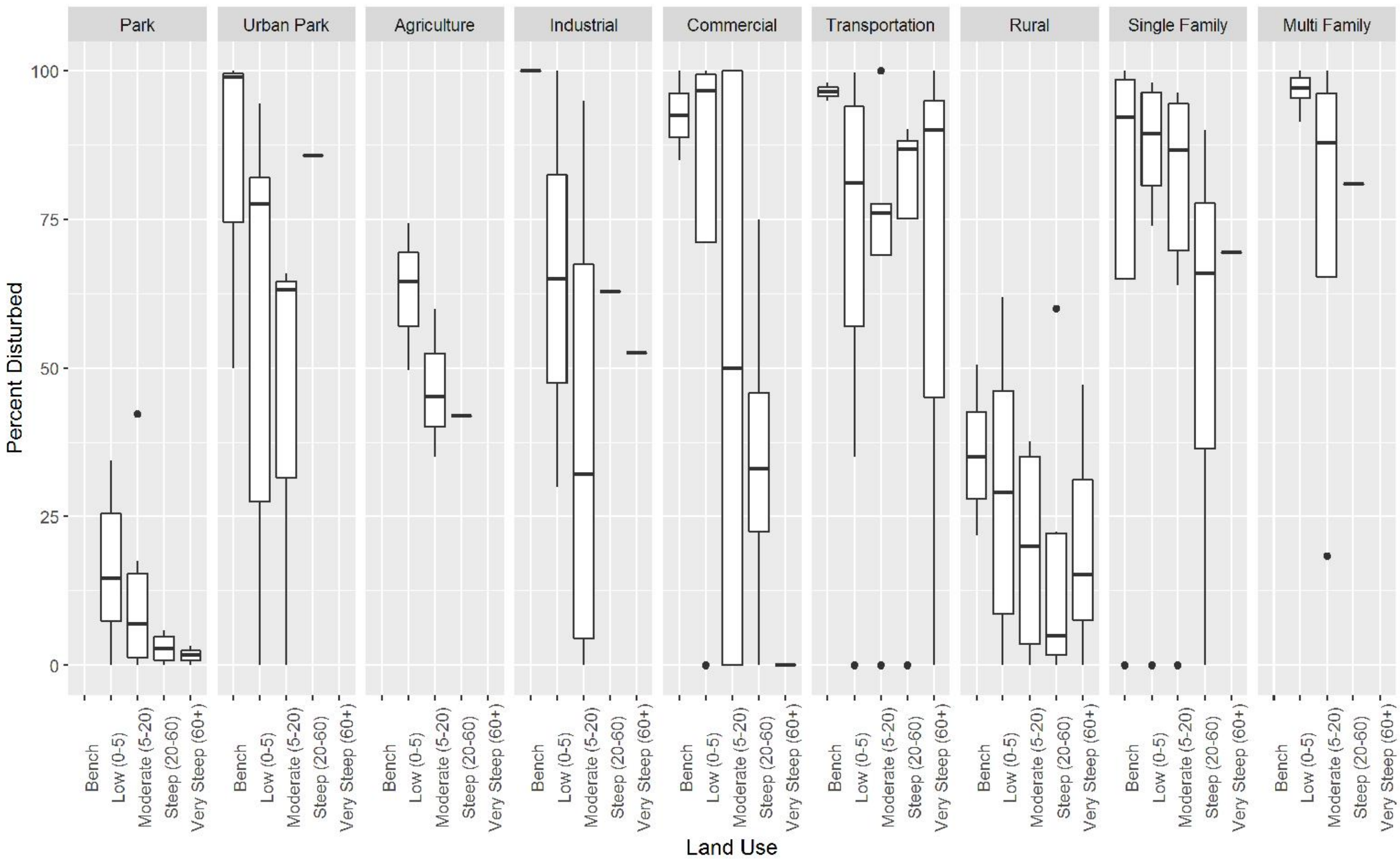


Figure 9: The percentage of disturbed shoreline across 10 lakes in the southern interior of British Columbia grouped by slope gradient.

4.3 Summary of Local Government Areas on Okanagan Lake

Aquatic Habitat Indices have been developed for many lakes in the southern areas of British Columbia. These indices have been widely used in many planning projects such as Official Community Plans or Shoreline Guidance Documents. The AHI identifies areas of higher overall environmental value, with key fisheries resources given a high priority or weighting in the index. The AHI uses biophysical data from the FIM data set, such as shore type, relative disturbance, or substrate. This data is combined spatially with other habitat features or values. For instance, on Okanagan Lake, important areas such as connection to sensitive ecosystems (i.e., SEI), known spawning areas (e.g., Kokanee) and other fisheries parameters such as potential juvenile rearing areas were included in the index. The result of the AHI is a 5-class system (Very Low, Low, Moderate, High, Very High).

To present this data, length of natural and disturbed shoreline were graphed for each municipality (refer to appropriate Appendix). The appendices contain the same information summaries as the whole lake discussed above and should be referred to as well. The total shoreline length for each municipality is also shown for reference in summary figures in the body of the text.

The data suggest that there is a reasonable length of shoreline remaining in natural condition in most regions. Most areas tended to have a greater percentage of natural shoreline in higher value areas when compared to lower values areas identified by the AHI. However, low gradient areas have greater overall disturbance, and were historically developed first, when compared to steeper areas across all region. This means that many of the important, large stream confluences have lost significant portions of natural shoreline surrounding them, and their inherent natural value is now lower because of urbanization.

The 2016 FIM identified that most of the steep and very steep areas still have a reasonable level of natural area remaining, and many of these areas are also of High or Very High habitat value. However, the observable rates of change were greatest in these areas when looking at areas that could be potentially developed within each jurisdiction. This occurred because many of these areas are currently transitioning from rural holdings to single family residential, commercial, or some combination thereof. It is probable that they may experience a more rapid rate of loss over the next 30 to 50 years as buildout and use of the lands increases.

This highlights the importance of residual natural areas within urban areas, and the need to focus on restoration opportunities at the time of redevelopment. Further, the losses of some of these areas is likely permanent, making a return to full shoreline function not likely possible. It is probable that many of these areas would have a much higher value, if they were still in a natural condition.

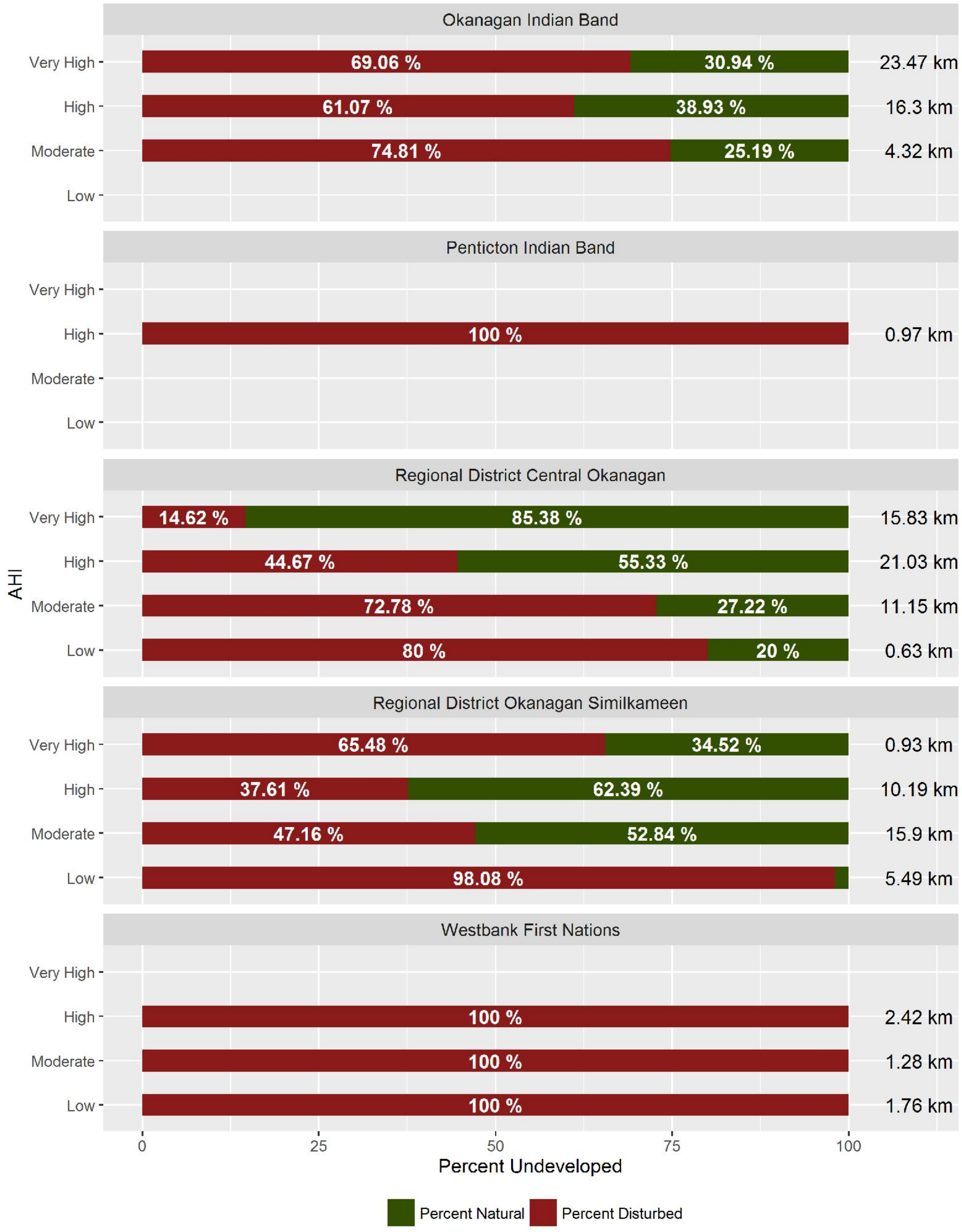


Figure 10: The percentage of shoreline natural and disturbed shorelines by region in each of the five different Aquatic Habitat Index Classes (Very Low, Low, Moderate, High, and Very High)

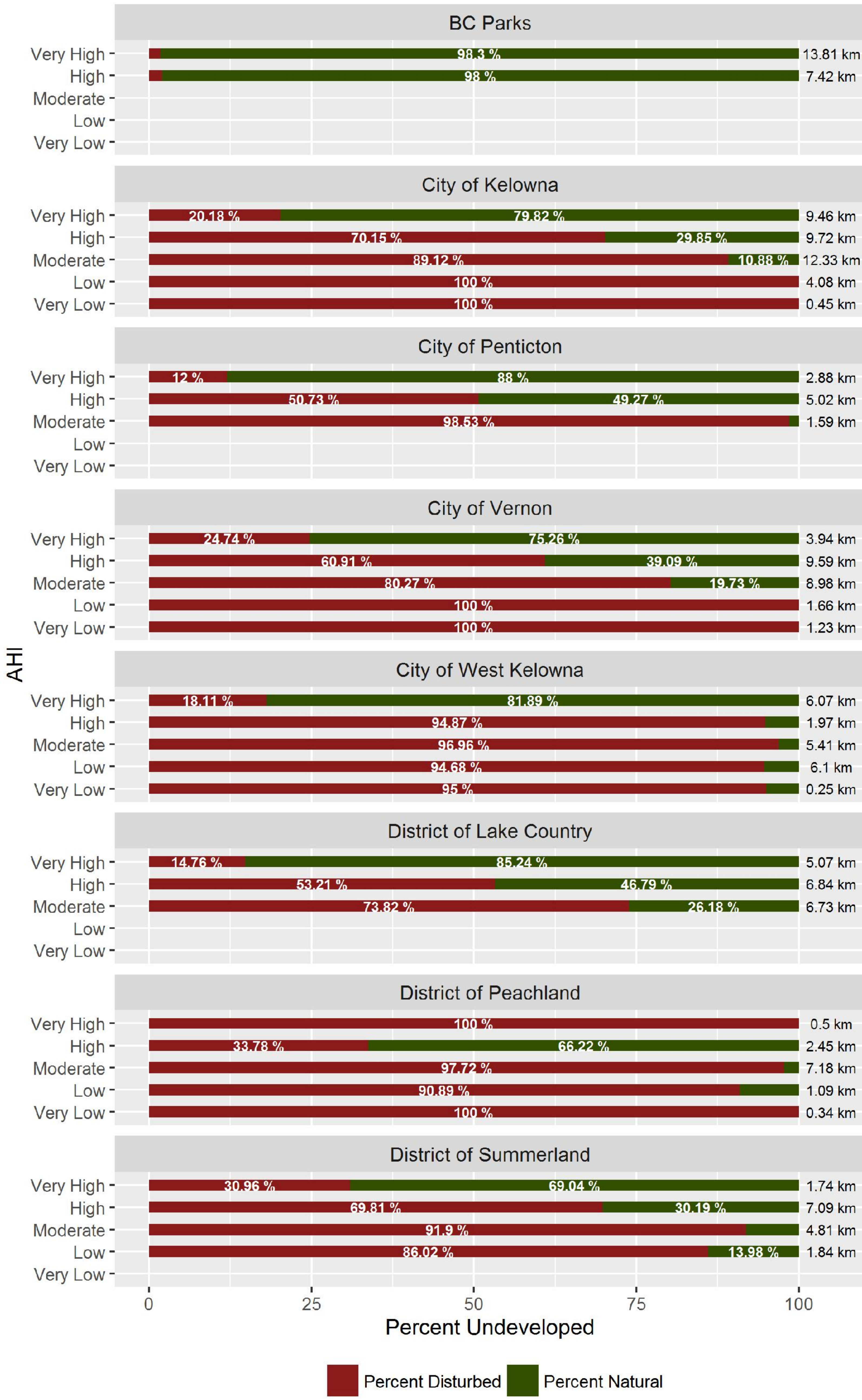


Figure 12: The percentage of shoreline natural and disturbed shorelines by region in each of the five different Aquatic Habitat Index Classes (Very Low, Low, Moderate, High, and Very High)

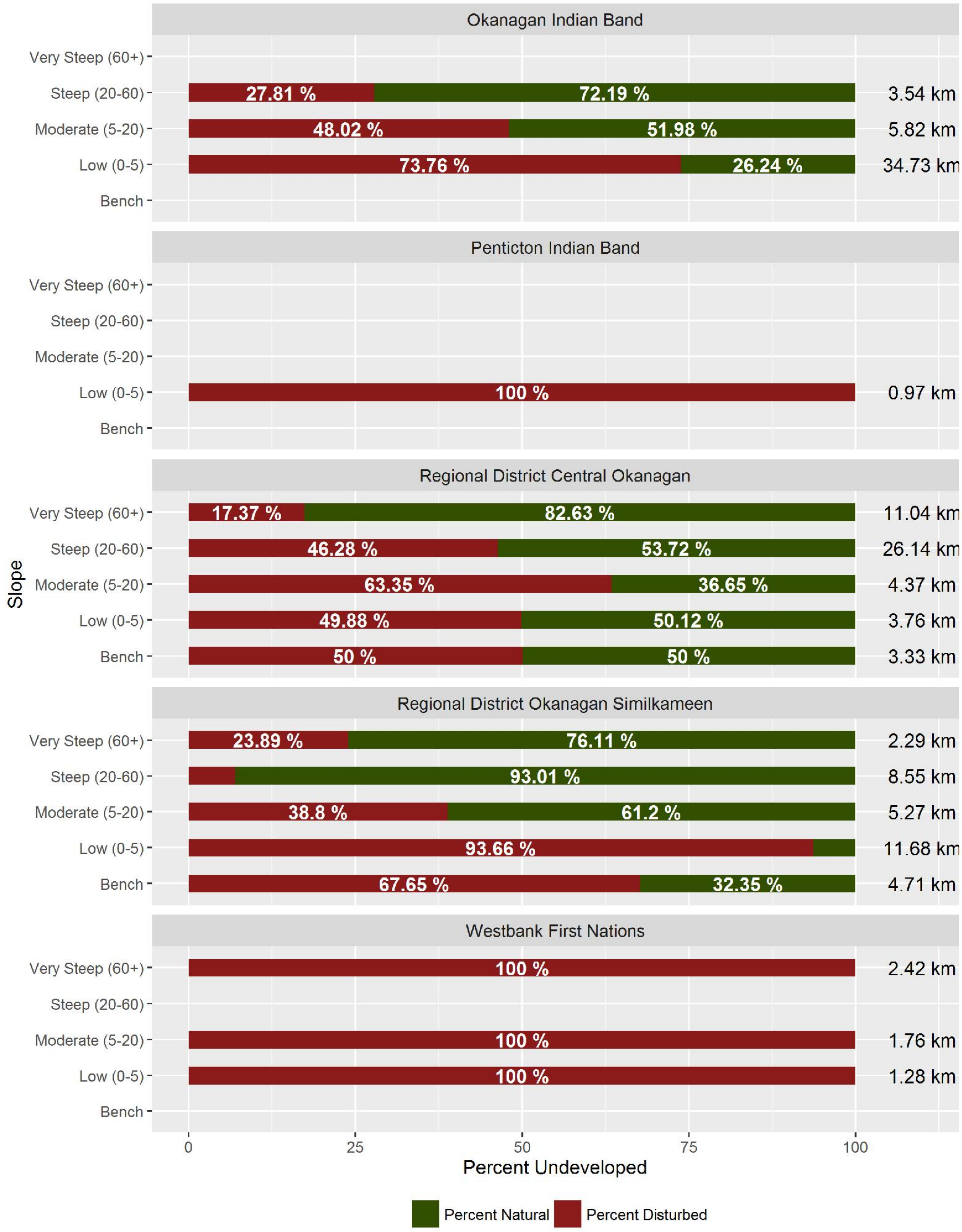


Figure 13: The percentage of shoreline natural and disturbed shorelines by region in each of the five different slope categories (Very Steep, Steep, Moderate, Low, and Bench)

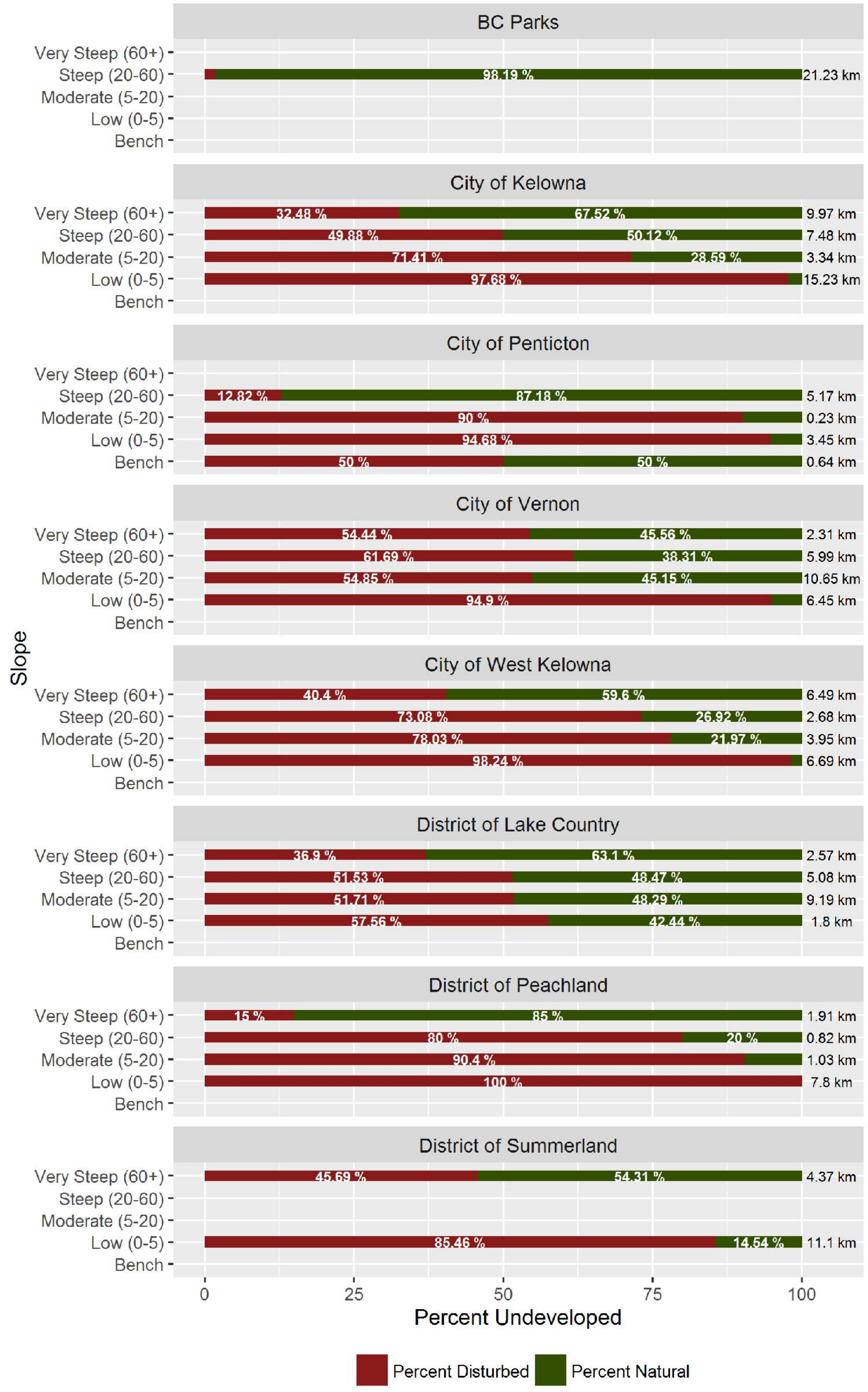


Figure 14: The percentage of shoreline natural and disturbed shorelines by region in each of the five different slope categories (Very Steep, Steep, Moderate, Low, and Bench)

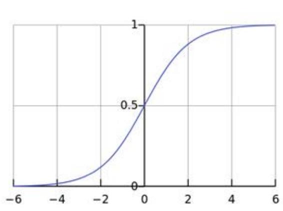
4.4 The Rates of Loss of Natural Shoreline along Okanagan Lake

The rate of change was estimated for Okanagan Lake. In brief, this was accomplished by using historical airphotos to estimate rates of loss in periods prior to 2004, and then coupled with data collected in 2004, 2009, and in this assessment. The data suggest that the greatest losses along the shoreline occurred during rapid development periods, which likely began between 1940 and 1960 depending upon the region. Between 1980 and 1990, the rate of loss began to decline.

This curve or function is called a logistic function. A logistic curve has an initial rate of loss that is generally slow, and then increases rapidly during periods of increased growth, when land use changes from rural to an increased density such as single family. Near the end of the curve, the rates begin to decrease, likely because there is significantly less available natural shoreline to disturb[4]. The asymptote, or point where the line flattens and reaches its maximum, represents the apex level of disturbance, which occurs between 59 to 85% (95% confidence interval). This means that for single family areas, after 100 years it is likely (95% chance) that the disturbance along the shoreline would range between 56 to 85%. The greatest impact occurs during the transition from rural (or some other lesser density land use) to single family (or some denser land use), which happens over a 30 to 60-year time period. It is noted here that the data used was only a small subset of Okanagan Lake, and it is highly probable that if more areas were analyzed, the asymtope or maximum for Okanagan Lake would be higher because the average disturbance for the lake in single family areas is 86%.

Many natural areas remain on Okanagan Lake, with many of them being of high overall value. The rates of change identified in this report provide a good summary of how land alterations change over time, where there is an initial slow rate of change, followed by a rapid increase in disturbance during periods of growth when land use changes and density increases.

Once densification occurs, it is expected that disturbance would occur rapidly over a 30 to 60 year period post approval, and then decline as the available natural areas diminishes. This trend has been observed across many lakes and many jurisdictions, and the rends are similar across broad land use types. This means that single family development will almost inevitably end up in a high level of shoreline disturbance, when compared to a less dense type such as rural. This rate of change is much faster than most biological systems can

4 

A typical logistic function or curve from Wikipedia.

adapt, and has a high risk that important habitats, species, or ecosystems will be lost or extirpated.

Both the period of rapid change or loss and the maximum observable disturbance can be influenced by policy, regulation or education through two mechanisms. First, the, rate can be reduced such that is occurs over a longer time frame (i.e., goes from a 30 year period to a 150 year period). Second, the maximum observed disturbance can be reduced (i.e., goes from 85% overall disturbance to 50% overall disturbance). It is both policy/regulation and education that would act to reduce either the maximum level observed or the timeline over which extensive disturbance occurs. Thus, changing behavior and attitudes (i.e., education) towards the shoreline and ensuring strong policy and regulation are in place is necessary to reduce the observed maximum disturbance and the rate of disturbance along Okanagan Lake. The easiest way to achieve this and prevent loss is to avoid changes in land use that result in increased density of the shoreline, leaving areas more rural in nature. After that, a regional approach that is multi-jurisdictional will likely be most effective at reducing the observed change along the shoreline, where common goals known, such as critical areas to preserve are identified and a collaborative approach to achieve them is taken.

For these reasons, governments at all levels must begin to actively pursue protection of natural areas by acknowledging that many areas along the shoreline should not increase in development intensity or density. All agencies must start to consider the cumulative effect along shorelines, and must start to plan for and acknowledge that the large interior lakes, like Okanagan, have a capacity and that the rate we are approaching that capacity is occurring quickly. Of immediate importance is considering areas where development intensity increases has already been approved and is currently being or soon to be constructed. These areas all provide important habitat, which once permanently altered is very difficult and costly to naturalize and restore (and some losses simply cannot be restored).

The above summary is corroborated by the data when it is viewed by slope category for each different region. In general, it was observed that the highest rates of loss of natural shoreline areas occurred in steeper shoreline areas. This occurred because these areas have a larger percentage of shoreline in a natural condition, when compared to lower gradient areas, and are just now being developed (i.e., they are at the start of the rapid change that occurs over a 30 to 60 time period). The highest rate of observable loss occurred in steep areas, where 2.8% of the shoreline transitioned from natural to disturbed between 2009 and 2016 within the City of Kelowna (refer to Appendix B). Interestingly, in all other major centers, losses in steep and very steep areas were typically around -1% over the period. To put this in perspective, this equates to nearly 1.3 linear kilometers lost or disturbed in steep and very steep areas over the 7-year period along the lake.

It is important to note that converting the percentage of natural shoreline to shoreline length through simple multiplication should be done with caution. The percentages do not entirely reflect shoreline length because the space that percent disturbance estimates is two dimensional (i.e., both the length of shoreline and width of the riparian area are considered. Although this method is not highly precise, it does provide a reasonable estimate of the shoreline length that is affected because in general, disturbance occurred throughout the entire two dimensional space and therefore, roughly corresponds to length. Considering the data in this fashion does provide a good perspective of how much shoreline is currently being lost in these important areas and summarizes how fast change is occurring, noting that it has provided a quantifiable estimate of loss that has been observed in only a 7 year period.

Further, if these rates continue, it is likely that over the next 40 to 160 years, a large proportion of the natural shoreline areas will become disturbed, assuming that the rate of loss is between -0.25 to 1 % per year. If appropriate planning policies, mechanisms and implementation of either existing or new regulation does not change, observed rates of loss will continue. Since it has been clearly demonstrated that disturbance is directly linked to land use, careful consideration of any proposed changes in density is warranted across the lake as a whole by every jurisdiction and agency. If it isn't considered, it is likely that the end point will be a high level of disturbance for much of Okanagan Lake, and permanent loss of key natural areas will occur..

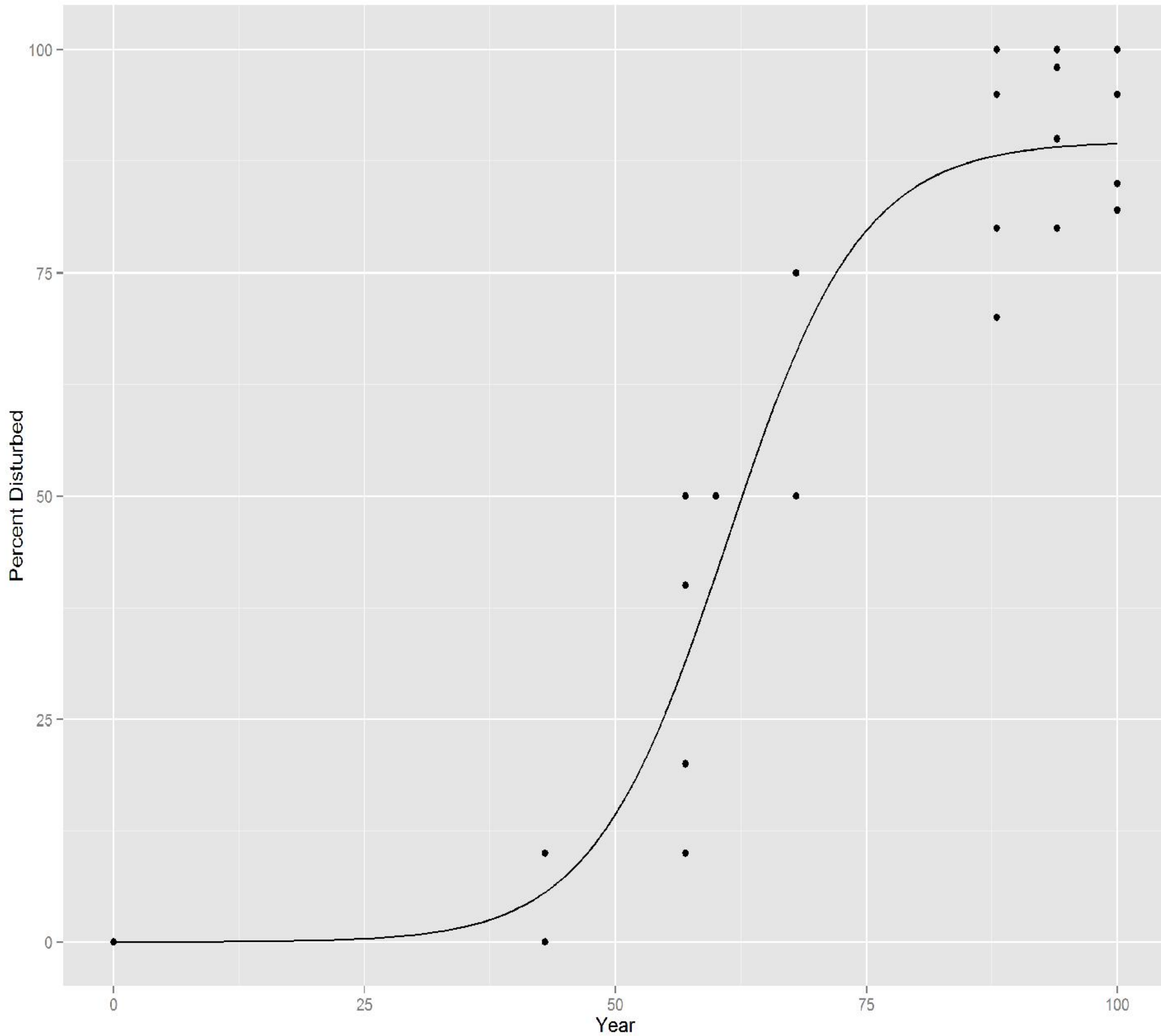


Figure 15: The rate of natural shoreline areas on Okanagan Lake summarized for rural, multi family, and single family development types.

5.0 CONCLUSIONS

5.1.1 Land Use Density

The data strongly suggests that as the land use changes and density increases, the level of observable disturbance correspondingly increases. This loss translates into a direct loss in the capability of the lake to support key fish, wildlife, and terrestrial ecosystems and provide ecosystem services such as clean water. From a social and economic perspective, this loss can result in added costs to the local economy, and affect the health and well-being of communities. As lands transition from large lot, rural holdings to single or multi-family development, the observed level of disturbance significantly increases along the shoreline. On average, all areas that increase in density from single family or greater, have lost nearly all natural character and have significantly reduced biological capability to support key ecosystem functions. In general, the more dense the development, the greater the observed disturbance level and the most likely end point of average disturbance is similar to the median summarized across all 10 large interior lakes.

At some point, it will become inevitable that consideration of the transition from rural to denser development will need to be addressed in shoreline planning, otherwise it is likely that we may reach a point where natural areas consist of only small residual patches (with the exception of Okanagan Mountain Park). If lakes are considered to have unlimited capacity, where the differences between more dense land uses are not acknowledged, there will be significant ongoing losses of natural areas as rural areas continue to be developed. The problem is that lakes do not have unlimited capacity, meaning that we must consider land use.

5.1.2 Density and Slope

The data from across BC, and specific to Okanagan Lake suggest that low gradient areas have the greatest level of disturbance with the highest development densities, and that this disturbance increases as the intensity of development increases. While steeper areas had less disturbance, it was apparent that many of the low gradient areas, associated with floodplains or wetlands, and often in proximity to larger centers had much higher levels of overall disturbance. Although these areas may have lower overall environmental value due to historic urbanization, they often still contain areas of important biological function (e.g., wetlands, stream confluences, etc.). Any natural areas in low gradient sites are a high priority for conservation, particularly wetlands and floodplain areas where regional losses are estimated to be as high as ~84%[5].

[5] Okanagan Basin Water Board Wetland Strategy

5.1.3 Restoration

There is an impending need to address restoration, where key restoration targets need to be set, especially in the low lying areas that account for 36.1% of the shoreline with only 4.6% remaining natural. A few good examples of restoration were observed along re-development sites on Okanagan Lake. However, despite the few examples, it was apparent that the "good examples" were rare, relative to the quantity of ongoing re-development around the lake (i.e., restoration of a sufficient level to achieve long term gain was not observed). In essence, what remains is better to be protected than disturbed, because current trends suggest that once it is disturbed, it is less likely it will be restored to a similar level of biological function. Further, it is likely that over the next 40 to 160 years, any areas that are not protected will become disturbed to a greater extent reducing the overall biological capacity of the Okanagan region, assuming the observed rates are not reduced. Maintaining natural shoreline areas and the resulting ecosystem services through shoreline planning and conservation is less costly in the long term than restoration – though both are needed on Okanagan Lake.

During the assessment, it was apparent that re-development provides the best opportunity to address the historic, cumulative losses that have occurred. There were a few examples of sites where well planned and executed restoration initiatives were undertaken, and there was an improvement when compared to 2010. However, when the quantity of re-build scenarios with good restoration plans (<5) is compared to the number of observed re-builds that occurred over the period (while we don't have an estimate, it is at least 30, probably more), it is readily apparent that most of these sites currently represent a lost opportunity. This failure to ensure that re-development does not coincide with some strong level of restoration means that it will be nearly impossible to reverse the rate of loss that is occurring, because it is unlikely that all natural or rural areas will remain at their current density.

Pre

Post

Restoration planning needs to be included in all redevelopment scenarios. Further, once properties re-develop, it is unlikely that they will be re-considered again for many years (i.e., homes are usually only rebuilt every 30 to 50 years). This can only be achieved if clear targets are created, and local government strictly adheres to them as a requirement.

It is complicated to develop policies or regulation for successful implementation of a good restoration initiative that will achieve long term transition to less shoreline disturbance. It requires many factors, such as but not limited: 1) A desire by either staff or politicians at the local government and Provincial level to ensure that ***all*** re-development applications include restoration plans, 2) Ensure that policy clearly identifies the level of expectation, 3) Ensure that qualified environmental professionals are engaged early in the development process, and 4) That environmental professionals are provided support from local government policy because they are often challenged by what is most sustainable (i.e., a good plan with biological merit) versus what is considered the "minimum requirement" (i.e., What is the least I have to do obtain approval?).

Many policies and regulations such as the Provincial Riparian Areas Regulation do not explicitly require restoration, meaning that a Qualified Environmental Professional (QEP) may have to present only a setback, leaving the local government to address any restoration requirements. Local government may not have adequate resources to undertake or enforce restoration works. This all points to the need for a regional lake management plan for Okanagan Lake, where all agencies are working collaboratively to inform policy and achieve common goals.

By ensuring that restoration expectations are identified in policy, less variability in "what is considered a good restoration plan" will occur (i.e., differences in professional opinion will be reduced), and focus of assessments can transition from setback identification to identifying natural areas and restoration planning that is consistently applied across the region.

5.1.4 Cumulative Impacts

The incremental, cumulative loss of natural shoreline observed over the last 7 years on Okanagan Lake was most apparent on steep shorelines where the rates observed ranged from -1% to as high as -2.8% of the shoreline within a given jurisdiction. This all occurred despite that fact that regulations such as Official Community Plans or the Riparian Areas Regulation were already in place during this period (i.e., even with regulation in place, loss of natural areas still occurred). There were many types of noncompliance observed, that were actively occurring, or had just occurred. Examples included new retaining walls, Crown Land encroachments, new boat lift covers, and loss of riparian vegetation.

All of this cumulative loss was created by numerous different types of processes. For instance, over the 7-year study period, 165 new retaining walls were observed, that affected approximately 1.45 km of shoreline. Lakebed substrate disturbance increased by 1.4% or along 4.1 km of shoreline. Over this same period, there were 164 new docks observed and 9 new marinas.

Currently, most lakeshore management protocols, such as the Official Community Plans around Okanagan Lake, or the Provincial Riparian Areas Regulation, all focus on mitigation strategies at the time of buildout (and somewhat at subdivision, but still only from a setback perspective) but do not generally take into consideration the cumulative effects of expected losses over time from increased density on a larger scale (e.g., the lake as a whole or within a given jurisdiction). Most local government and Provincial policies, or regulations do not contain specific strategies to address this key element of lakeshore planning, specifically the ongoing and expected incremental, cumulative loss associated with changes in density that occurs over time. This again, highlights the need for a regional approach, where key and critical habitat areas are both identified, and set aside from changes in density that will ultimately reduce habitat capability and function because disturbances will most likely be high once a density of single family occurs.

5.1.5 Lake Shoreline Planning

This all suggests that focus of shoreline planning on Okanagan Lake needs to address two key factors. First, shoreline planning must address and acknowledge that the entire lake is not available for development and further densification. If the entire lake is deemed available for densification, it is highly probable that many areas will transition from rural to some more dense land use type. If this occurs, a large portion of the natural areas will experience a similar rate of observable change to what has happened in the past, and ultimately end up at a similar end point of greater than 75% disturbance. At these levels, biological function of many shoreline areas, the capacity to support critical habitats, and other important ecological functions (e.g., water quality protection) are at high risk of failure.

Secondly, planning initiatives need to begin to consider more than just setbacks from the lake. Currently, nearly all shoreline planning utilizes either prescribed setbacks, or follows an explicit methodology such as the Riparian Areas Regulation. While these regulations are useful at providing some level of protection from disturbance, they do not address the overarching effects of land use change. Ultimately, they only address site specific mitigation measures to reduce disturbance at the time of construction. They do not factor in human behavior, where individuals do not envision their small actions as having a large consequence (e.g., its only two trees!). Typically, individual land owners are unaware of the large cumulative effect that small change associated with land use can have. While it is important to identify setbacks, it is still likely that disturbance will continue ultimately reaching a point where ecosystem function and services fail. It is possible that existing policy in place will help reduce the rate on a site by site basis, if some level of compliance is achieved. However, it is likely that noncompliance will occur, resulting in some loss, especially in areas where densification is increased, and that incrementally over time, a high level of disturbance will still be attained no matter what setback is used.

5.1.6 Education

As noted in the past FIM Report, education is seen as a key tool to assist in land stewardship of the shoreline of Okanagan Lake. It was suggested that a communication and outreach strategy be developed to inform stakeholders and the public of the findings of this study and improve stewardship and compliance. The outreach strategy is required because many people are not aware of the impacts of their activities and are also not fully aware of appropriate and governing legislation for development activities adjacent to shoreline areas. Education of the public will help with compliance, because as awareness increases, there will be more eyes available to report extreme non-compliance, which are typically the cases where change and disturbance occurs very rapidly.

5.1.7 Summary

In summary, the data from Okanagan Lake and across BC, all suggest that land use is a driving factor influencing natural shoreline areas. Further, it is apparent that the rate of change observed is rapid, when viewed from a biological perspective. Since the shoreline provides critical habitat and has high economic value, a suite of recommendations has been prepared to help aid shoreline planning along Okanagan Lake. Specifically, reference to the need to develop a more holistic, lakeshore management document is presented. Ultimately, for our most important resource to maintain some level of natural character, support key environmental services, and continue to be a big economic draw to our area, a regional planning effort is needed where Federal, Provincial, and local governments work towards a common set of goals and policies for Okanagan Lake. Urgent action is necessary to ensure shoreline protection and restoration, which need to be explicit in policy and consistently applied across multiple jurisdictions. Key means to address the issue is to raise the level of awareness of those that use and enjoy the shoreline of Okanagan Lake and to collaboratively develop regulation or policy to protect and restore the shoreline of Okanagan Lake.

It is both policy/regulation and education that would act to reduce either the maximum level observed or the timeline over which extensive disturbance occurs. Thus, changing behavior and attitudes (i.e., education) towards the shoreline and ensuring strong policy and regulation are in place is necessary to reduce the observed maximum disturbance and the rate of disturbance along Okanagan Lake. The easiest way to achieve this and prevent loss is to avoid changes in land use that result in increased density of the shoreline, leaving areas more rural in nature. After that, a regional approach that is multi-jurisdictional will likely be most effective at reducing the observed change along the shoreline, where common goals known, such as critical areas to preserve are identified and a collaborative approach to achieve them is taken.

6.0 RECOMMENDATONS

The following recommendations are considered necessary to slow the observed rates of change, and protect or restore key shoreline areas on Okanagan Lake. To achieve these goals, planning must be undertaken on a lake wide or regional scale, with a high level of participation by all regions working collaboratively to a common goal.

1. **All level of government need to equally work towards common goals.** Currently, lake shore management is complicated and could be improved if all levels of government worked collaboratively and towards a common goal. Developing an overarching lake shoreline management plan or direction would be more achievable as each region would know areas to focus on. .
   a. **Collaboration will require a lead.** This could be one organization such as the Okanagan Basin Water Board or the combination of a number of organizations to include the South Okanagan – Similkameen Conservation Program and Okanagan Collaborative Conservation Program.
   b. **Address consistency in the implementation of existing legislation and policy**. Currently, many areas have similar policies, but each region is operating independently. Shoreline planning will and should continue to be under individual jurisdiction but there is a need to ensure all areas are aware of and in keeping with an overall vision for shoreline development on Okanagan Lake.
   c. **Regulation and policy should be adjusted based upon habitat values present.** In areas of Very Low to Moderate value, allowable activities should be efficiently approved through implementation of policy and regulatory processes, with focus on restoration. Conversely, regulatory review of proposals in areas of High and Very High value should be scrutinized carefully to ensure they achieve the goals of the lake shoreline management plan and that they preserve sufficient natural area to maintain key aquatic, ecosystem, and terrestrial/wildlife habitat functions. This would achieve both a reduction in overhead associated with policy implementation in areas of lower value, and help direct more intense development to these areas.
2. **A Lake Shoreline Management Plan needs to be developed.** Currently, Okanagan Lake does not have one consistent management plan that all levels of government are using. Given the unique governance structure in the Okanagan Basin a unique approach and

partnership may be required. Clear targets should be included as part of a Lake Management Plan and key areas to retain as natural are identified regionally.

a. **Consider regionally consistent lakeshore setbacks, utilizing targets for retention of natural areas and restoration.** Such regulation, policy and targets should acknowledge individual site conditions and habitat values using the AHI, and other important habitat elements. Utilization a regulation such as the Provincial Riparian Areas Regulation may be insufficient on Okanagan Lake, and local governments may need to develop bylaws or policies that exceed a minimum standard to fully protect areas of higher habitat value.

b. **Set clear targets for restoration.** Setting restoration targets for development is key. A reasonable target for restoration should vary, depending upon the value of habitat, where higher value areas require higher levels of restoration. For instance, in areas of Very Low to Moderate AHI value, a target of 20 to 30% may be reasonable. For areas of High and Very High value, a larger minimum target (perhaps 50% to 70%) for restoration of disturbed areas could be considered.

c. **Set clear targets for retention of natural areas.** Clear targets for retention need to be developed. These targets need to consider the current condition, habitat values present (i.e., AHI), and other factors, where retention of High and Very High AHI shorelines is a high priority.

d. **Retention should focus on remaining natural areas, which are most predominant in rural areas.** Areas that have the greatest and highest biological capacity (aside from Natural Parks) are the most important areas to currently consider for conservation priority. Natural or rural areas that are left, mostly on the north Westside, north Arm, and fringe areas surrounding Naramata and Summerland, are most important for conservation efforts. In other larger centers like Kelowna, West Kelowna, and Lake Country, rural areas that have been approved for development need to ensure that natural shoreline areas are protected, and strategies to mitigate the incremental cumulative loss are addressed. Remaining large parcel areas that are still rural and of high value are likely critically important to consider as natural retention areas in these larger centers because of the extent of development that has already occurred in these areas. *It is acknowledged here that these are broad statements and a full review of all remaining natural or rural areas has not been undertaken. These broad statements are* *made to highlight the importance of residual areas that remain in close proximity to the larger centers around the lake.*

e. **Set clear targets for rates of change**. This assessment has identified that rates of change from natural to disturbed shoreline are generally small when considered only as a percentage. The assessment also highlights how observed rates were greatest in steep and very steep areas, currently experiencing greater development pressure. Targets need to be set lower than -0.5%, per year to be effective, which will result in a loss of ±1.4 km of natural shoreline per year.

3. **Education and Outreach.** It is apparent that human behavior plays a key role. Well planned educational initiatives and potentially demonstration projects are needed to change perceptions of what shorelines represent. Society needs to begin to treat these areas as having high economic value because of the services they provide. In doing so, there will be a greater acceptance and effort made to integrate into the natural environment, rather than adapt it to individual preference. Further, if a higher value is perceived for these areas, there will be a stronger desire to protect them.

    a. **Develop a communication and outreach strategy.** To inform stakeholders and the public of the findings of this study and improve stewardship and compliance. A joint initiative involving the OBWB, Regional Districts and SOSCP/OCCP could be considered to ensure a coordinated approach and message.

    b. **Develop and distribute communication material for local land owners and other interested parties.** This could include a primer or other outreach material or demonstration projects to address restoration or disturbed areas on Okanagan Lake.

7.0 REFERENCES

Schleppe, J., 2010. Okanagan Lake Foreshore Inventory and Mapping. Ecoscape Environmental Consultants Ltd. Project File: 10-596. 2011. Prepared for: Okanagan Collaborative Conservation Program

APPENDIX A

FORESHORE INVENTORY AND MAPPING METHODS

FORESHORE INVENTORY AND MAPPING

Standard Methods for Completion of Foreshore Inventory And Mapping Projects

Prepared By:

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

ECOSCAPE
Environmental Consultants Ltd.

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Fraser Salmon and Watersheds Program
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With proper management, we may begin to find a balance within our ecosystems. Without the ongoing support for inventory and mapping initiatives, the objective of sustainable development and balance will not be achieved.

Helpful comments and reviews of this document were completed by:

Brad Mason, Community Mapping Network
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1.0 INTRODUCTION

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

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

2.0 FORESHORE INVENTORY AND MAPPING OVERVIEW

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

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

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

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

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

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

2.1 Development of the Foreshore Inventory and Mapping Protocol

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

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

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

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

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

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

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

3.0 FOREHORE INVENTORY AND MAPPING OVERVIEW

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

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

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

Shoreline Data Collection (Step 2) is where most of the field data for the assessment is collected. This is often referred to as Pass 2. During this stage, data is entered into the GPS data dictionary for all applicable fields. Other information that may be collected includes shoreline habitat mapping (e.g., delineating the extent of shore marshes on air photos), mapping significant changes in substrates within a segment, etc.

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

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

4.0 FIELD ASSESSMENT

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

4.1 Pre-Field Overview

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

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

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

2. Any topography information for the shoreline. Topographic information is available for almost all areas of the province from the TRIM mapsheets and can be obtained digitally (GIS files). This information can help assessors determine reach breaks and assess slope.

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

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

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

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

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

4.2 Shoreline Video

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

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

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

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

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

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

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

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

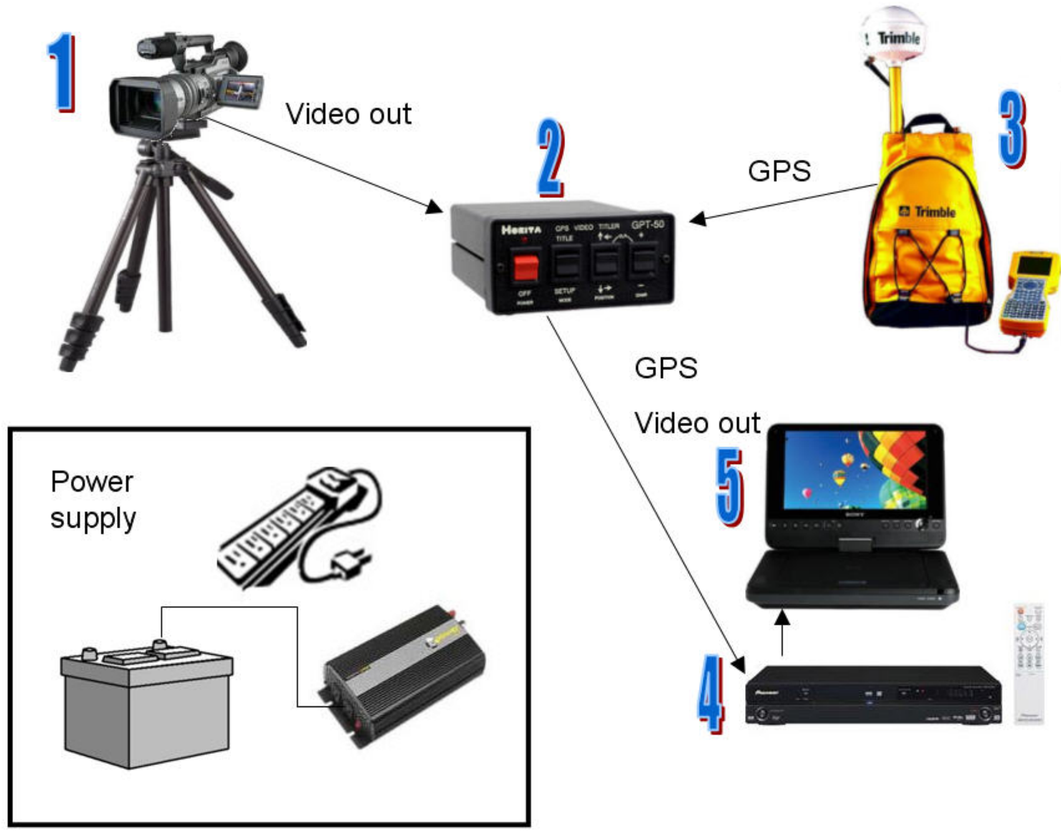


Figure 1: Shoreline video setup. 1) Digital video camera, 2) GPS stamper unit, 3) GPS data logger and receiver, 4) Digital video recorder, 5) Digital video player

4.3 Shoreline Data Field Collection

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

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

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

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

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

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

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

4.3.1 Lake Reference

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

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

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

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

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

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

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

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

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

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

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

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

4.3.2 Segment Class

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

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

   Determining Shore Segment Breaks

   Shore segments should consider the following different criteria:

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

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

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

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

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

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

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

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

6. *Level of Impact* Level of impact is a categorical field that is used to describe the general disturbance that is observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered the shoreline including foreshore substrates, vegetation, or the shoreline itself (e.g., retaining walls). Level of impact is considered both looking at the length of the shore line (i.e., along the segment) and the depth of the shore zone area to between 15 to 50 m back. In more rural settings, typically the assessment area is greater (i.e., 50 m) and in more developed shorelines, typically the assessment area is less (i.e., 15 to 30 m). In cases of roadways or railways, one should generally consider the location of the rail or roadway along the segment (i.e., how far back is it set, is the lake infill, etc.). To facilitate interpretation of this category, air photo interpretation is recommended to better estimate disturbance. Disturbance categories include High (>40%), Medium (10-40%), Low (<10%), or None. Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The RDCO Foreshore Inventory and Mapping report defines the *Level of Impact* as follows (Magnan and Cashin, 2004):
    a. *Low*- Segments that show little or limited signs of foreshore disturbance and impacts. These segments exhibit healthy, functioning riparian vegetation. They have substrates that are largely undisturbed, limited beach grooming activities, and no to few modifications.
    b. *Moderate* - Segments that show moderate signs of foreshore disturbance and impacts. These segments exhibit isolated, intact, functioning riparian areas (often between residences). Substrates (where disturbed) exhibit signs of isolated beach grooming activities. Retaining walls (where present) are generally discontinuous. General modifications are well spaced and do not impact the majority of the foreshore segment.
    c. *High* - Segments that show extensive signs of disturbance and impacts. These segments exhibit heavily disturbed riparian vegetation, often completely removed or replaced with non-native species. Modifications to the foreshore are extensive and likely continuous or include a large number of docks. Generally, residential development is high intensity. Modifications often impact a majority of the foreshore.

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

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

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

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

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

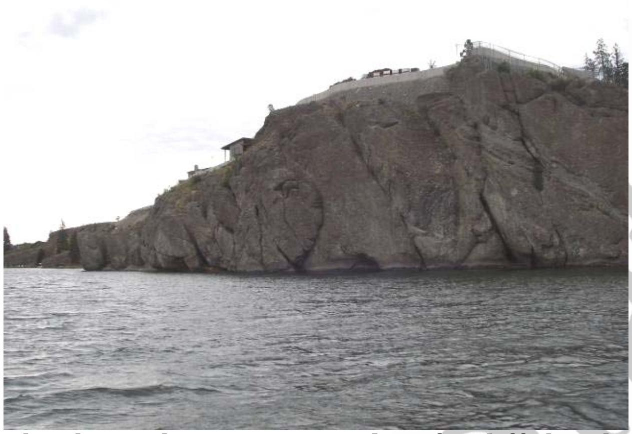
4.3.3 Shore Type

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

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

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

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



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

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

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

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

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

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

The photo above shows a typical sandy shoreline.

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

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

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

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

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

4.3.4 Land Use

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3.5 Substrates

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3.6 Vegetation Bands (Vegetation Band 1 & 2)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3.7 Littoral Zone

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

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

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

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

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

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

4.3.8 Modifications

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3.9 Flora and Fauna

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

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

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

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

5.0 DATA PROCESSING AND QUALITY ASSURANCE

The data processing and quality assurance portions of these projects are extremely important. It is preferred if assessors carry out these steps because they have first hand knowledge of the shoreline and it's condition. Although data entry into the GPS unit results in minimal errors (i.e., forgotten fields, etc.), there is often times small items that are missed or accidentally overlooked. It is during the data processing stages that data gets reviewed and finalized.

5.1 Data Processing

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

5.1.1 Accuracy and Determining the Shoreline Location

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

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

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

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

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

3. Using existing Terrain Resource Information Mapping shorelines;

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

5.1.2 Segment Breaks

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

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

5.2 Data Management and Quality Assurance

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

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

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

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

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

6.0 REPORTING

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

6.1 Data Analysis

Data analysis can be completed in numerous different ways using FIM databases. Most reports prepared to date have followed the templates developed by the Regional District Central Okanagan for the central regions of Okanagan Lake. There reports contain numerous different graphs, figures, and correlations prepared using the dataset, and all help with understanding and interpreting data. Important correlations can lead to a better understanding of modified shorelines.

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

7.0 RECOMMENDATIONS FOR ONGOING DATA MANAGEMENT

The following are recommendations for management of these data sets:

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

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

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

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

8.0 REFERENCES

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Appendix A – Foreshore Inventory and Mapping Field Code Definitions

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

Dictionary Section	Abbreviated Database Column Heading	Un-Abbreviated Column Heading	Previous Database Column Headings (if different)	Type	Definition	Unit of Measurement
Segment Class	LAND_USE	Land Use		Categorical	Land use is a categorical field that is used to describe the dominant land use observed along the segment. Categories include Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single Family, Rural, and Urban Park. Land use can be determined based upon a combination of field observation, review of zoning and bylaw maps, and air photo interpretation. Please refer to detailed definitions of the different land use types to better understand the different categories.	
	LEV_OF_IMP	Level of Impact		Categorical	Level of impact is a categorical field that is used to describe the general disturbances that are observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered shoreline including foreshore substrates, vegetation, or the shoreline (e.g., retaining walls). Level of impact is considered both looking at the length of the shore line (i.e., along the segment) and the depth of the shore zone area to between 15 to 50 m back. In more rural settings, typically the assessment area is greater (i.e., 50 m) and in more developed shorelines, typically the assessment area is less (i.e., 15 m). In cases of roadways or railways, one should generally assess the location of the rail or roadway along the segment. To facilitate interpretation of this category, air photo interpretation is recommended to better estimate disturbance. Disturbance categories include High (>40%), Medium (10-40%), Low (<10%), or None. Consistency of determination is very important and assessors should consistently use the same criteria to determine the level of impact.	
	LIVEST_ACC	Livestock Access		Categorical	Livestock access is a categorical field that is used to determine whether livestock, such as cattle, have access to the foreshore. Choices include Yes or No or blank. If the field is left blank, one should assume that cattle do not have access.	
	DISTURBED	Percentage of the Shoreline that is Disturbed		Numeric	Percentage of the shoreline that is disturbed is a measurement of the approximate length and depth of the shore zone that has been disturbed. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the percentage disturbed should correspond to the level of impact (i.e., a high percentage of disturbance should translate into a High level of impact). The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.	%
	NATURAL_	Percentage of the Shoreline that is Natural		Numeric	Percentage of the shoreline that is natural is a measurement of the approximate length and depth of the shore zone that remains in a natural condition. Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed. Generally, the percentage natural should correspond to the level of impact. The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.	%
	PHOTONUM	Photo Number		Alphanumeric	Photo number is a field that is used to enter in digital or still photos taken during the assessment.	
	TAPE_NUMB	Tape Number		Alphanumeric	Original Video tape number	
	VIDEO_TIME	Video Time		Alphanumeric	Delineates that start and stop time of the video segments. Assessors may also just enter in the start time of the segment, as it is generally inferred that the start time of one segment corresponds with the stop time of a previous segment.	
	CMMNT_CLAS	Class Comments		Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the class data fields above.	
Shore Type	CLIFF_BLUF	Cliff and/or Bluff Shore Type		Numeric	The Cliff / Bluff field contains the percentage of the segment, based upon the shore segment length that is a cliff or bluff shore type. A cliff shore type is typically very steep with substantial vertical elements. A bluff shore type is typically steep or very steep, and then flat for a substantial distance, typically formed by the fast recession of water levels during glacial periods.	%
	ROCKY	Rocky Shore Type	Low Rocky Shoreline and/or Vegetated Shoreline	Numeric	The Rocky Shoreline field contains the percentage of the segment, based upon the shore segment length that is rocky. Rocky shores consist mostly or boulders and bedrock, with components of large cobble and some gravels. These shores tend to occur on steeper shorelines. Previous versions of the data dictionary called these shorelines low rocky shorelines or possible (but less so) vegetated shorelines.	%

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

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

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

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

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

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

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

Appendix B – Data Base and Field Code Version Consolidation

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

Appendix C – SHIM Lake v. 2.6 Data Dictionary

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Shim Lake 2008
June 23, 2008

Lake_Shoreline          Line Feature, Label 1 = Segmnt_Num, Label 2 = Aquatic_Veg
                        Lake shore
   ____________________       Separator
   LAKE REFERENCE       Separator
   Lake_Name            Text, Maximum Length = 100
                        Normal, Normal
   Lake_level           Numeric, Decimal Places = 2
                        Minimum = 0, Maximum = 3000, Default Value = 0
                        Normal, Normal
   Sechi_depth          Numeric, Decimal Places = 1
                        Minimum = 0, Maximum = 50, Default Value = 0
                        Normal, Normal
   Organization         Text, Maximum Length = 50
                        Normal, Normal
   Date                 Date, Auto generate Create, Year-Month-Day Format
                        Normal, Normal
   Time                 Time, Auto generate Create, 24 Hour Format
                        Normal, Normal
   Crew                 Text, Maximum Length = 50
                        Normal, Normal
   Weather              Menu, Normal, Normal
      Light Rain [L]
      Heavy Rain [H]
      Snow/Sleet [N]
      Over cast [OV]
      Clear [S]
      Partly Cloudy [PC]
      Other [O]
   Air_Temp             Numeric, Decimal Places = 1, degrees centigrade
                        Minimum = -25, Maximum = 45, Default Value = 0
                        Normal, Normal
   Water_Temp           Numeric, Decimal Places = 1, degrees celsius
                        Minimum = -2, Maximum = 29, Default Value = 0
                        Normal, Normal
   Jurisdiction         Text, Maximum Length = 100, Jurisdiction
                        Normal, Normal
   Comments             Text, Maximum Length = 100
                        Normal, Normal
   ____________________       Separator
   SEGMENT CLASS        Separator
   Segmnt_Num           Numeric, Decimal Places = 1, Unique Identification number for segment
                        Minimum = 0, Maximum = 99999, Default Value = 0
                        Required, Required
   Shore_Type           Menu, Required, Normal
      Cliff/Bluff
      Rocky Shore
      Gravel
      Sand
      Stream Mouth
      Wetland
      Other
   Shore_Modifier       Menu, Normal, Normal
      Log Yard
      Marina_small (6-20)
      Marina_large (20+)
      Railway
      Road
      None   Default
      Other
   Slope                Menu, Normal, Normal, general slope of shore landward
      Bench
      Low (0-5)
      Moderate (5-20)
      Steep (20-60)
      Very Steep (60+)
   Land_Use             Menu, Normal, Normal, observed
      Agriculture
      Commercial
      Conservation
      Forestry
      Industrial
      Institution
      Multi Family
      Natural Area
      Park
      Recreation
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   Rural
   Single Family
   Urban Park
Lev_of_Imp          Menu, Normal, Normal, Level of Impact
   None   Default
   Low (<10%)
   Medium (10-40%)
   High (>40%)
Livest_Acc          Menu, Normal, Normal, Stream segmnet accessible to live-stock
   Yes
   No   Default
Disturbed           Numeric, Decimal Places = 0, Percent of segment disturbed
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Natural             Numeric, Decimal Places = 0, Percent of segment natural
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
PhotoNum            Text, Maximum Length = 100, Roll and print number of photograph
                    Normal, Normal
Tape_Numb           Text, Maximum Length = 100, Original Video Tape Number
                    Normal, Normal
Video_Time          Text, Maximum Length = 100, Time stamp on original video tape
                    Normal, Normal
Cmmnt_Clas          Text, Maximum Length = 100, Comments for Segment
                    Normal, Normal
____________________      Separator
SHORE TYPE          Separator
Cliff/Bluff         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Rocky               Numeric, Decimal Places = 0, Rocky Shore
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Gravel              Numeric, Decimal Places = 0, Gravel Shore
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Sand                Numeric, Decimal Places = 0, Sand Beach
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Stream_mouth        Numeric, Decimal Places = 0, Stream mouth
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Wetland             Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Other               Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Stype_comm          Text, Maximum Length = 100, Comments for Segment
                    Normal, Normal
____________________      Separator
LAND USE            Separator
Agriculture         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Commercial          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Conservation        Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Forestry            Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Industrial          Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Institution         Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Multi Family        Numeric, Decimal Places = 0, Percent mult family residential (condo)
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Natural Area        Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
Park                Numeric, Decimal Places = 0, Percent
                    Minimum = 0, Maximum = 100, Default Value = 0
                    Normal, Normal
```

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1_Riparian             Line Feature
```

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

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

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

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

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

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

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

Appendix D – Brief GPS Overview

Global Positioning System (GPS)

Theory

What is GPS?

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

GPS System Configuration

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

Position Computation

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

Sources of Error

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

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

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

Increasing Accuracy of Position

Dilution of Precision (DOP) Mask

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

Position Correction: Differential GPS

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

Post-Processing Reference Data

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

Real-Time GPS Surveying

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

Sound to Noise Ratio (SNR) Mask

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

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

Elevation Mask

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

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

Accuracy Requirements for SHIM

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

General Field Methods for Poor GPS Reception

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

Using the Trimble Pathfinder

Upload the Data Dictionary from Pathfinder Office
Configure GPS

Field Mapping

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

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

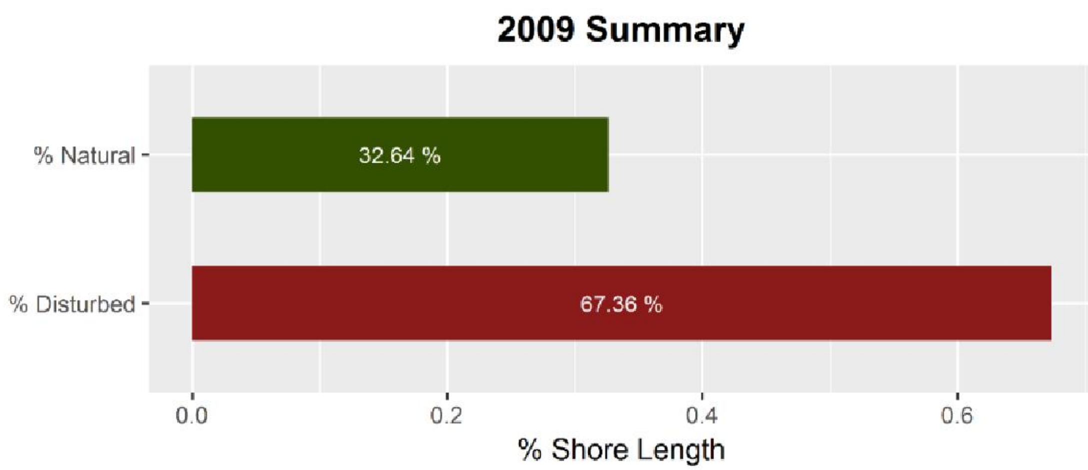
Entering Shoreline Information

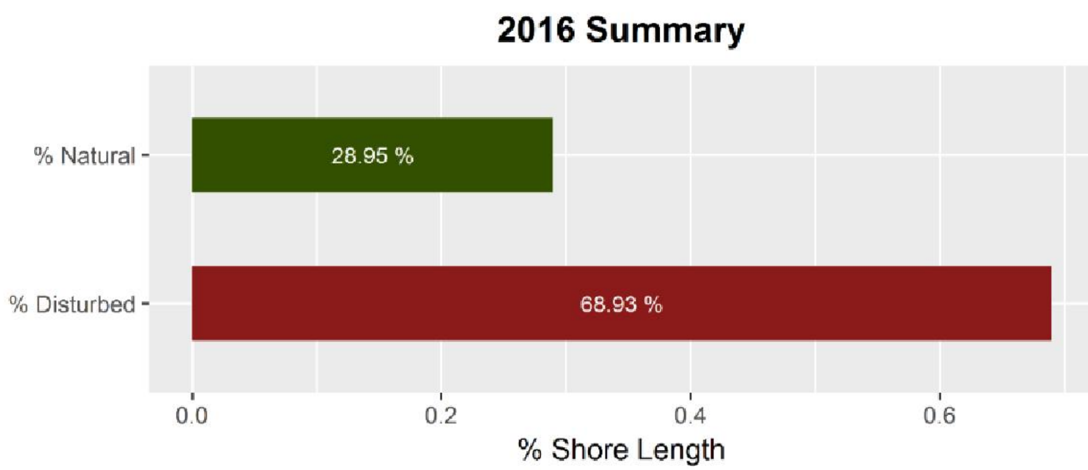
Note: *Remember to pause logging before stopping to enter information into the data logger, and resume when you continue walking the stream centreline.*

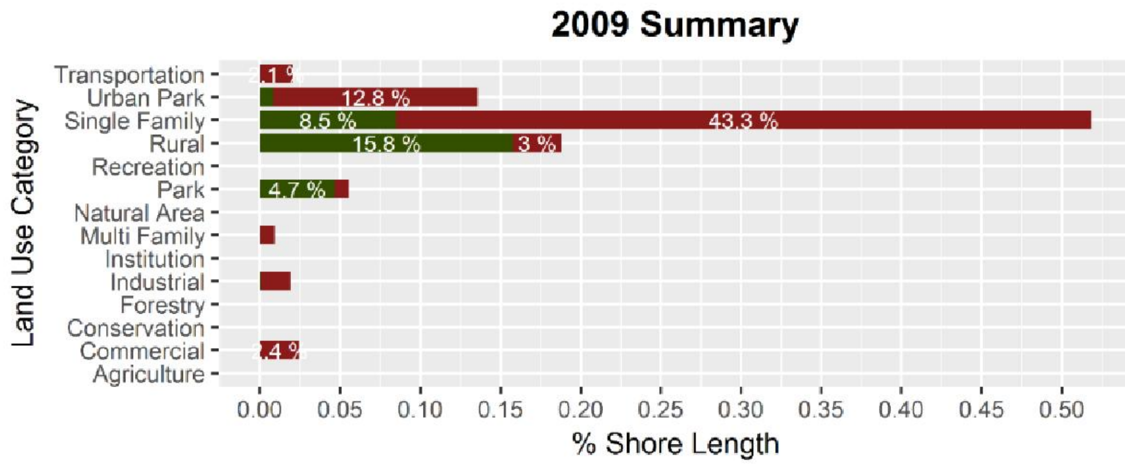
Reference Information applies to the entire shoreline feature you are mapping. It is usually entered while standing at the start point, but the timing depends on crew preference. For example you may prefer to do it at the same time as entering characteristics for the first segment. In any case, the data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

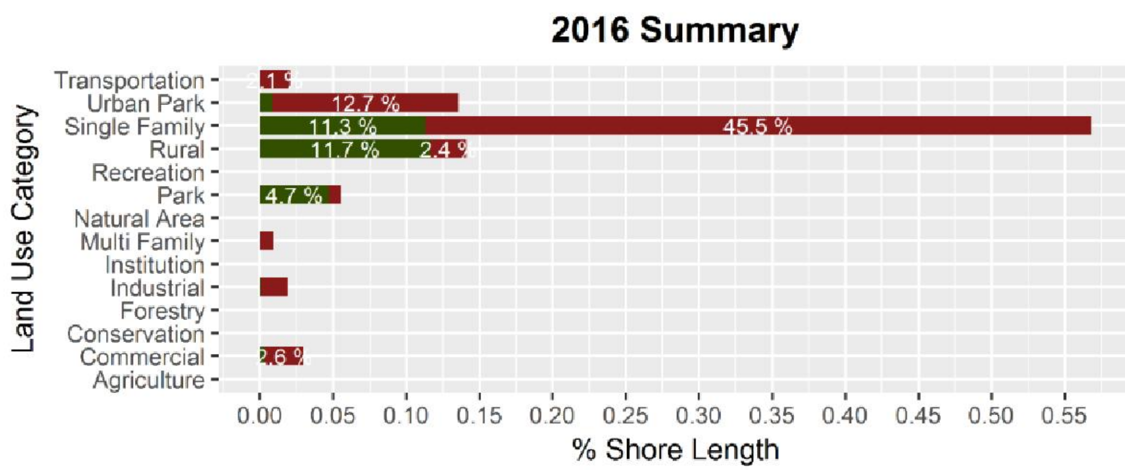
APPENDIX B

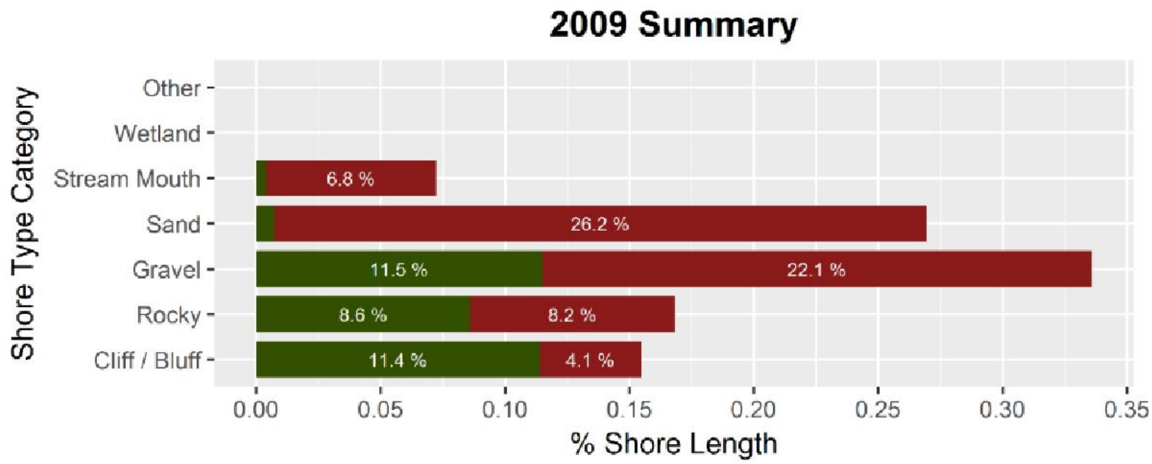
CITY OF KELOWNA DATA SUMMARY

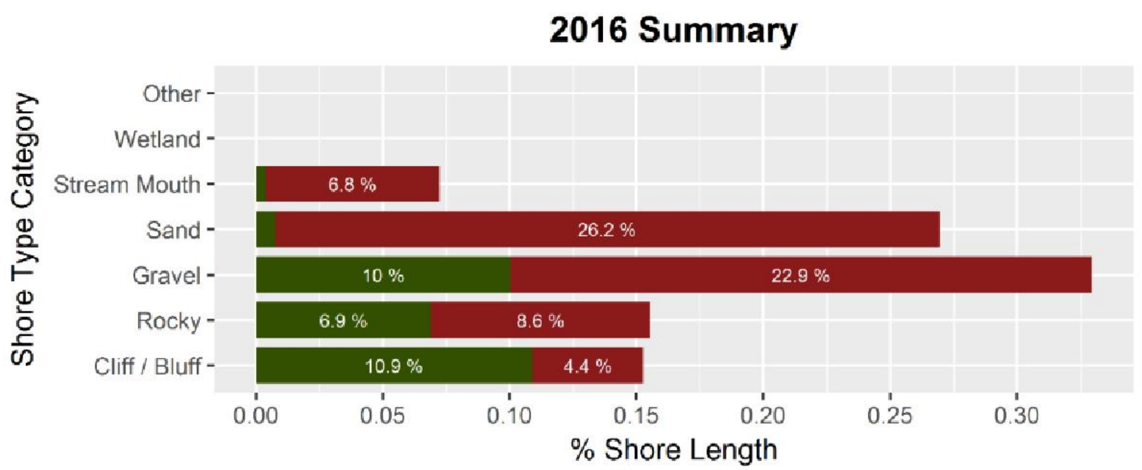

2009 Summary
% Natural
32.64 %
% Disturbed
67.36 %
0.0
0.2
0.4
0.6
% Shore Length

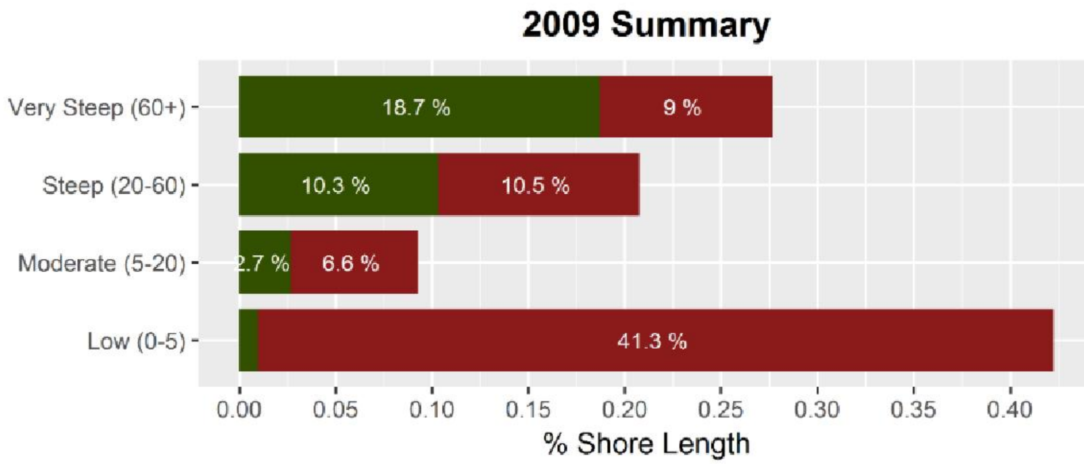

2016 Summary
% Natural
28.95 %
% Disturbed
68.93 %
0.0
0.2
0.4
0.6
% Shore Length

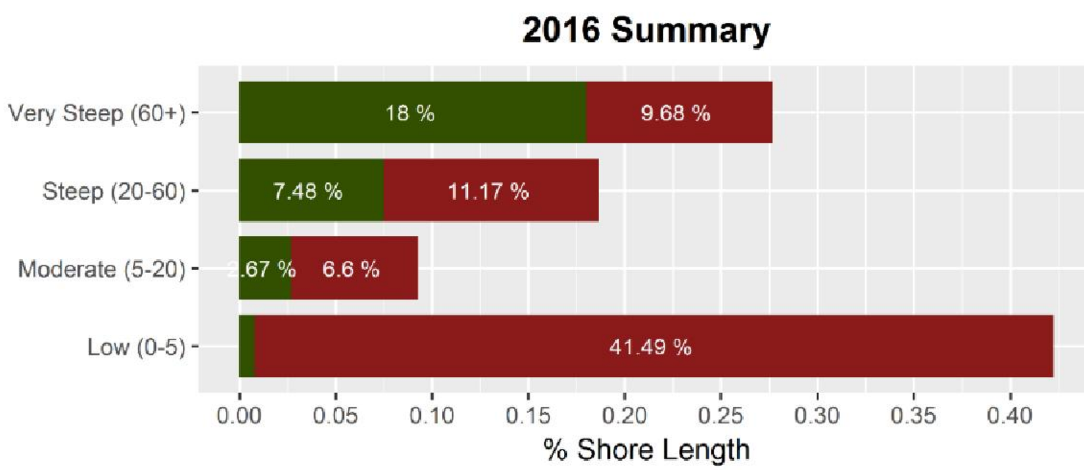

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
12.8 %
8.5 %
43.3 %
15.8 %
3 %
4.7 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

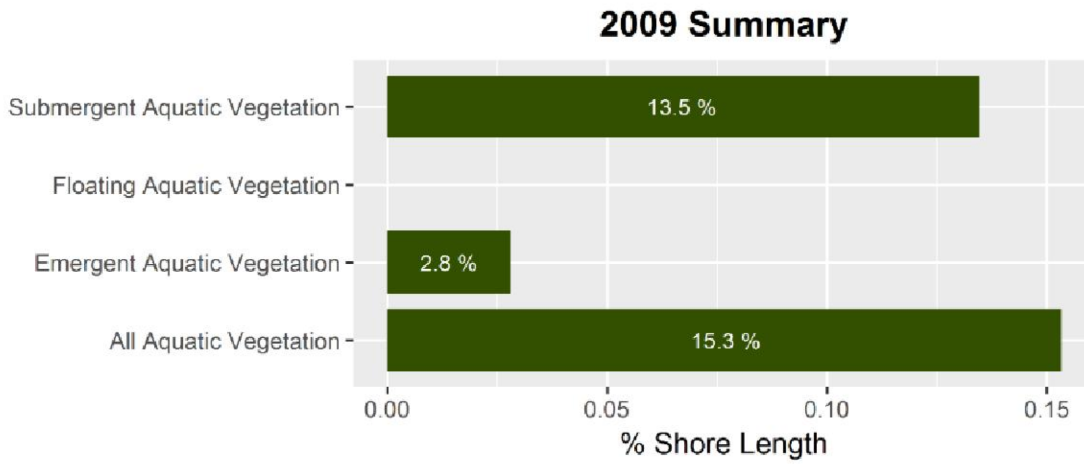

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
12.7 %
11.3 %
45.5 %
11.7 %
4.7 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

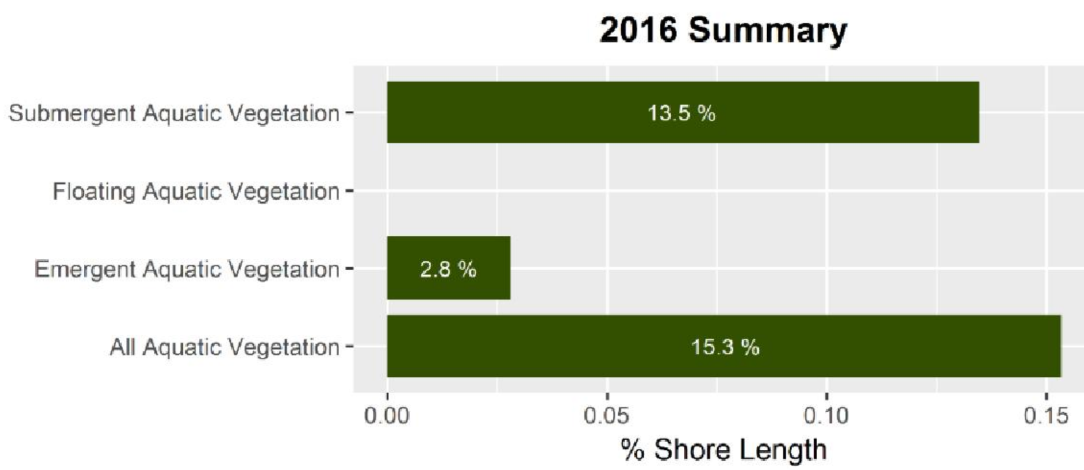

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
6.8 %
26.2 %
11.5 %
22.1 %
8.6 %
8.2 %
11.4 %
4.1 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

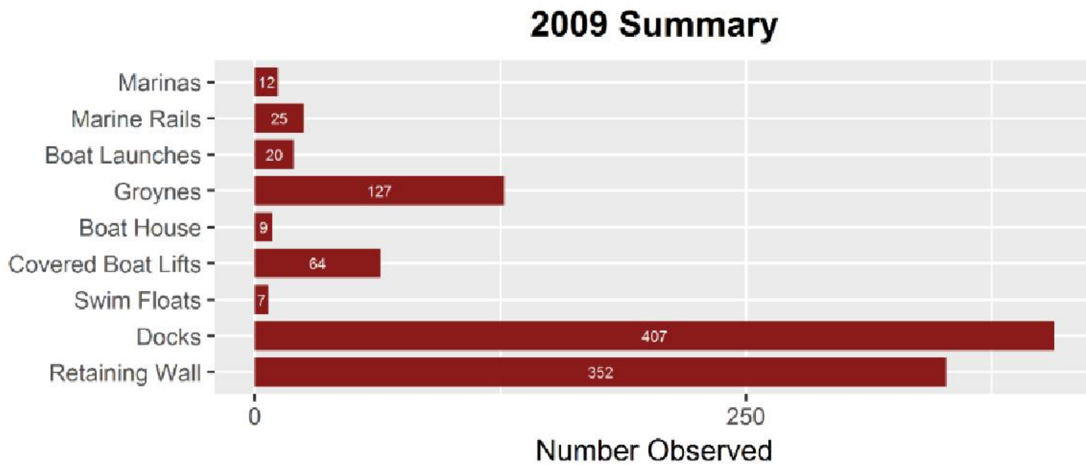

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
6.8 %
26.2 %
10 %
22.9 %
6.9 %
8.6 %
10.9 %
4.4 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
% Shore Length

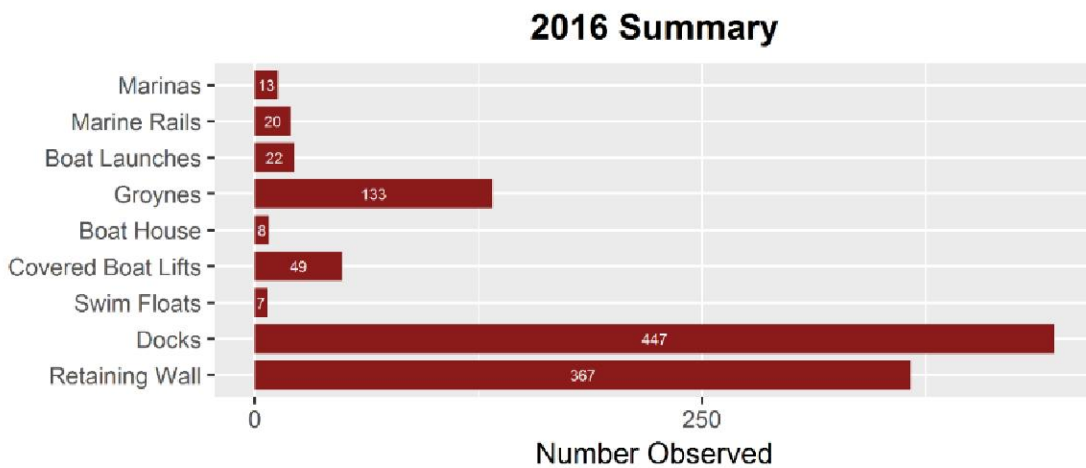

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
18.7 %
9 %
10.3 %
10.5 %
2.7 %
6.6 %
41.3 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

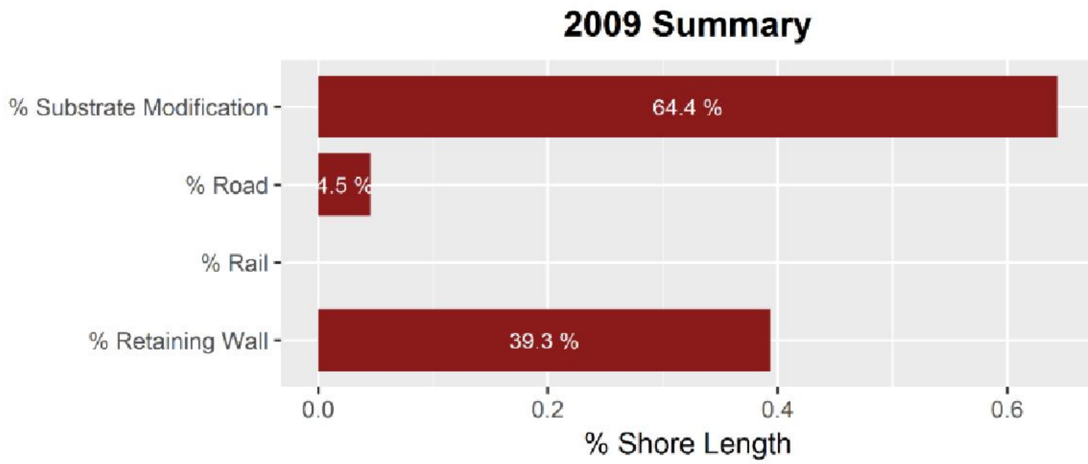

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
18 %
9.68 %
7.48 %
11.17 %
.67 %
6.6 %
41.49 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

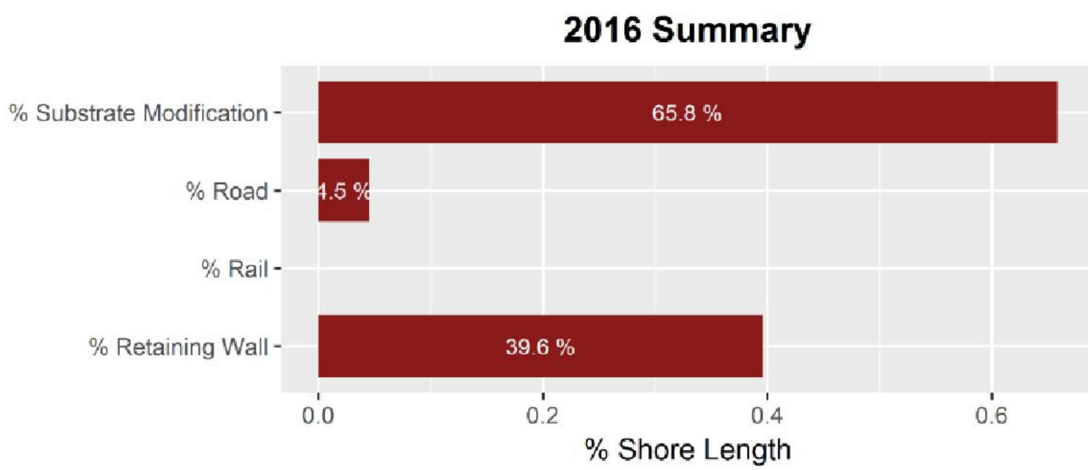

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
13.5 %
2.8 %
15.3 %
0.00
0.05
0.10
0.15
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
13.5 %
2.8 %
15.3 %
0.00
0.05
0.10
0.15
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
12
25
20
127
9
64
7
407
352
0
250
Number Observed

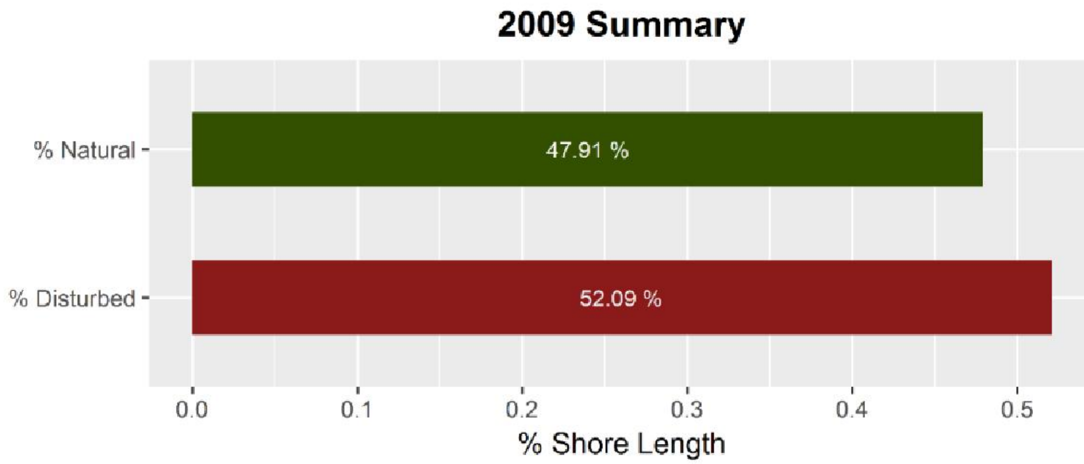

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
13
20
22
133
8
49
7
447
367
0
250
Number Observed

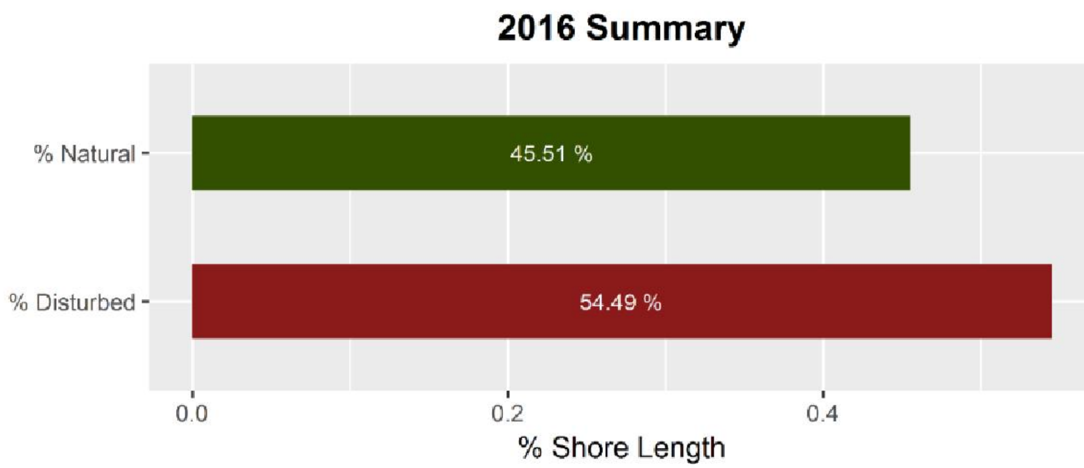

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
64.4 %
4.5 %
39.3 %
0.0
0.2
0.4
0.6
% Shore Length

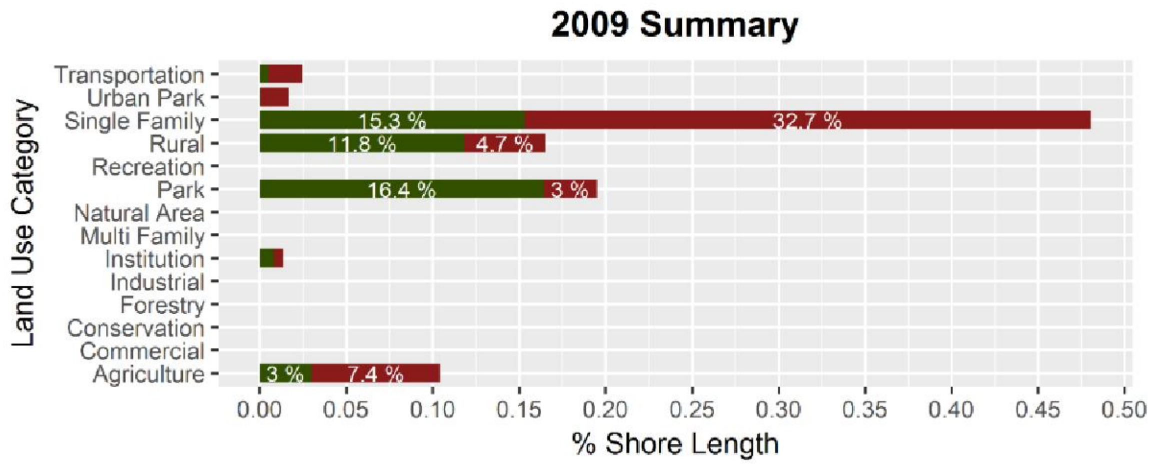

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
65.8 %
4.5 %
39.6 %
0.0
0.2
0.4
0.6
% Shore Length

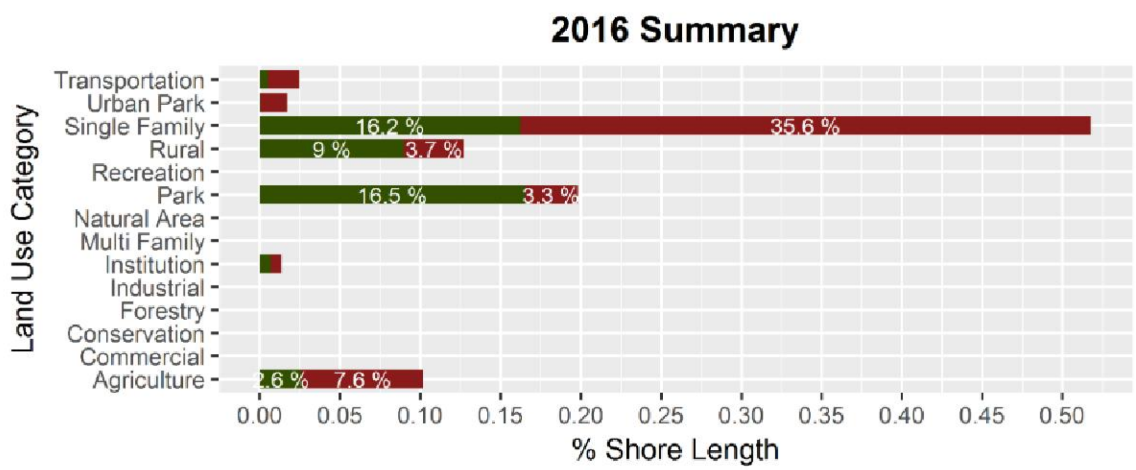
APPENDIX C

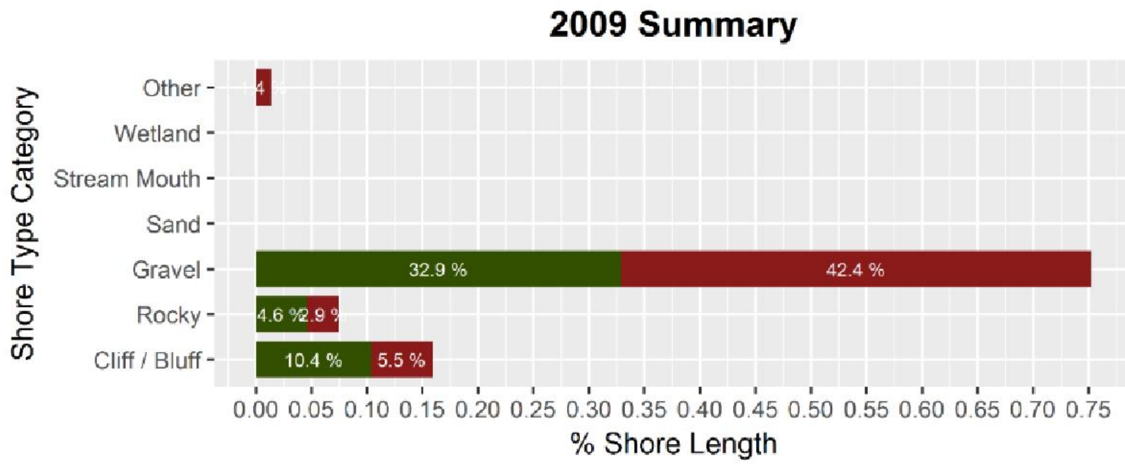
DISTRICT OF LAKE COUNTRY DATA SUMMARY

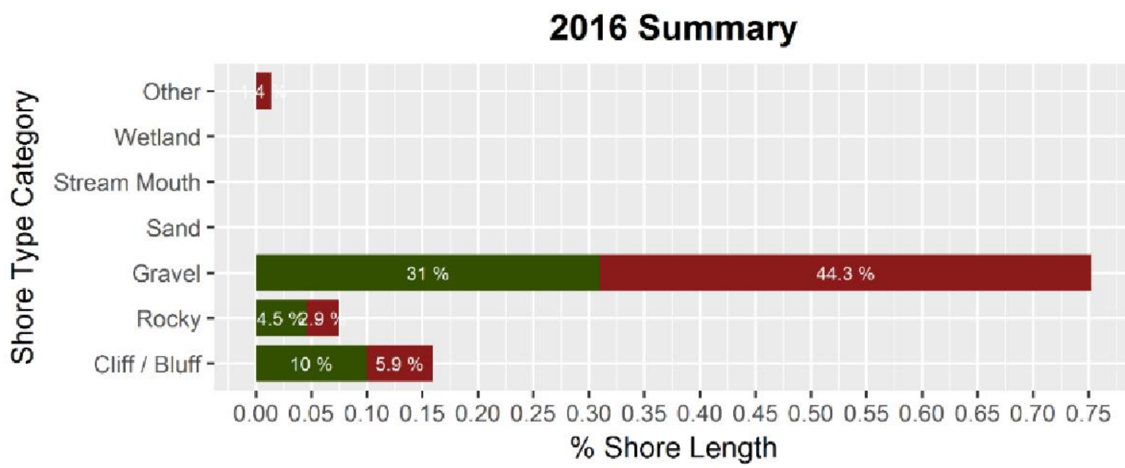

2009 Summary
% Natural
% Disturbed
47.91 %
52.09 %
0.0
0.1
0.2
0.3
0.4
0.5
% Shore Length

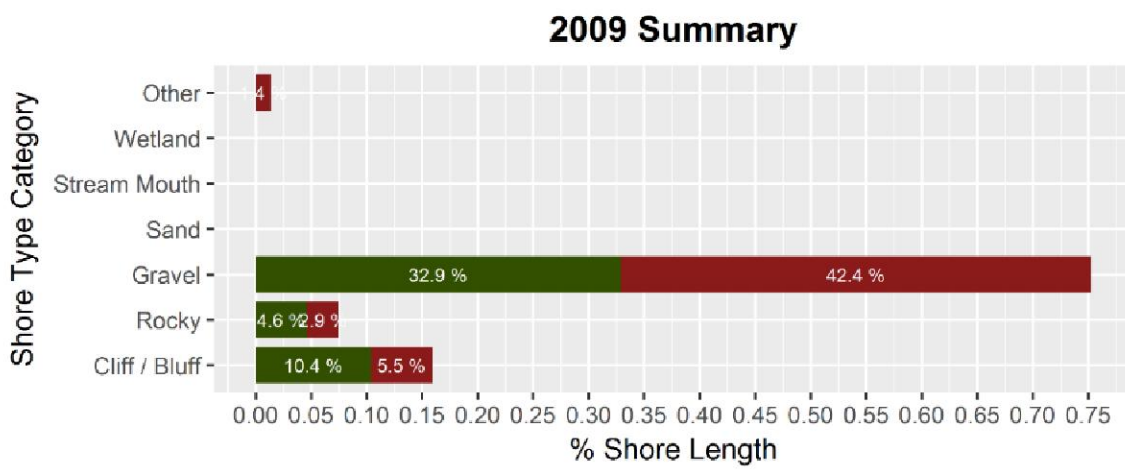

2016 Summary
% Natural
% Disturbed
45.51 %
54.49 %
0.0
0.2
0.4
% Shore Length

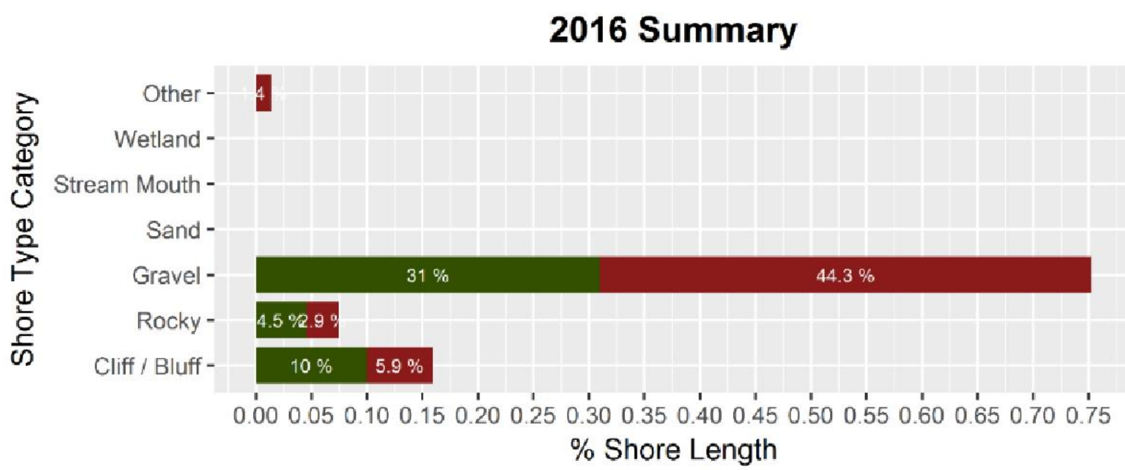

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
15.3 %
32.7 %
11.8 %
4.7 %
16.4 %
3 %
3 %
7.4 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

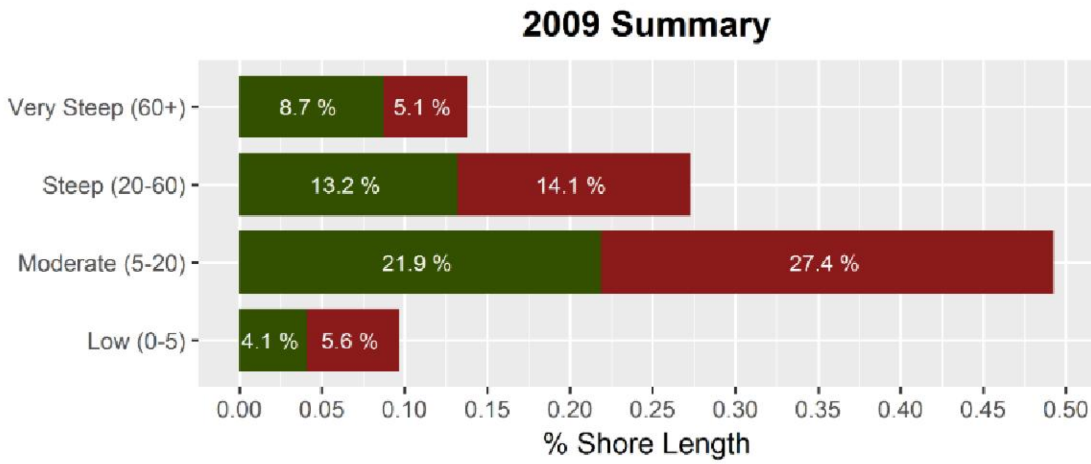

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
16.2 %
35.6 %
9 %
3.7 %
16.5 %
3.3 %
7.6 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

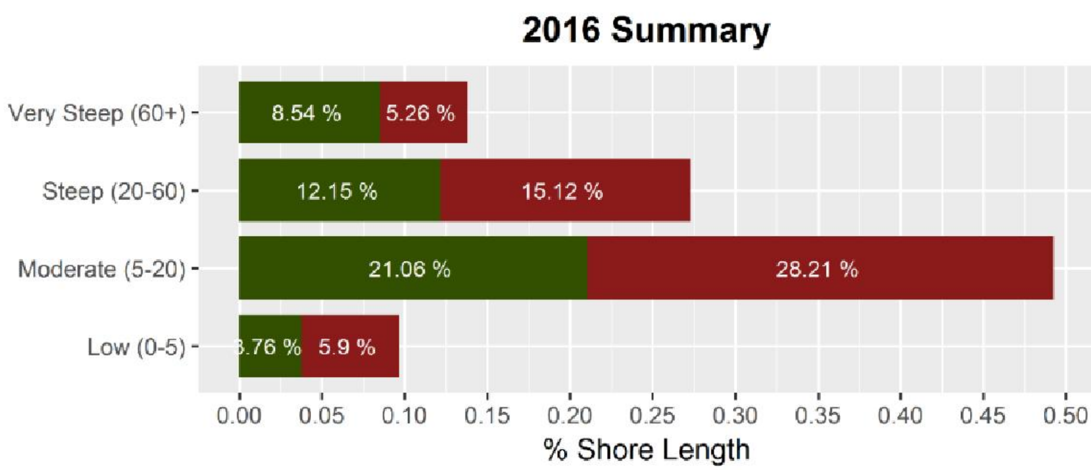

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
32.9 %
42.4 %
4.6 %
2.9 %
10.4 %
5.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

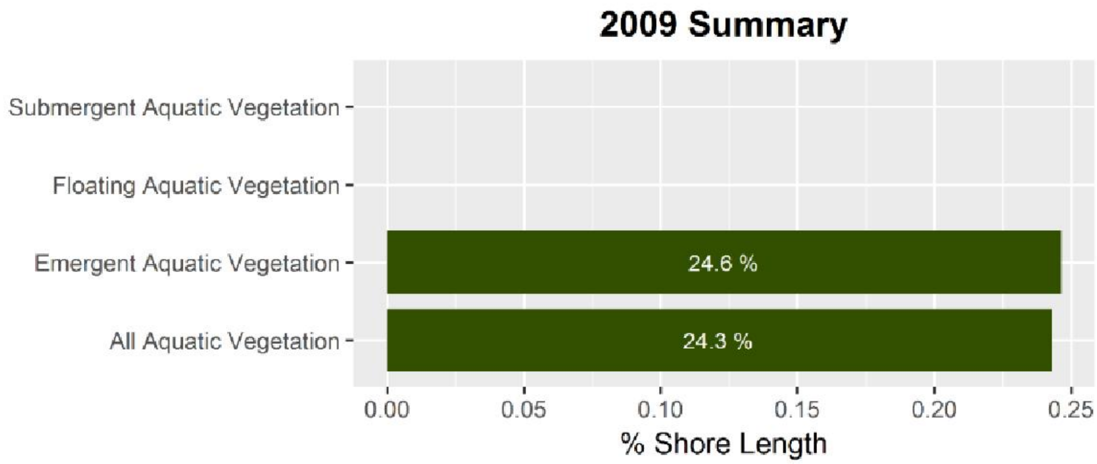

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
31 %
44.3 %
4.5 %
2.9 %
10 %
5.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

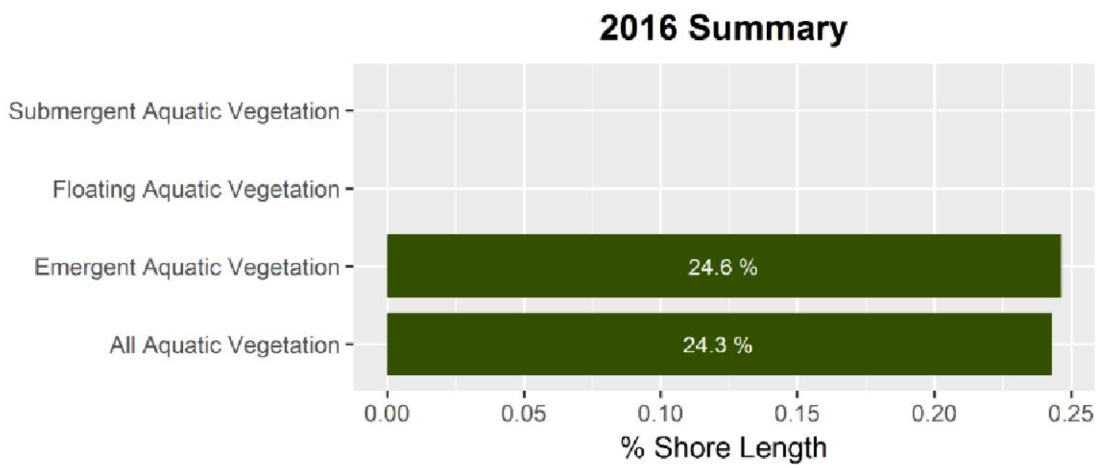

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
32.9 %
42.4 %
10.4 %
5.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

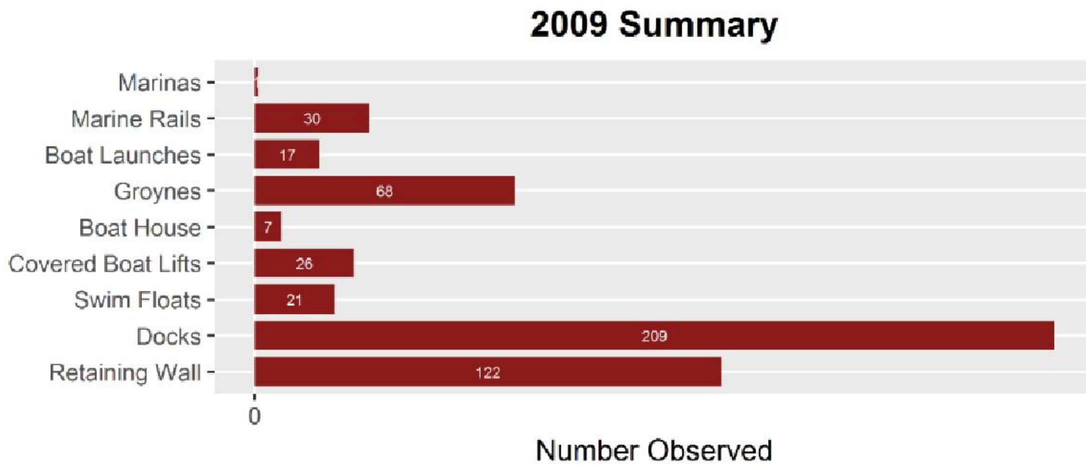

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
31 %
44.3 %
10 %
5.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

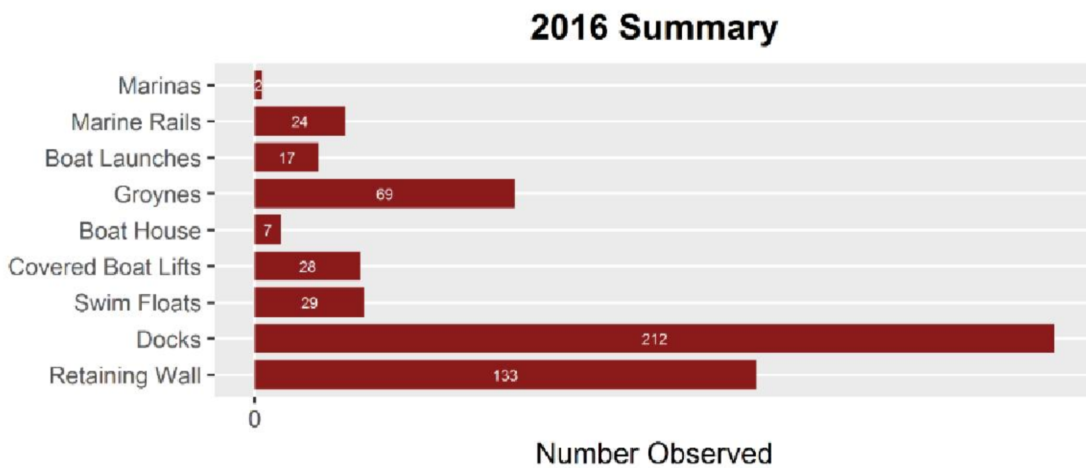

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
8.7 %
5.1 %
13.2 %
14.1 %
21.9 %
27.4 %
4.1 %
5.6 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

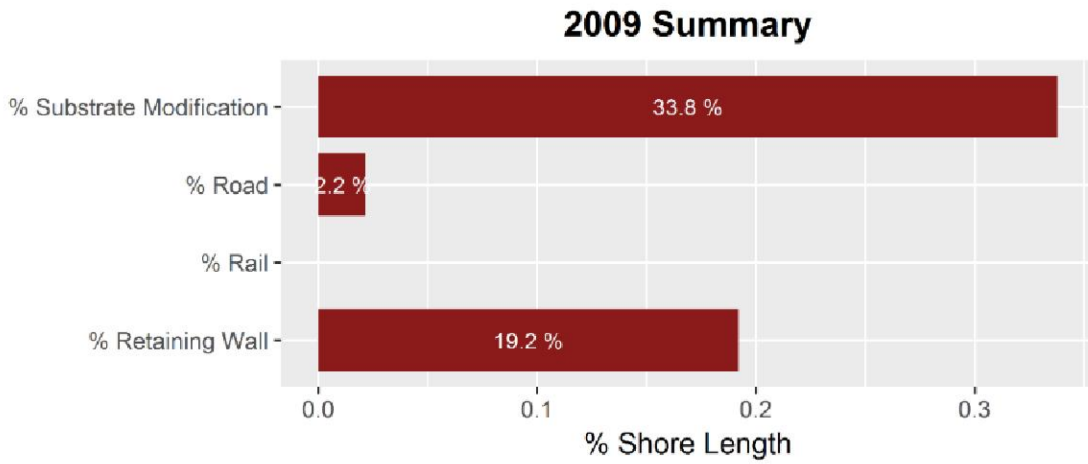

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
8.54 %
5.26 %
12.15 %
15.12 %
21.06 %
28.21 %
5.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

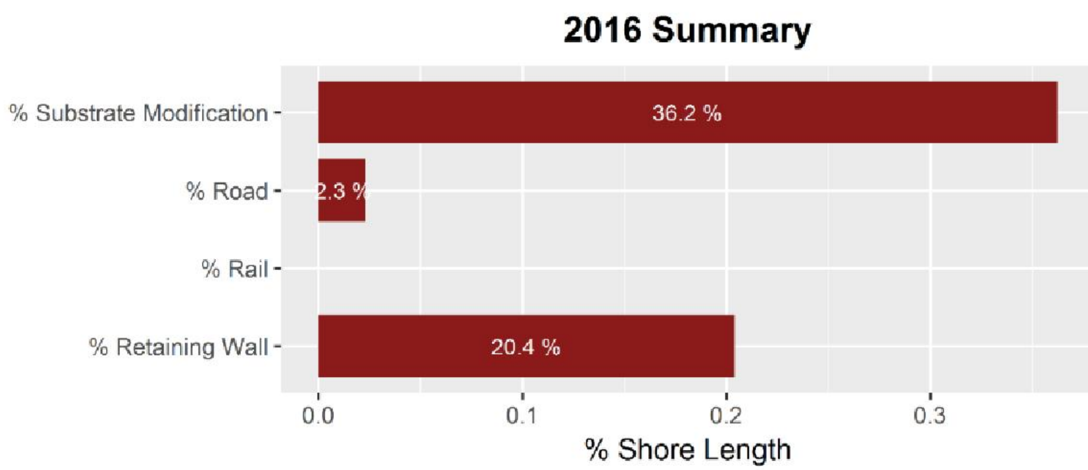

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
24.6 %
24.3 %
0.00
0.05
0.10
0.15
0.20
0.25
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
24.6 %
24.3 %
0.00
0.05
0.10
0.15
0.20
0.25
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
30
17
68
7
26
21
209
122
0
Number Observed

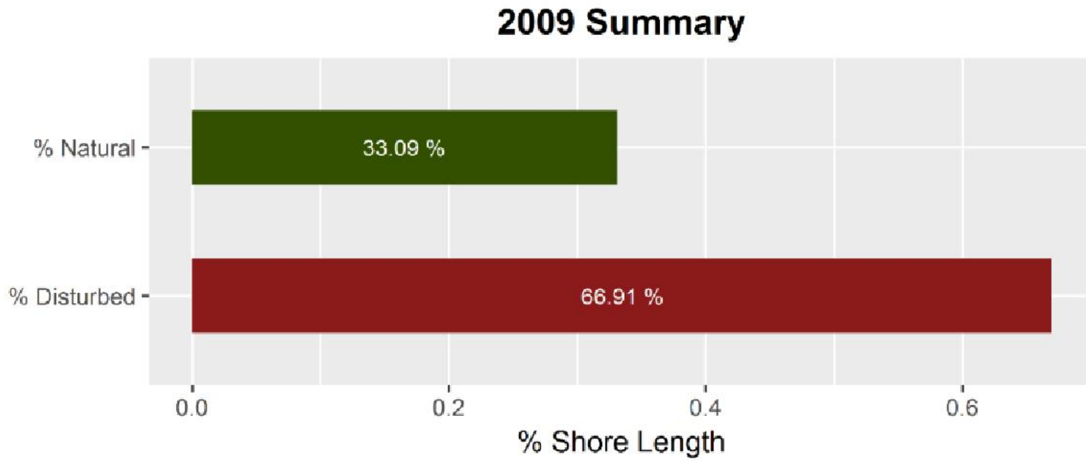

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
24
17
69
7
28
29
212
133
0
Number Observed

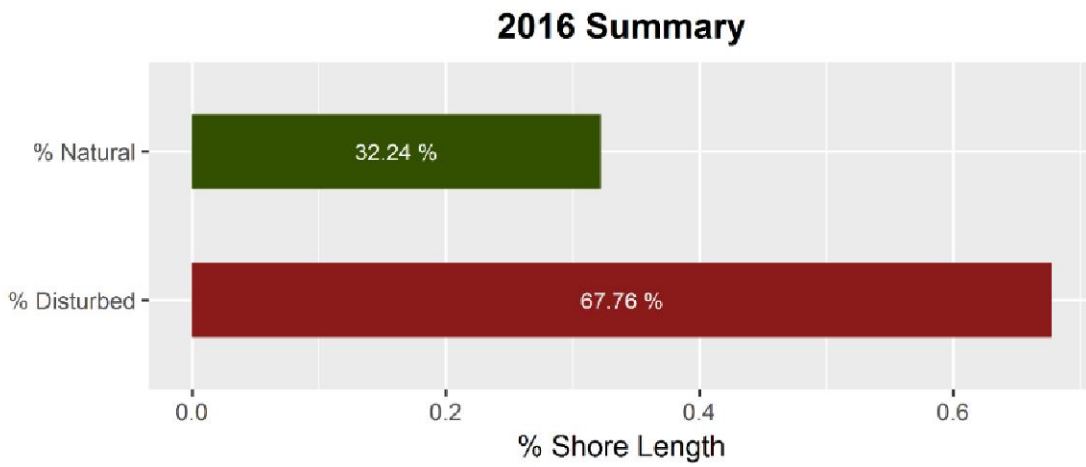

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
33.8 %
2.2 %
19.2 %
0.0
0.1
0.2
0.3
% Shore Length

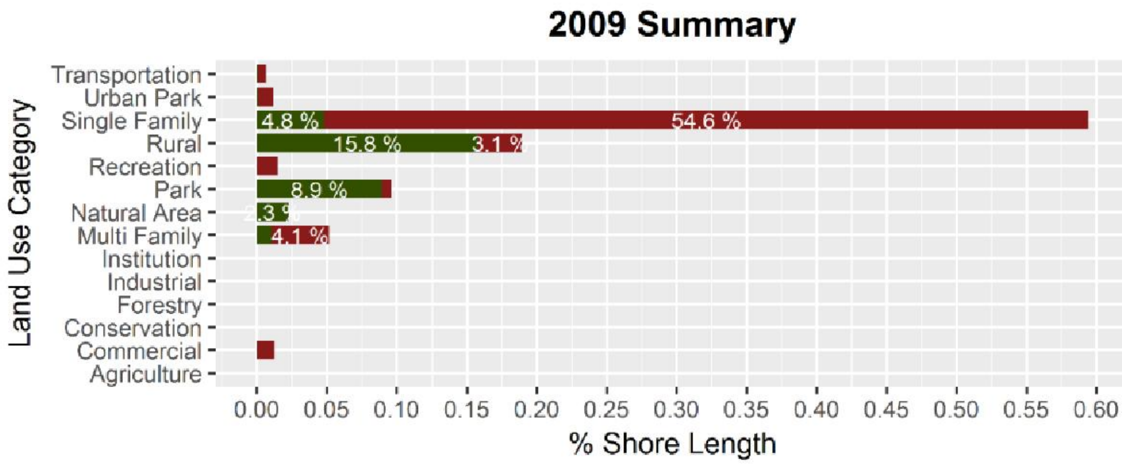

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
36.2 %
2.3 %
20.4 %
0.0
0.1
0.2
0.3
% Shore Length

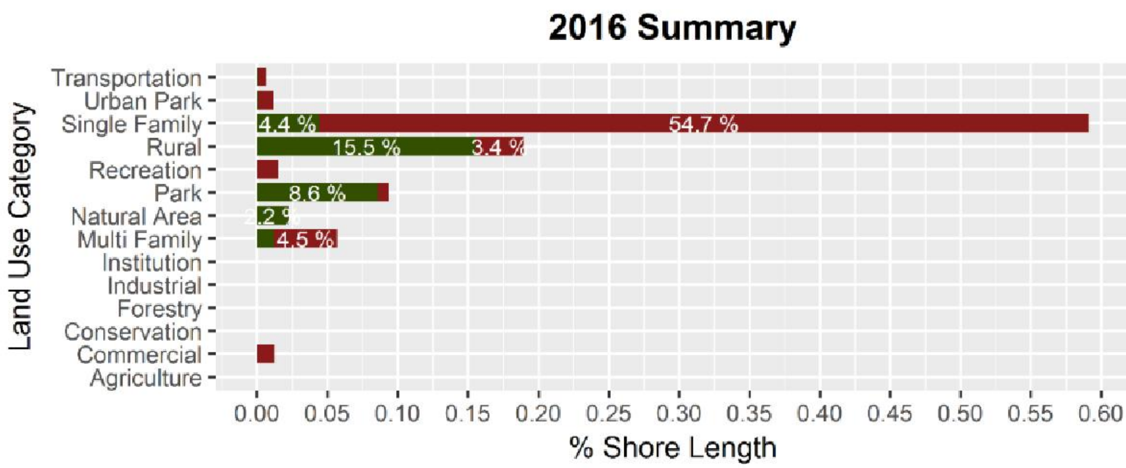
APPENDIX D

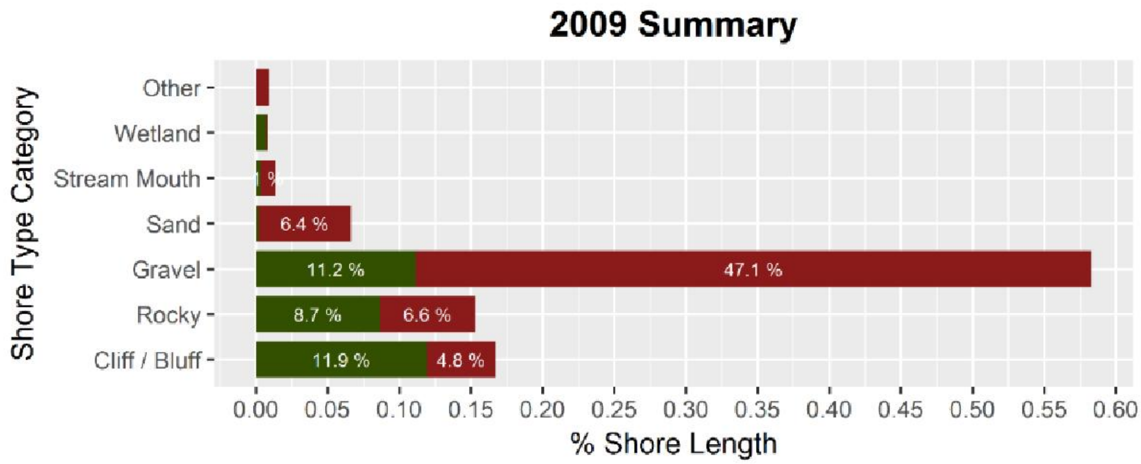
CITY OF VERNON DATA SUMMARY

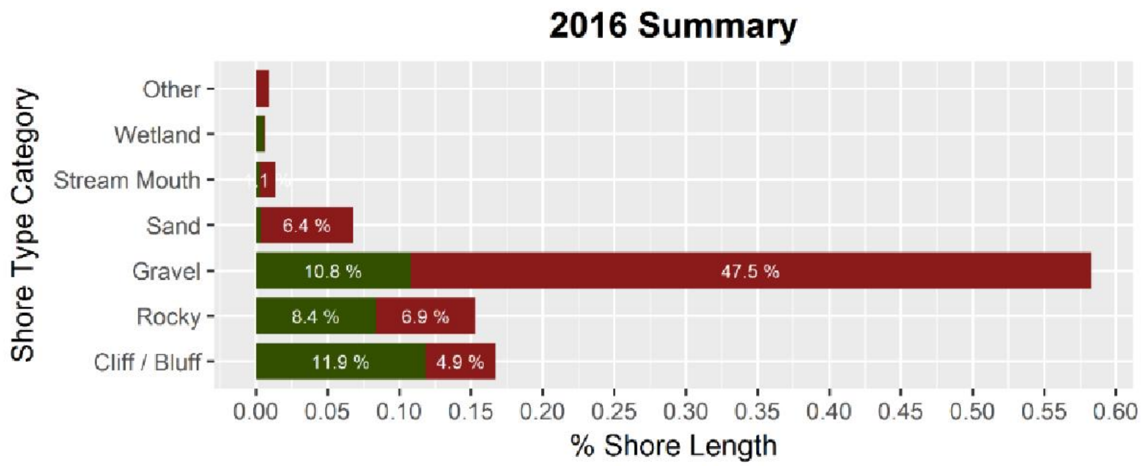

2009 Summary
% Natural
33.09 %
% Disturbed
66.91 %
0.0
0.2
0.4
0.6
% Shore Length

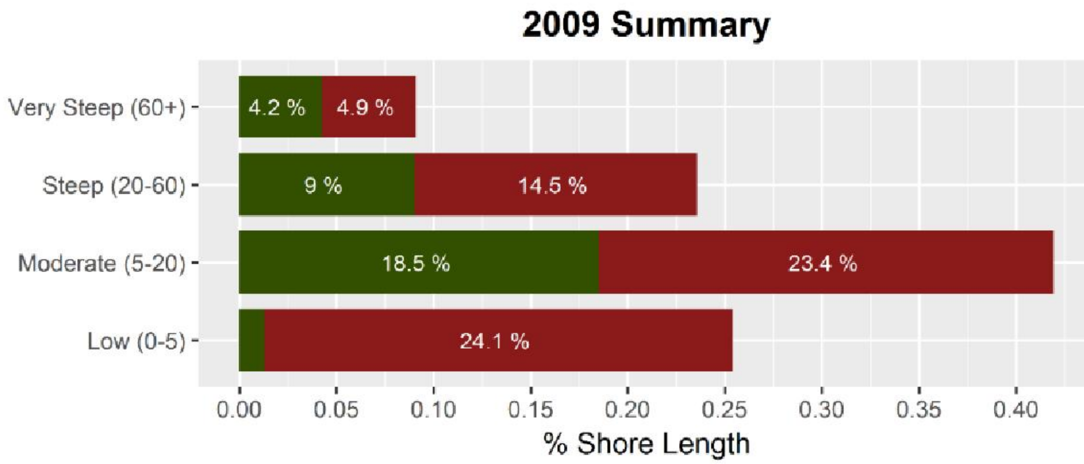

2016 Summary
% Natural
32.24 %
% Disturbed
67.76 %
0.0
0.2
0.4
0.6
% Shore Length

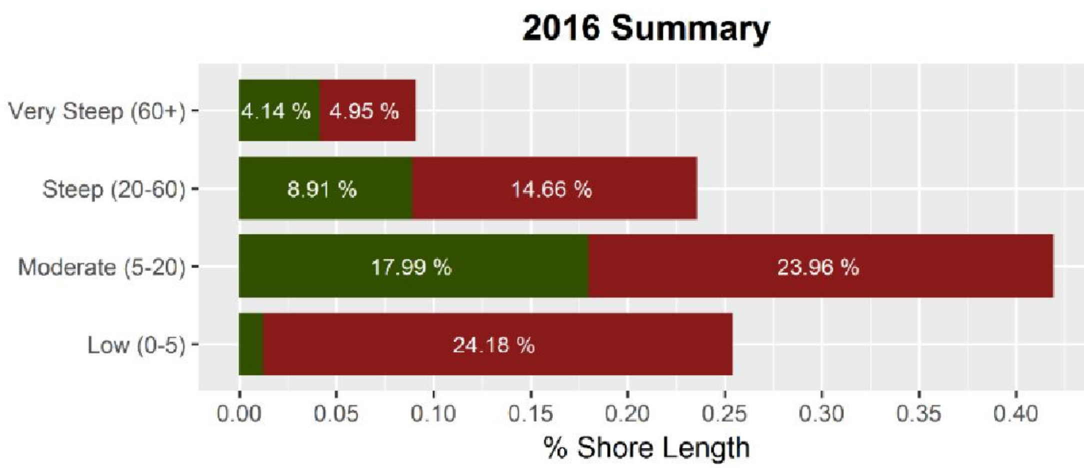

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
4.8 %
54.6 %
15.8 %
3.1 %
8.9 %
4.1 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

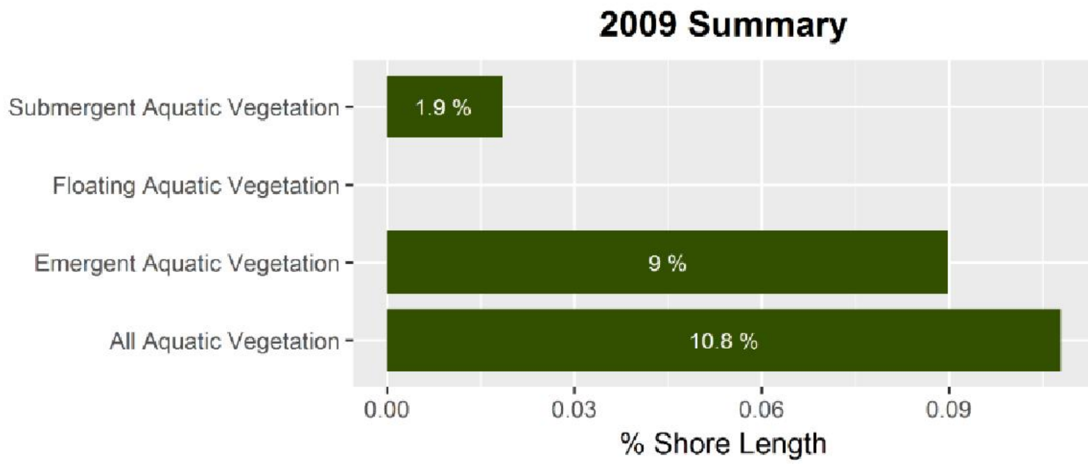

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
4.4 %
54.7 %
15.5 %
3.4 %
8.6 %
4.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

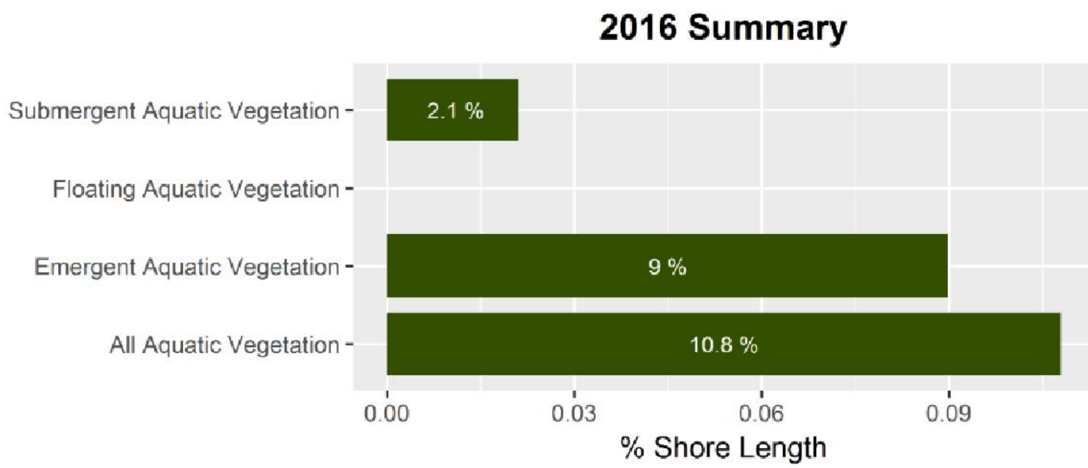

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
6.4 %
11.2 %
47.1 %
8.7 %
6.6 %
11.9 %
4.8 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

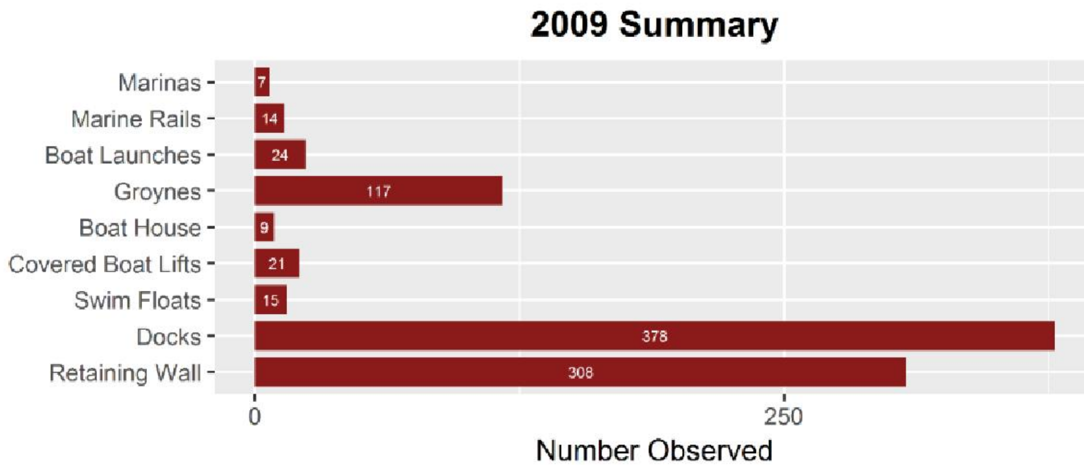

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
6.4 %
10.8 %
47.5 %
8.4 %
6.9 %
11.9 %
4.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

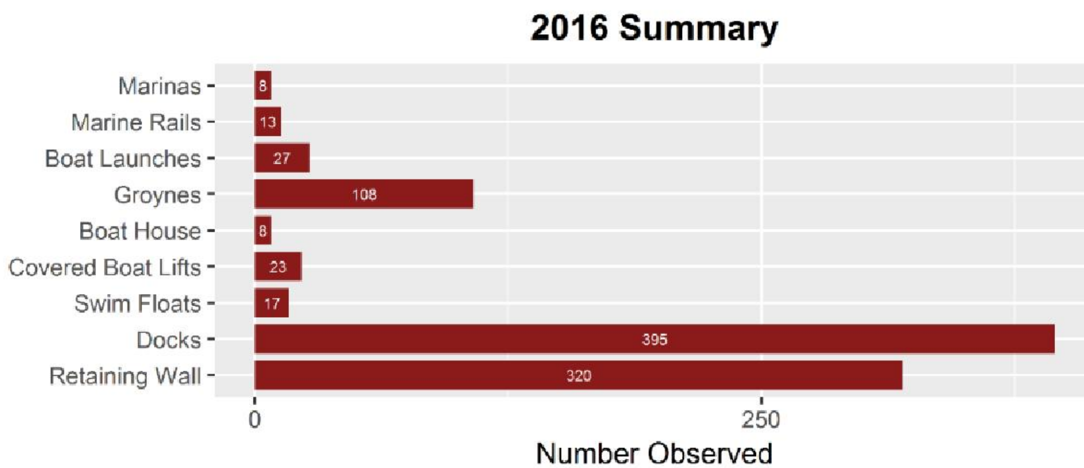

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
4.2 %
4.9 %
9 %
14.5 %
18.5 %
23.4 %
24.1 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

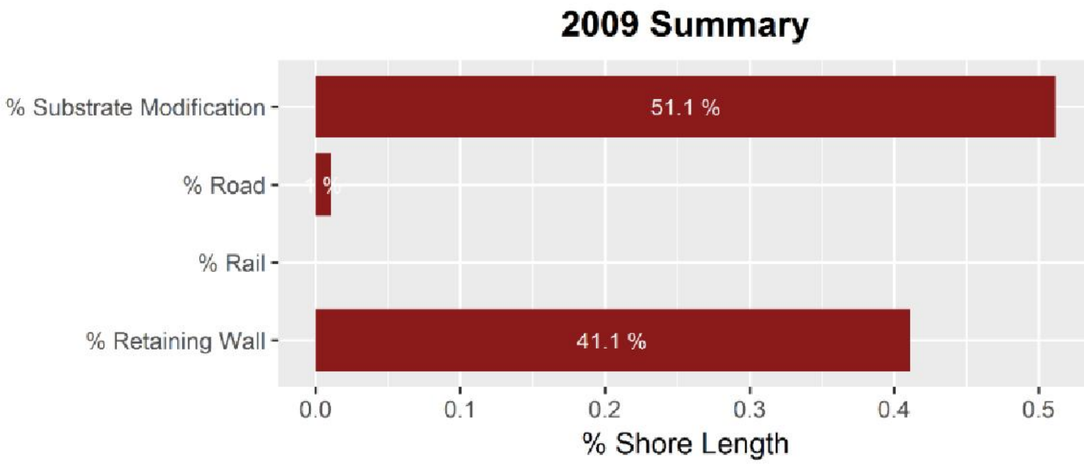

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
4.14 %
4.95 %
8.91 %
14.66 %
17.99 %
23.96 %
24.18 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

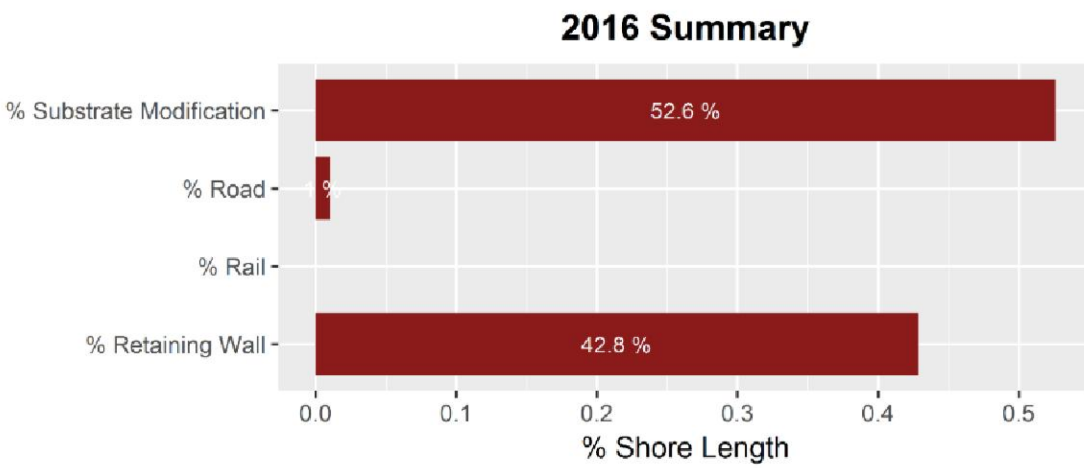

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
1.9 %
9 %
10.8 %
0.00
0.03
0.06
0.09
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
2.1 %
9 %
10.8 %
0.00
0.03
0.06
0.09
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
7
14
24
117
9
21
15
378
308
0
250
Number Observed

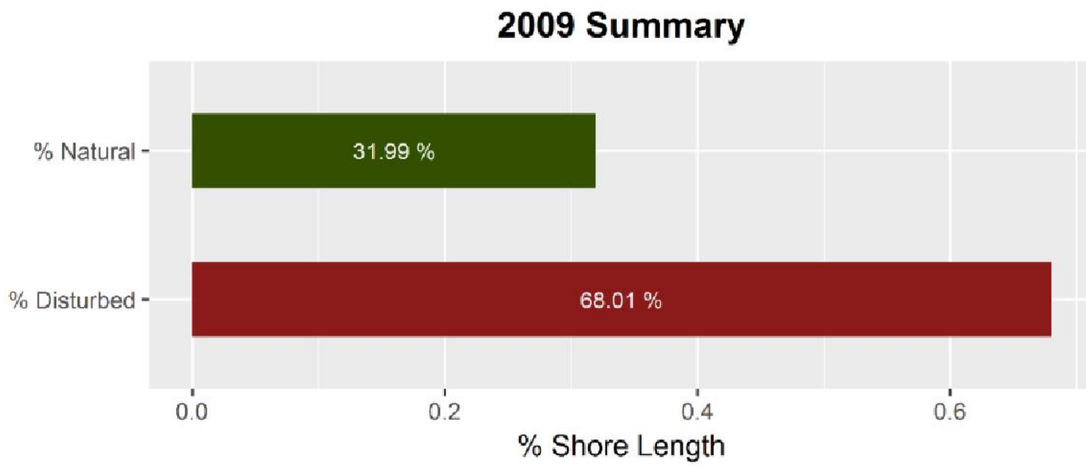

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
8
13
27
108
8
23
17
395
320
0
250
Number Observed

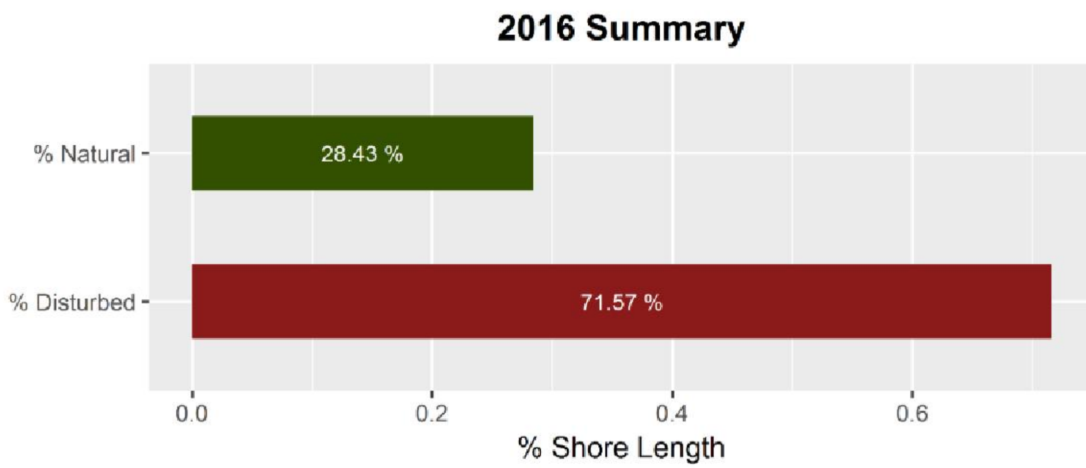

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
51.1 %
41.1 %
0.0
0.1
0.2
0.3
0.4
0.5
% Shore Length

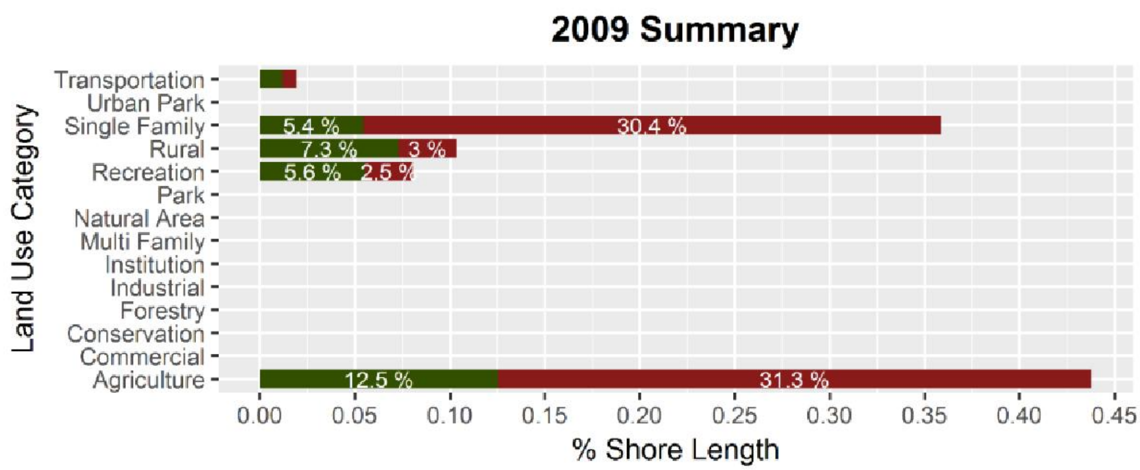

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
52.6 %
42.8 %
0.0
0.1
0.2
0.3
0.4
0.5
% Shore Length

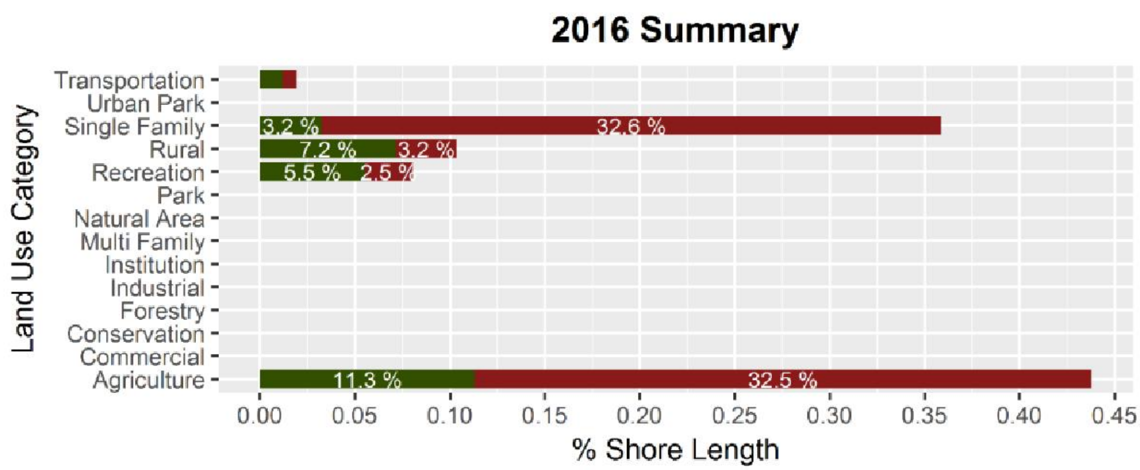
APPENDIX E

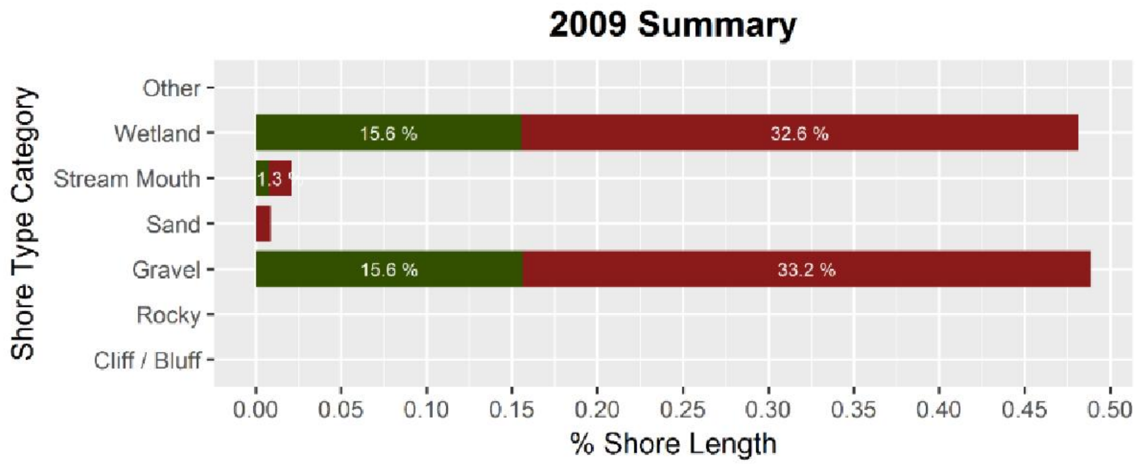
OKANAGAN INDIAN BAND DATA SUMMARY

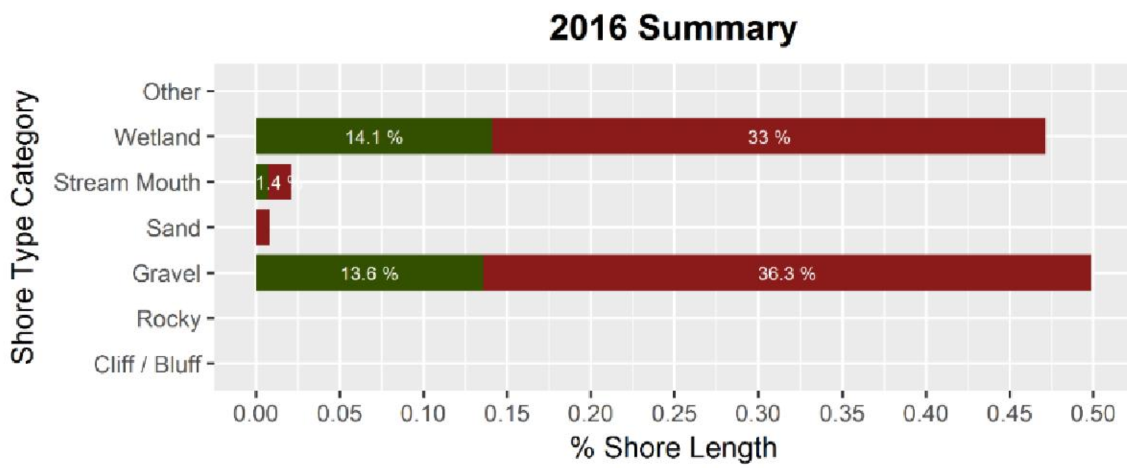

2009 Summary
% Natural
31.99 %
% Disturbed
68.01 %
0.0
0.2
0.4
0.6
% Shore Length

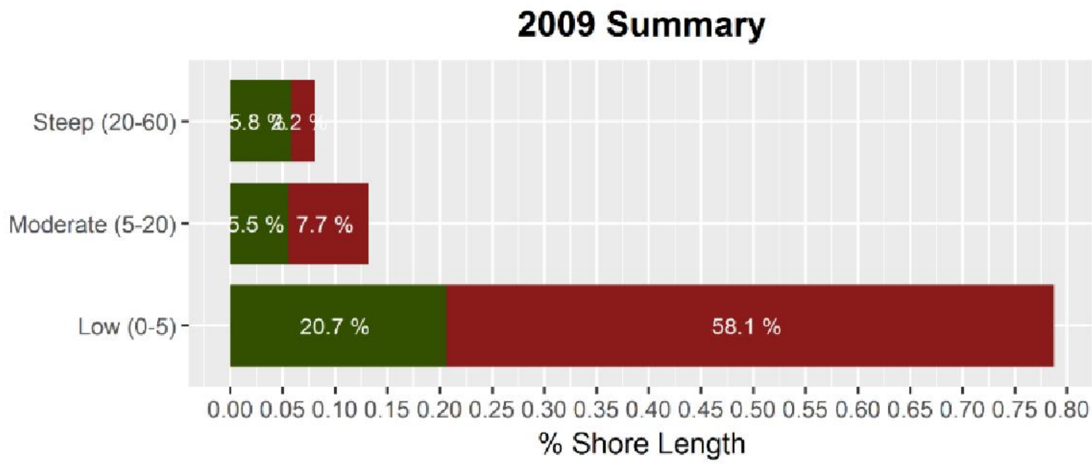

2016 Summary
% Natural
28.43 %
% Disturbed
71.57 %
0.0
0.2
0.4
0.6
% Shore Length

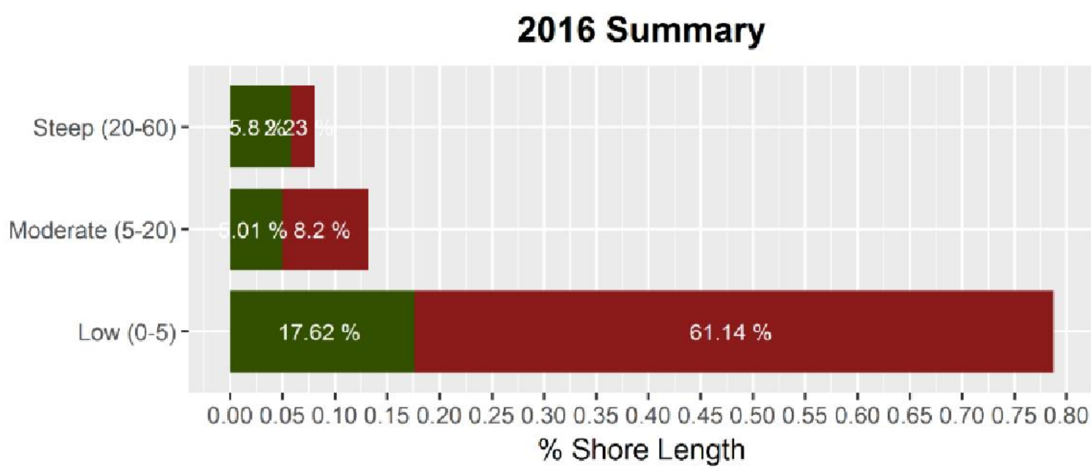

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
5.4 %
30.4 %
7.3 %
3 %
5.6 %
2.5 %
12.5 %
31.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

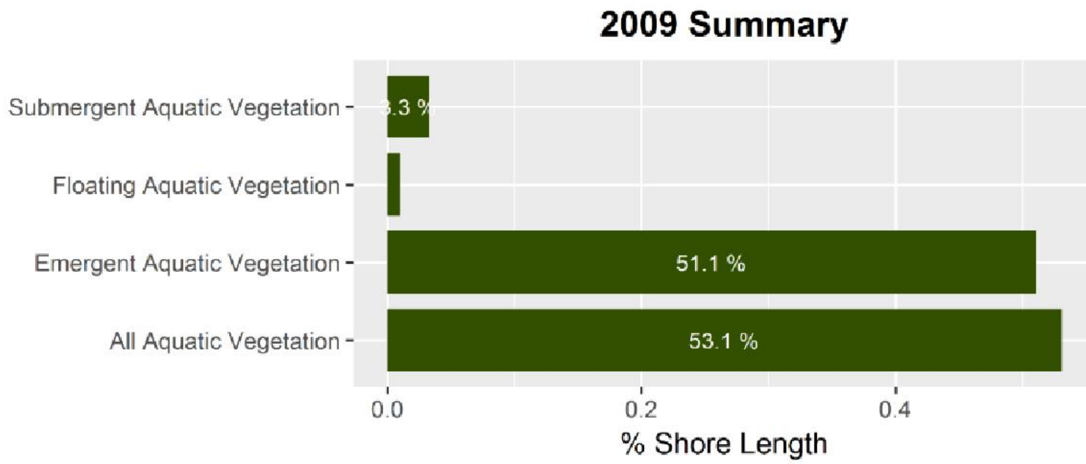

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
3.2 %
32.6 %
7.2 %
3.2 %
5.5 %
2.5 %
11.3 %
32.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

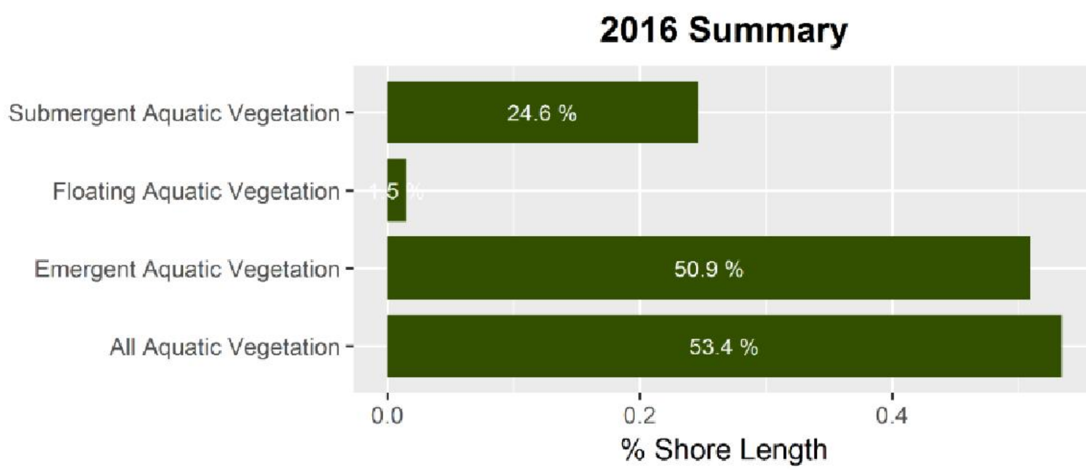

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
15.6 %
32.6 %
15.6 %
33.2 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

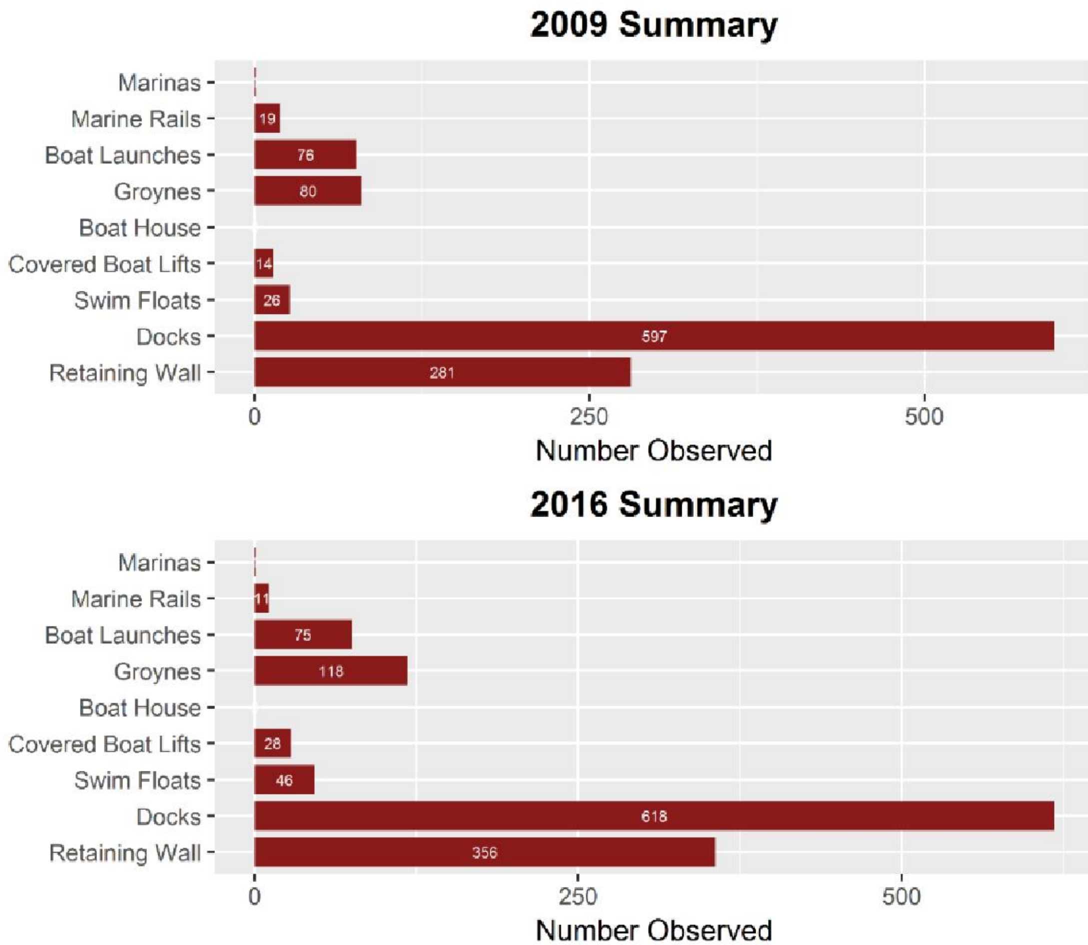

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
14.1 %
33 %
13.6 %
36.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

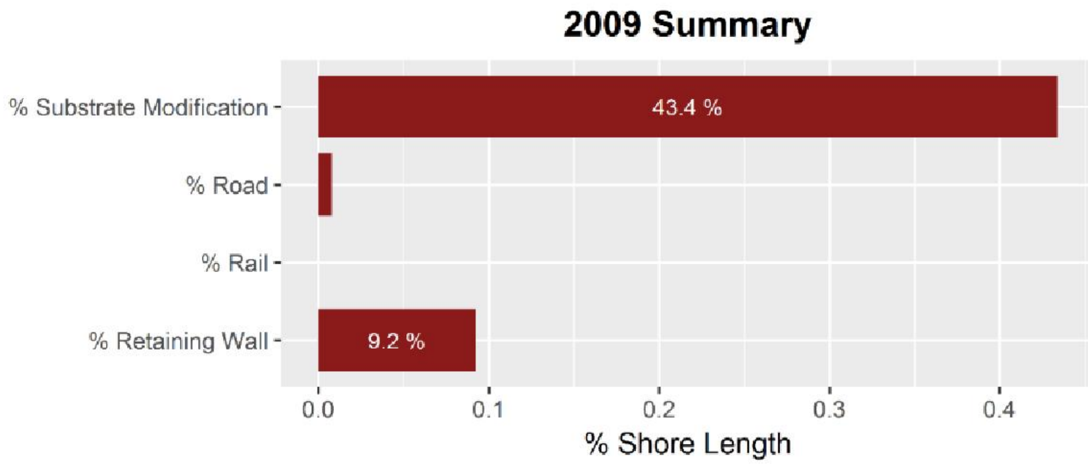

2009 Summary
Steep (20-60)
Moderate (5-20)
Low (0-5)
7.7 %
20.7 %
58.1 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
% Shore Length

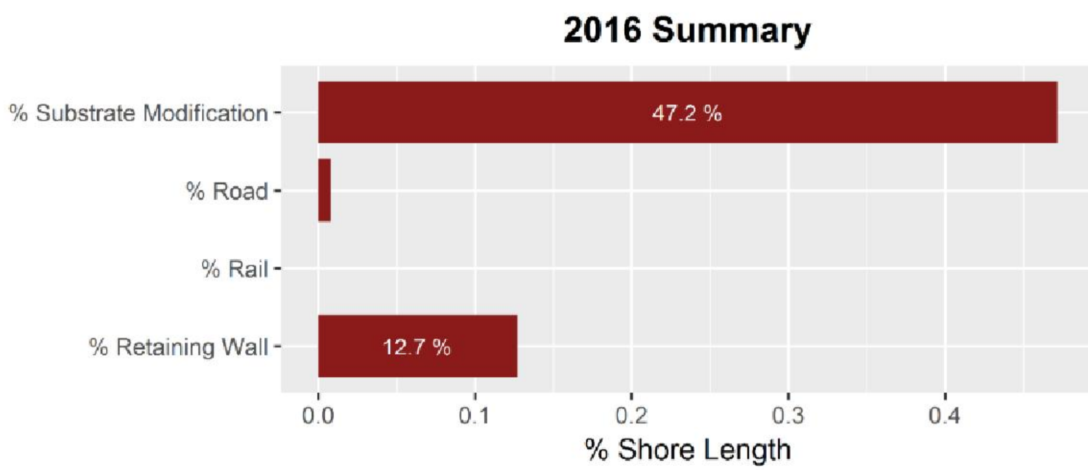

2016 Summary
Steep (20-60)
Moderate (5-20)
Low (0-5)
8.2 %
17.62 %
61.14 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
% Shore Length


2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
51.1 %
53.1 %
0.0
0.2
0.4
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
24.6 %
50.9 %
53.4 %
0.0
0.2
0.4
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
19
76
80
14
26
597
281
0
250
500
Number Observed
2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
11
75
118
28
46
618
356
0
250
500
Number Observed

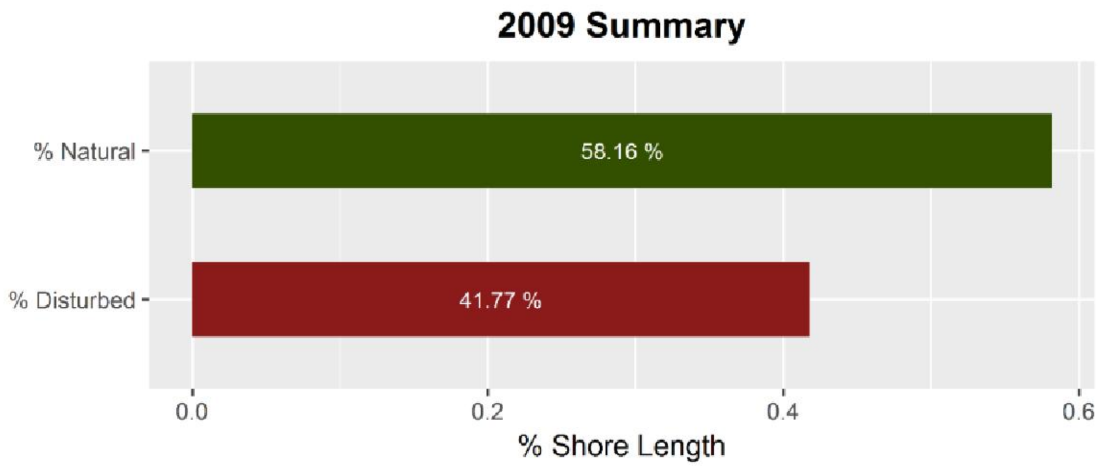

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
43.4 %
9.2 %
0.0
0.1
0.2
0.3
0.4
% Shore Length

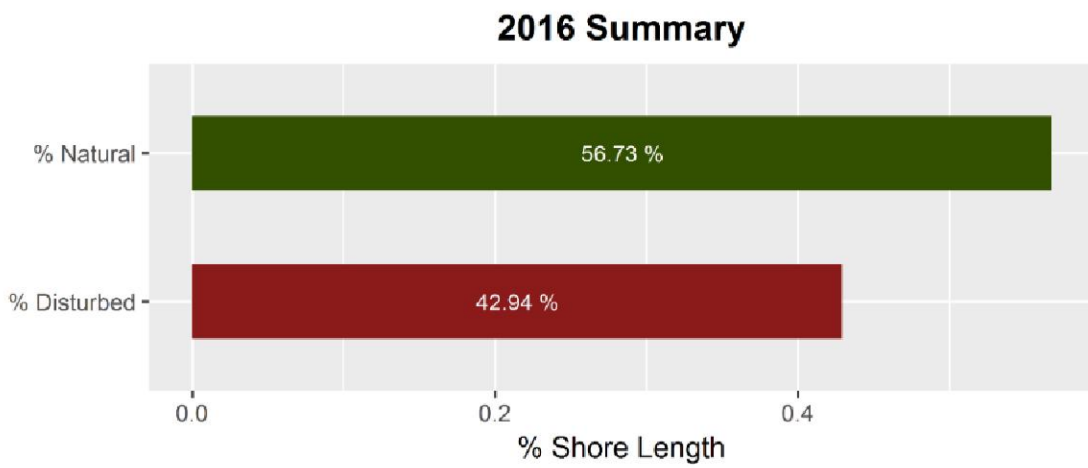

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
47.2 %
12.7 %
0.0
0.1
0.2
0.3
0.4
% Shore Length

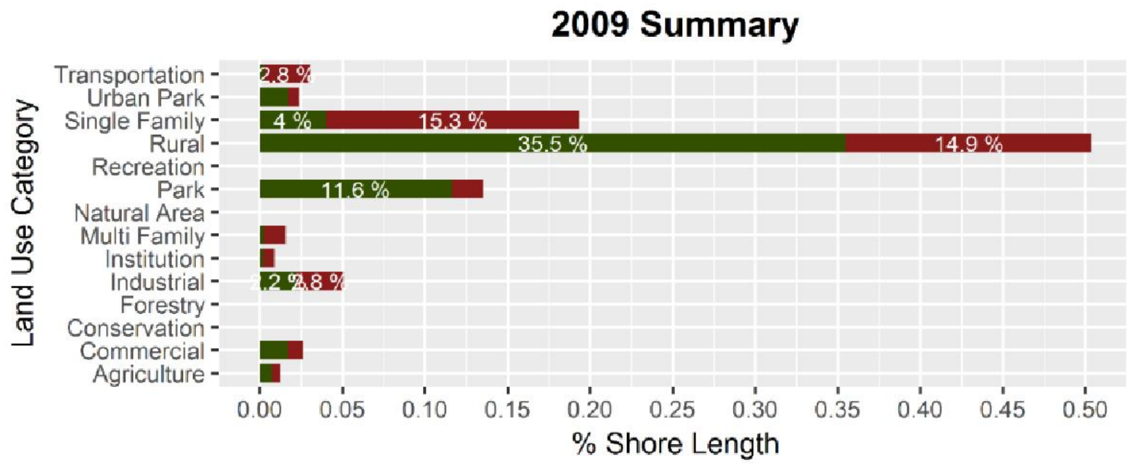
APPENDIX F

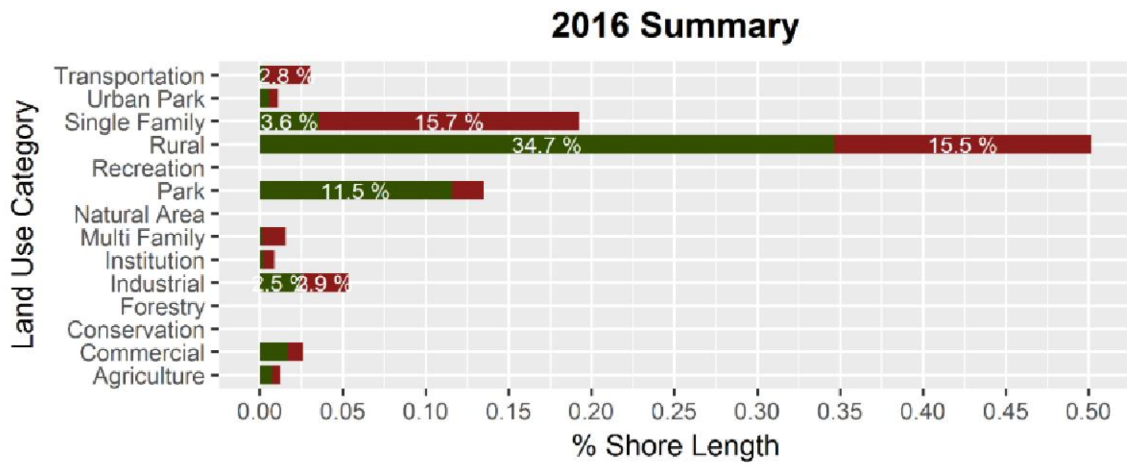
RDCO DATA SUMMARY

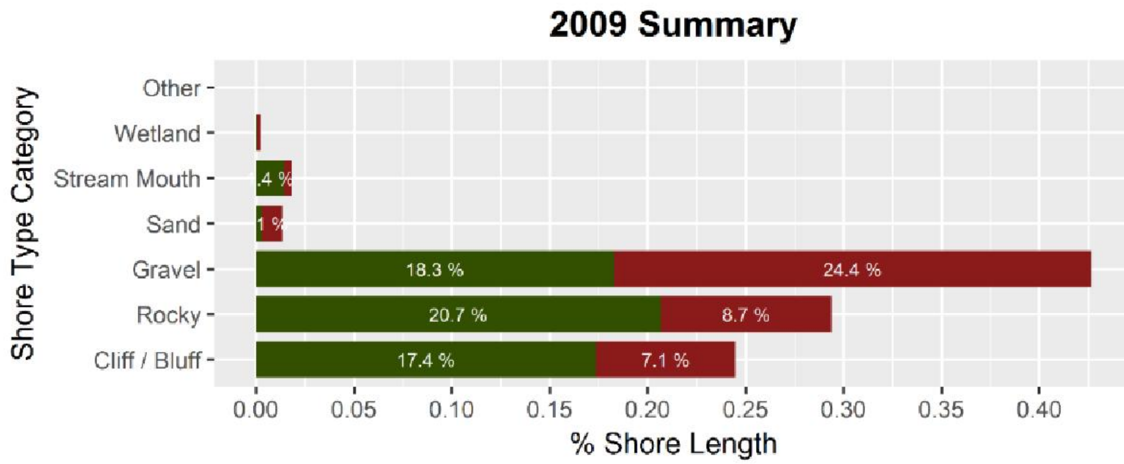
Note: Data only includes the RDCO and does not include member municipalities.

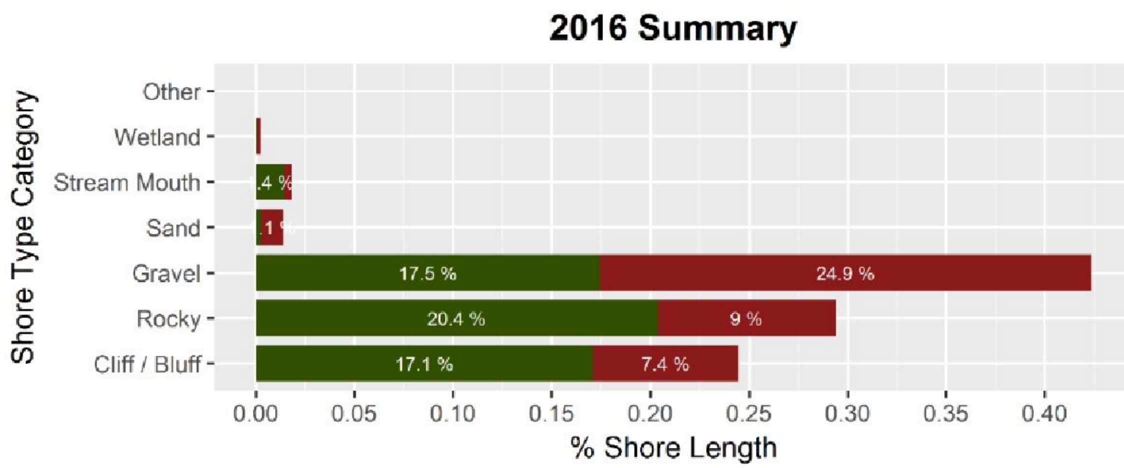

2009 Summary
% Natural
58.16 %
% Disturbed
41.77 %
0.0
0.2
0.4
0.6
% Shore Length

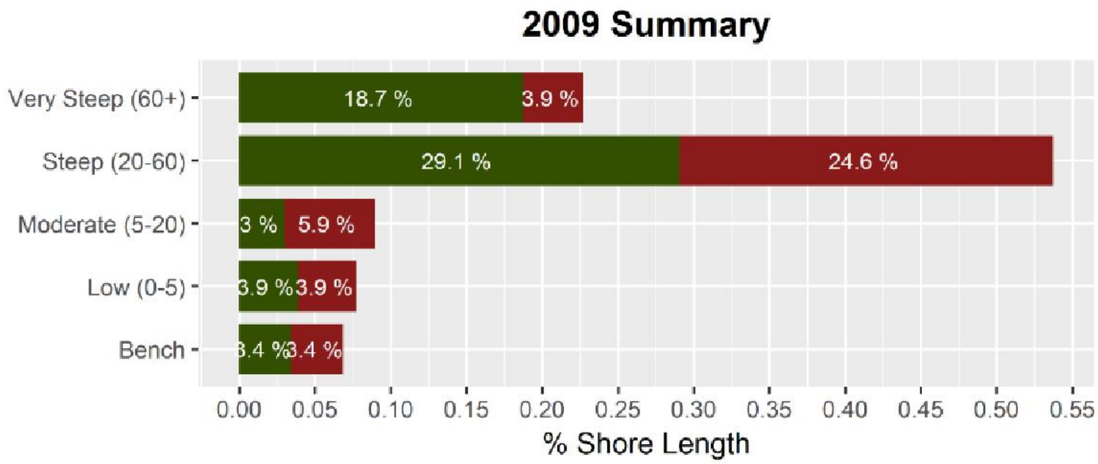

2016 Summary
% Natural
56.73 %
% Disturbed
42.94 %
0.0
0.2
0.4
% Shore Length

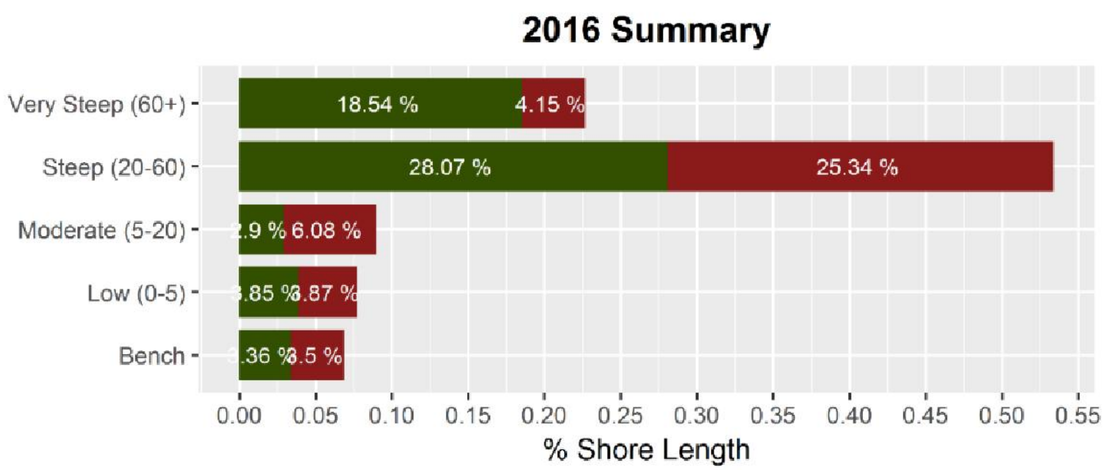

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
2.8 %
4 %
15.3 %
35.5 %
14.9 %
11.6 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

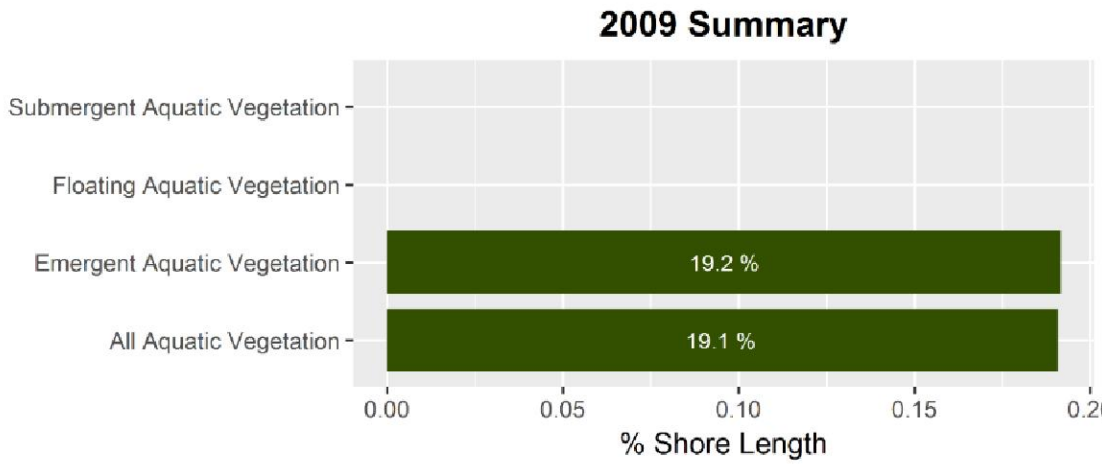

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
2.8 %
3.6 %
15.7 %
34.7 %
15.5 %
11.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

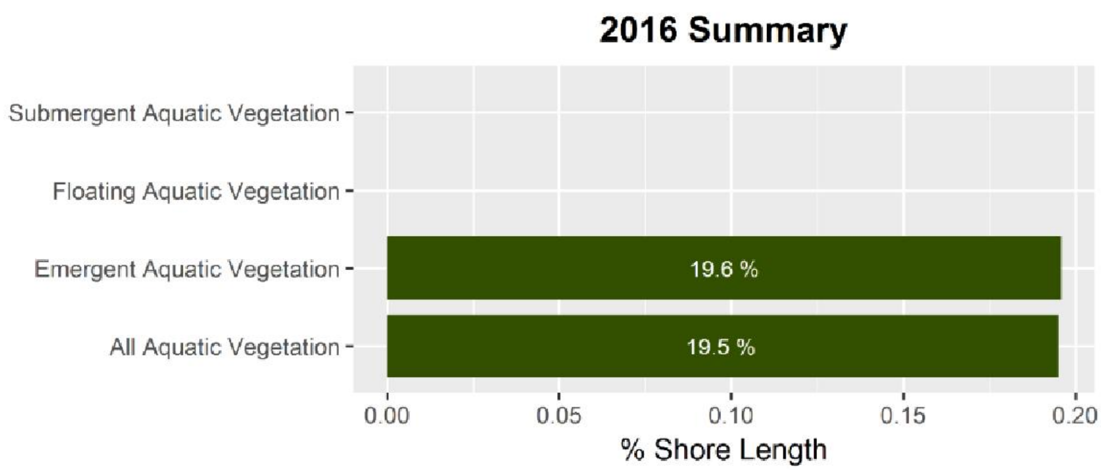

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
18.3 %
24.4 %
20.7 %
8.7 %
17.4 %
7.1 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

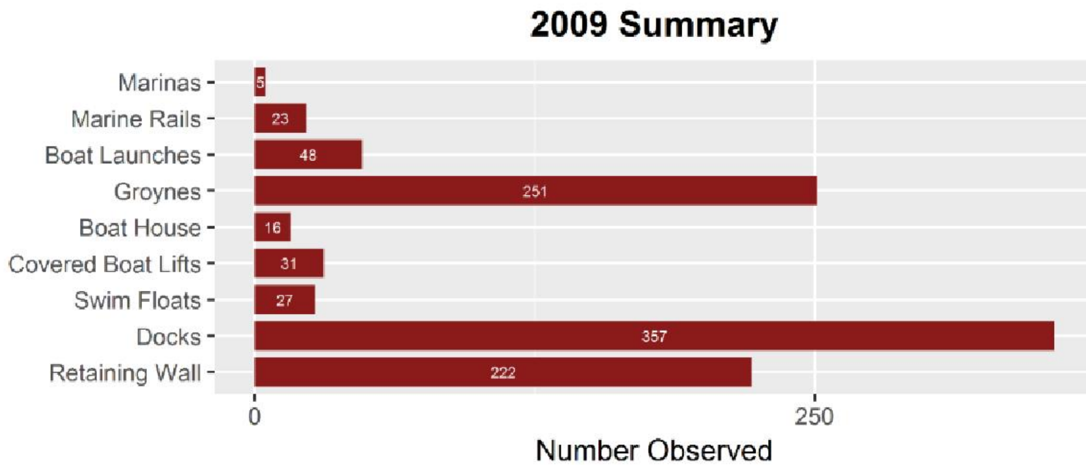

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
17.5 %
24.9 %
20.4 %
9 %
17.1 %
7.4 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

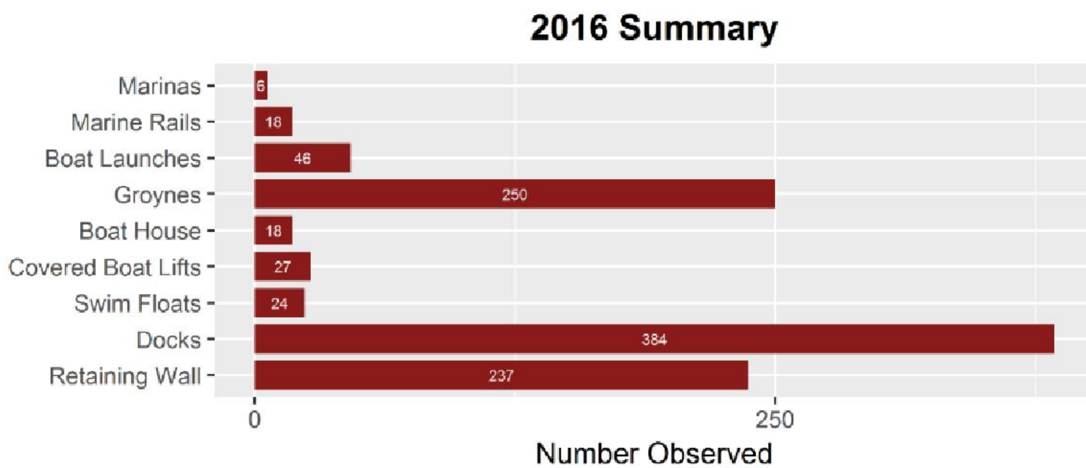

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
18.7 %
3.9 %
29.1 %
24.6 %
5.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

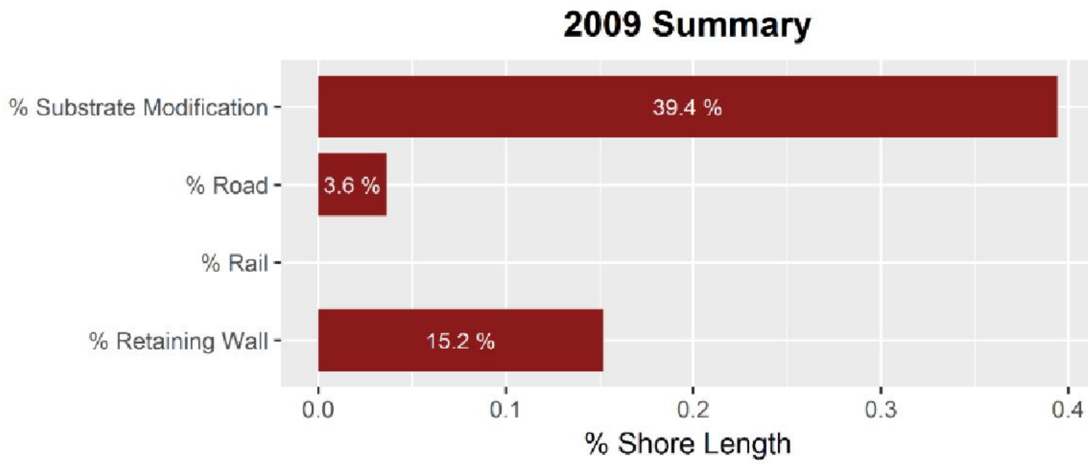

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
18.54 %
4.15 %
28.07 %
25.34 %
6.08 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

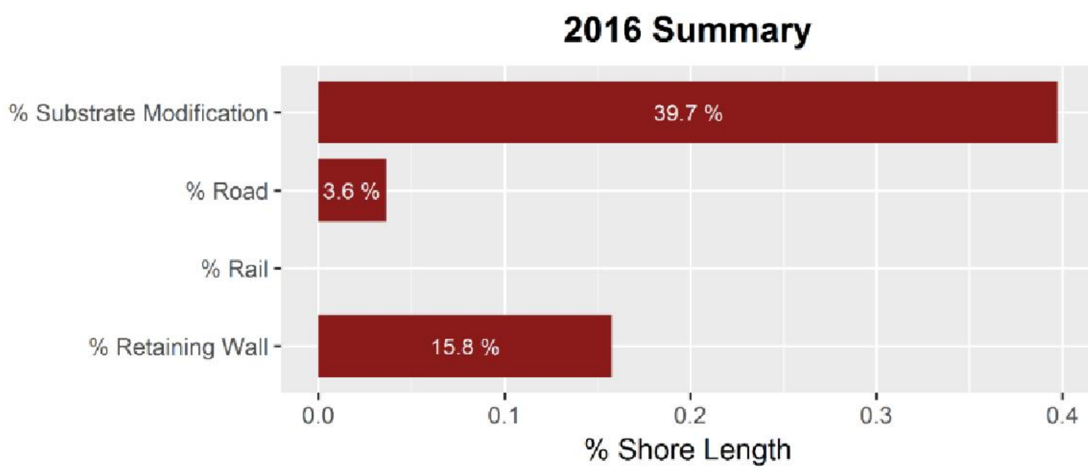

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
19.2 %
19.1 %
0.00
0.05
0.10
0.15
0.20
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
19.6 %
19.5 %
0.00
0.05
0.10
0.15
0.20
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
5
23
48
251
16
31
27
357
222
0
250
Number Observed

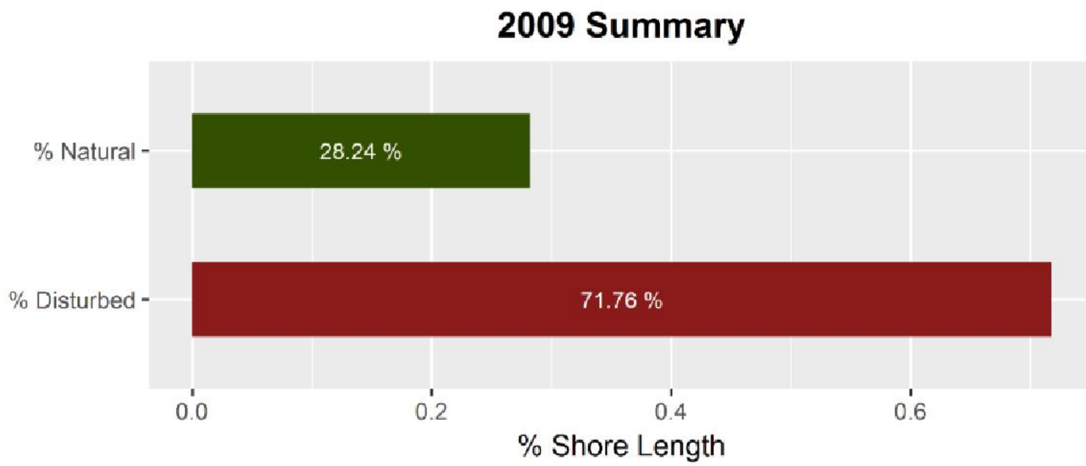

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
6
18
46
250
18
27
24
384
237
0
250
Number Observed

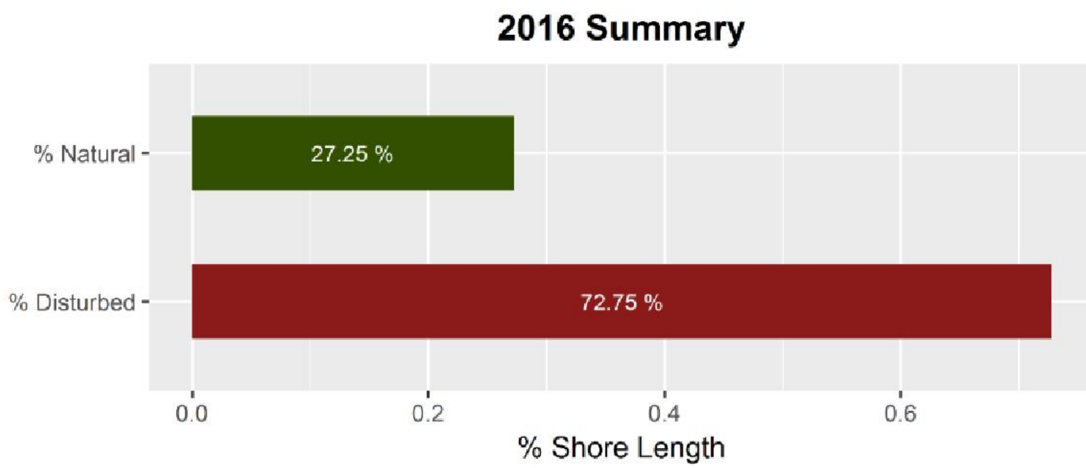

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
39.4 %
3.6 %
15.2 %
0.0
0.1
0.2
0.3
0.4
% Shore Length

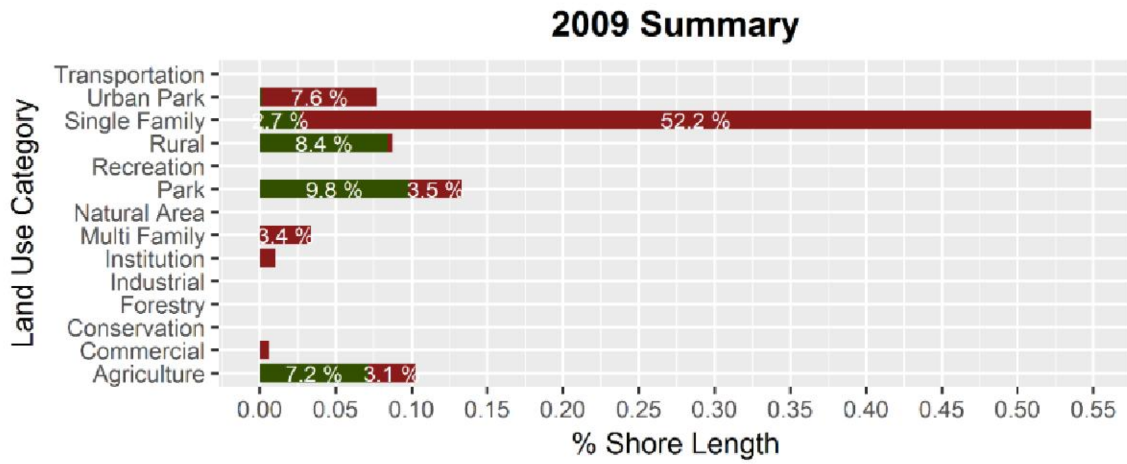

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
39.7 %
3.6 %
15.8 %
0.0
0.1
0.2
0.3
0.4
% Shore Length

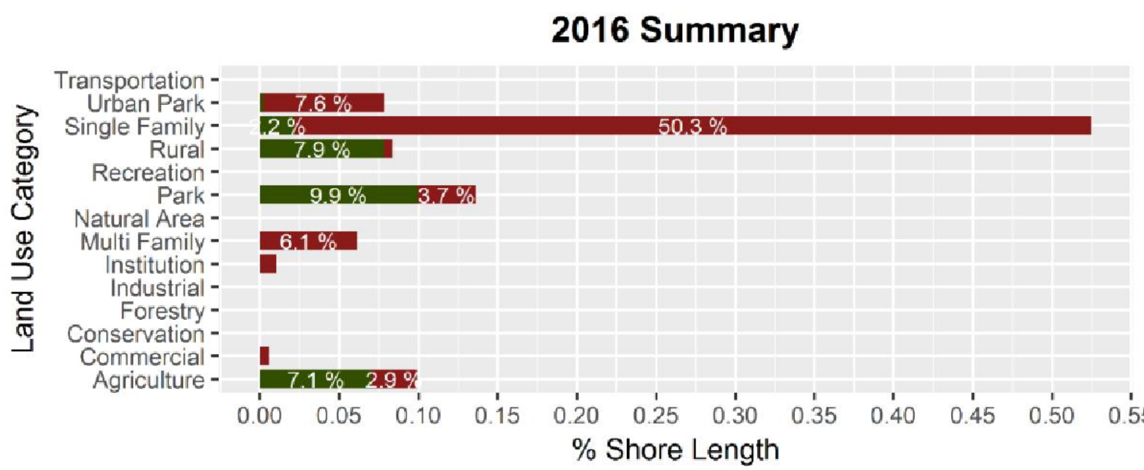
APPENDIX G

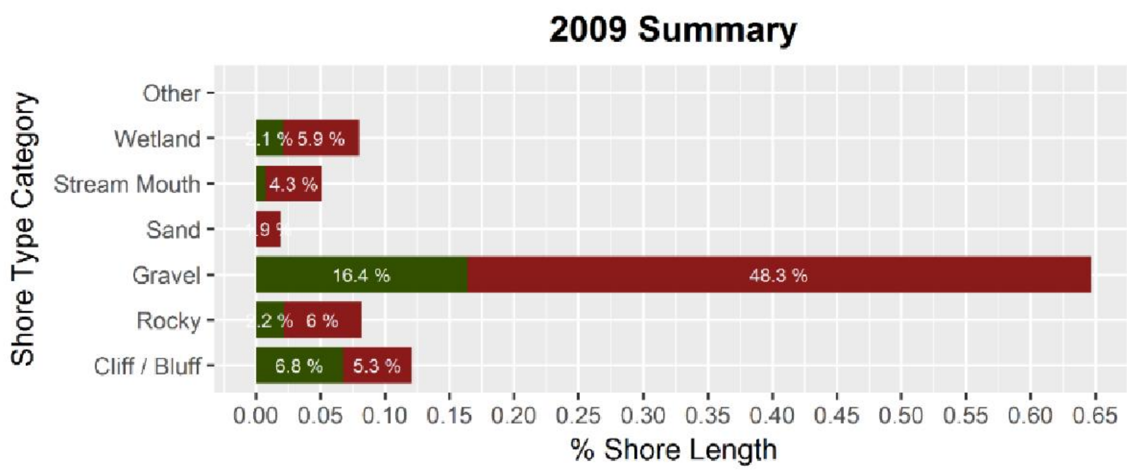
CITY OF WEST KELOWNA DATA SUMMARY

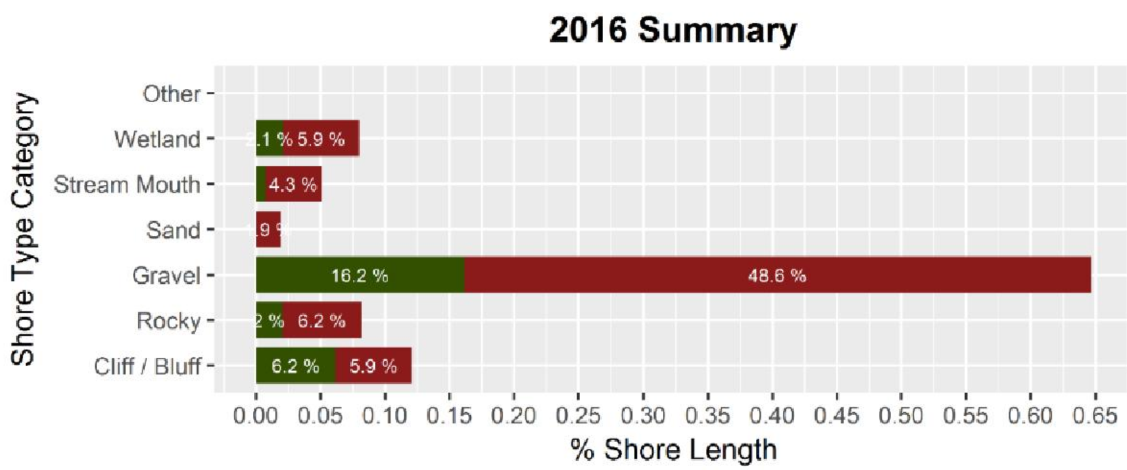

2009 Summary
% Natural
% Disturbed
28.24 %
71.76 %
0.0
0.2
0.4
0.6
% Shore Length

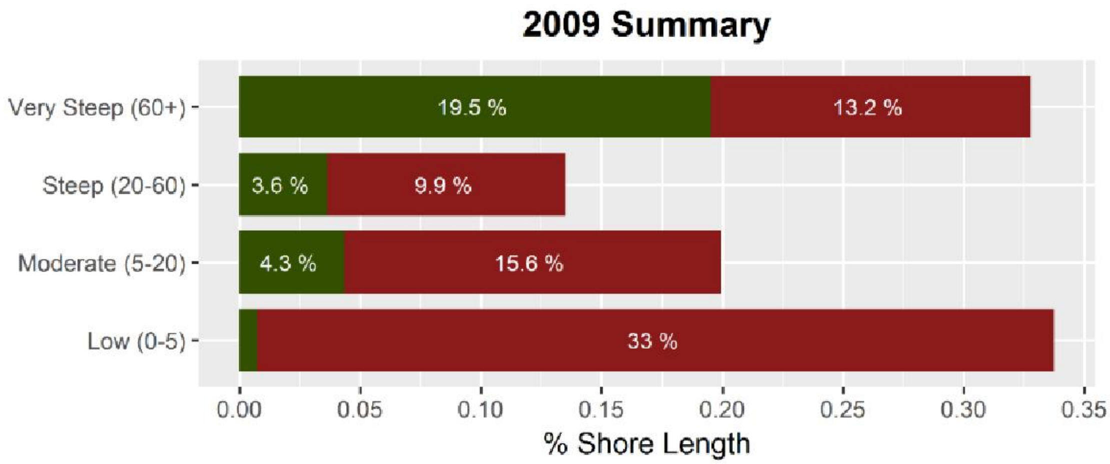

2016 Summary
% Natural
% Disturbed
27.25 %
72.75 %
0.0
0.2
0.4
0.6
% Shore Length

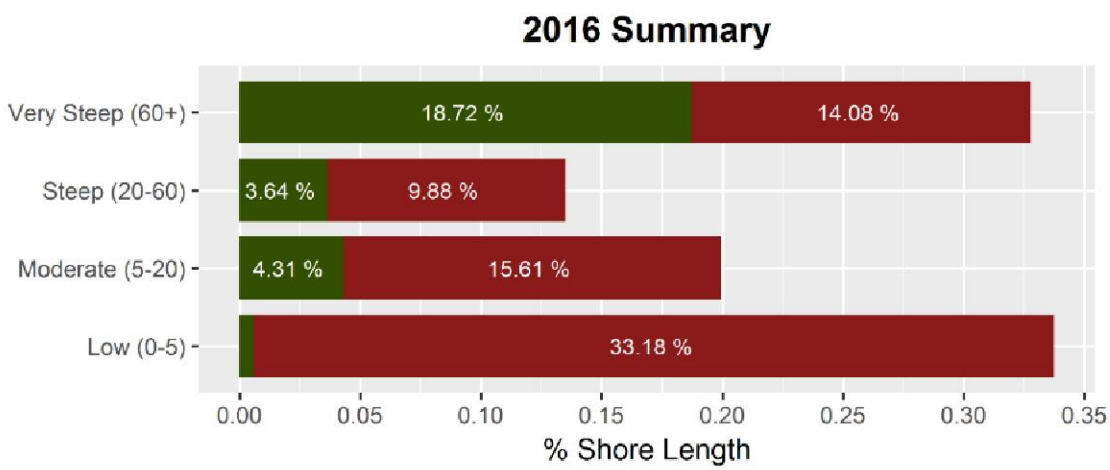

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
7.6 %
52.2 %
8.4 %
9.8 %
3.5 %
7.2 %
3.1 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

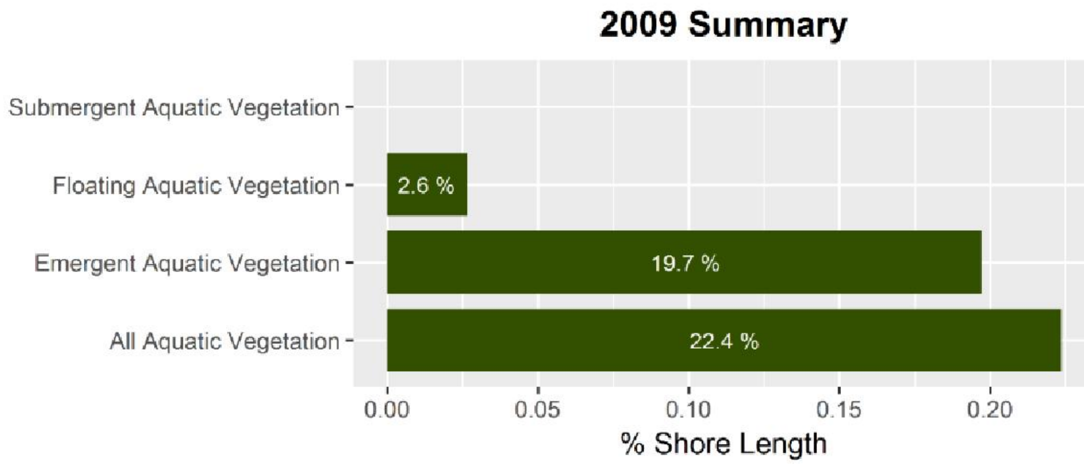

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
7.6 %
50.3 %
7.9 %
9.9 %
3.7 %
6.1 %
7.1 %
2.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
% Shore Length

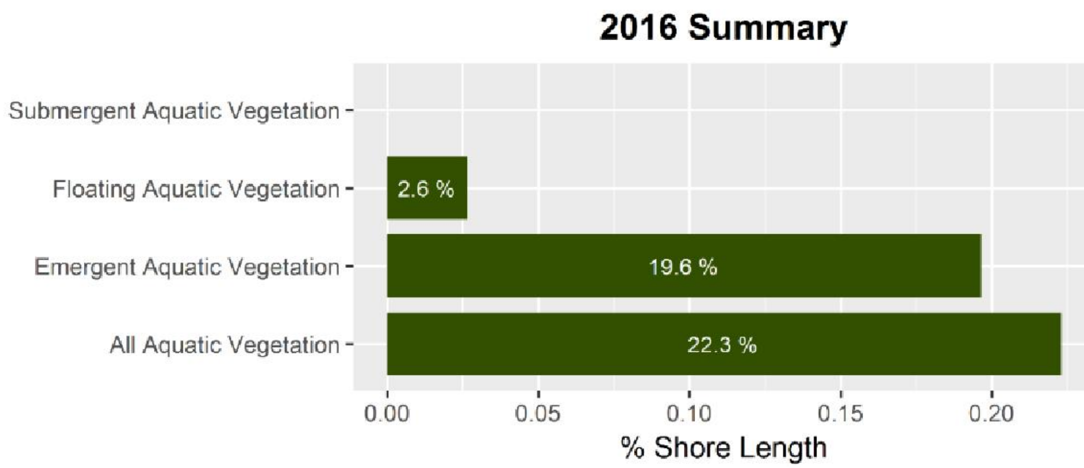

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
5.9 %
4.3 %
16.4 %
48.3 %
6 %
6.8 %
5.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65
% Shore Length

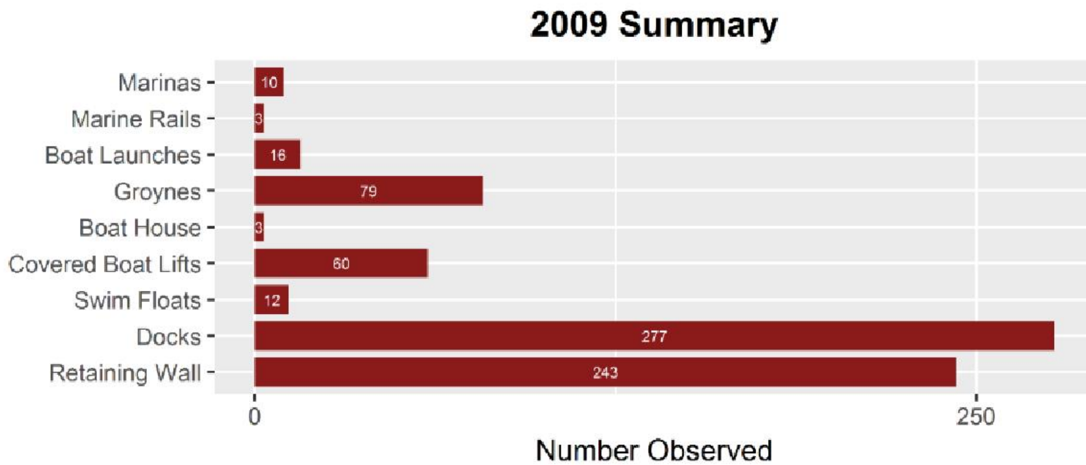

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
5.9 %
4.3 %
16.2 %
48.6 %
6.2 %
6.2 %
5.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65
% Shore Length

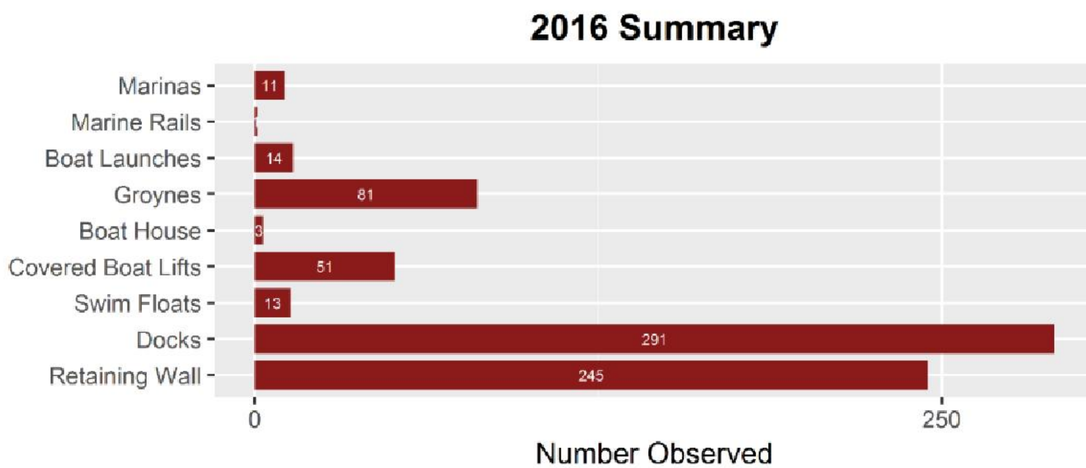

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
19.5 %
13.2 %
3.6 %
9.9 %
4.3 %
15.6 %
33 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

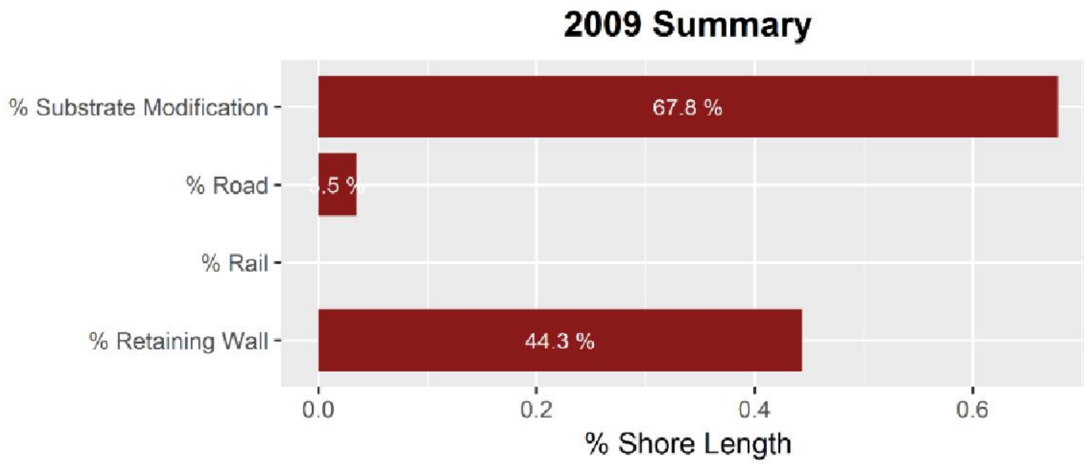

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
18.72 %
14.08 %
3.64 %
9.88 %
4.31 %
15.61 %
33.18 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

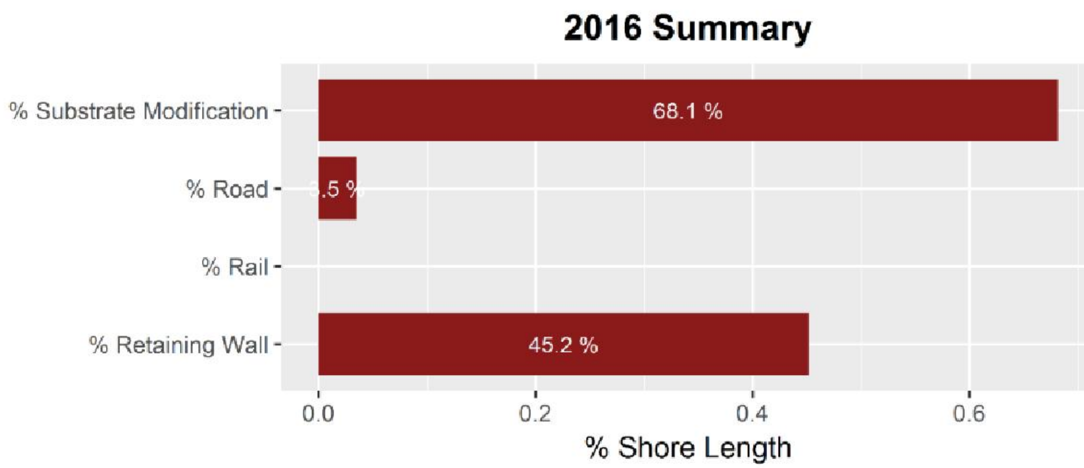

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
2.6 %
19.7 %
22.4 %
0.00
0.05
0.10
0.15
0.20
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
2.6 %
19.6 %
22.3 %
0.00
0.05
0.10
0.15
0.20
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
10
3
16
79
3
60
12
277
243
0
250
Number Observed

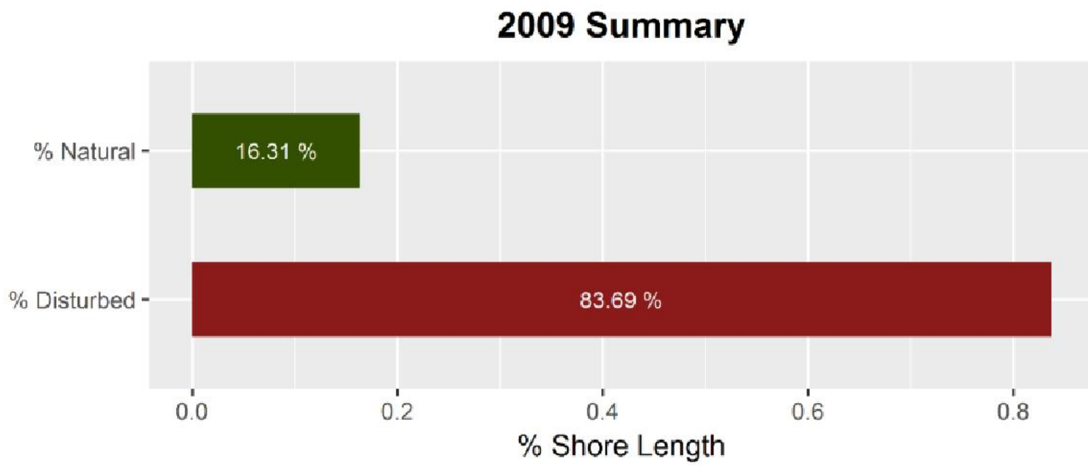

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
11
14
81
3
51
13
291
245
0
250
Number Observed

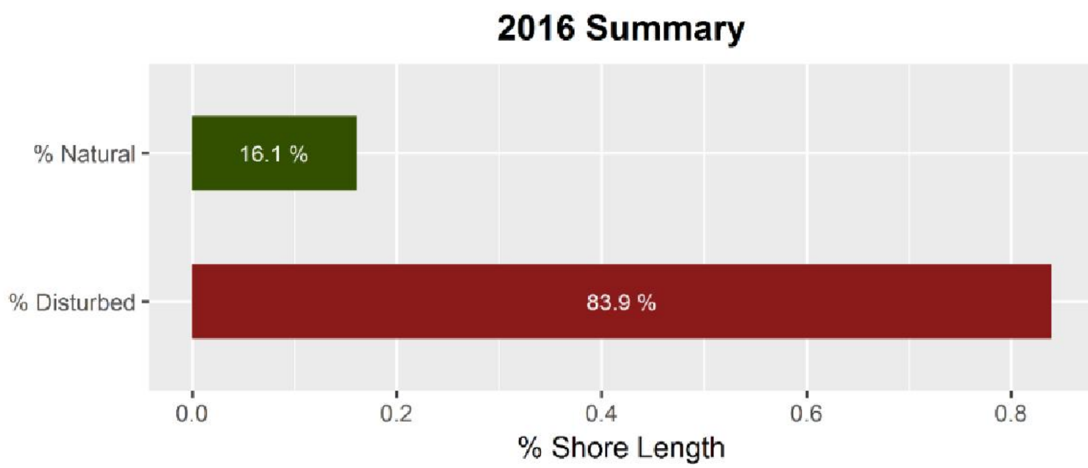

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
67.8 %
44.3 %
0.0
0.2
0.4
0.6
% Shore Length

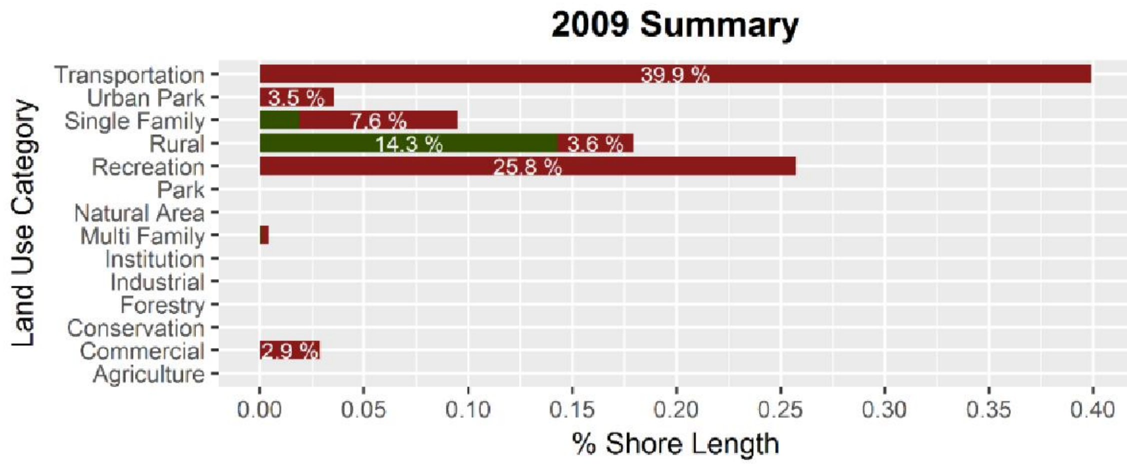

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
68.1 %
45.2 %
0.0
0.2
0.4
0.6
% Shore Length

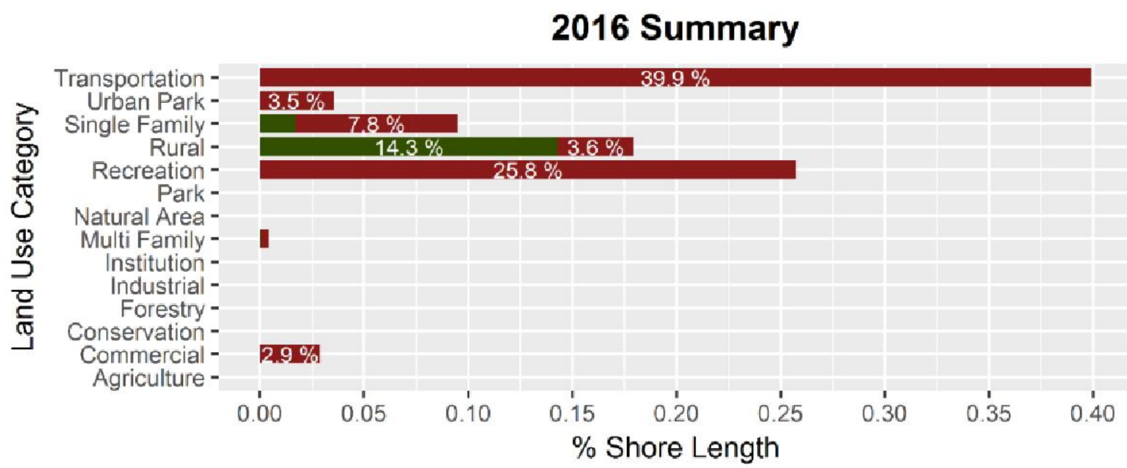
APPENDIX H

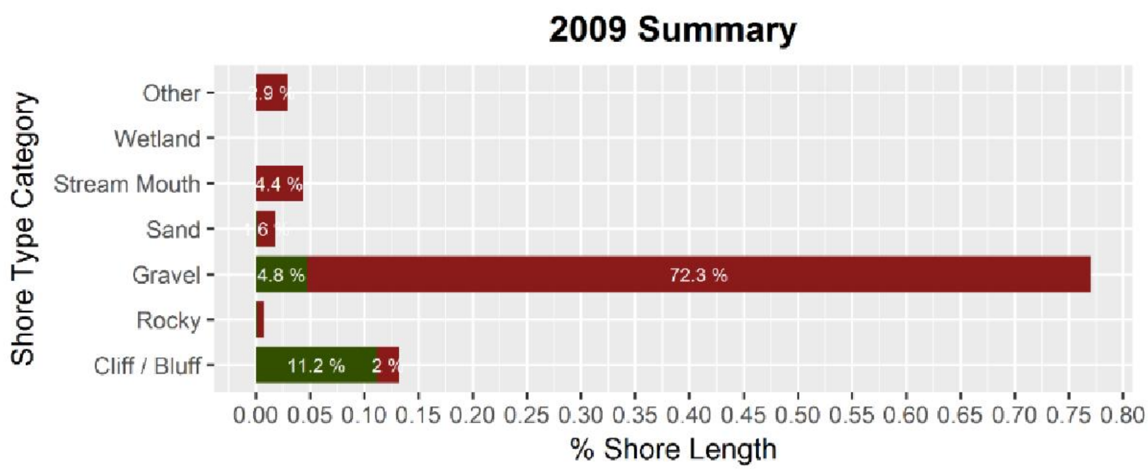
DISTRICT OF PEACHLAND KELOWNA DATA SUMMARY

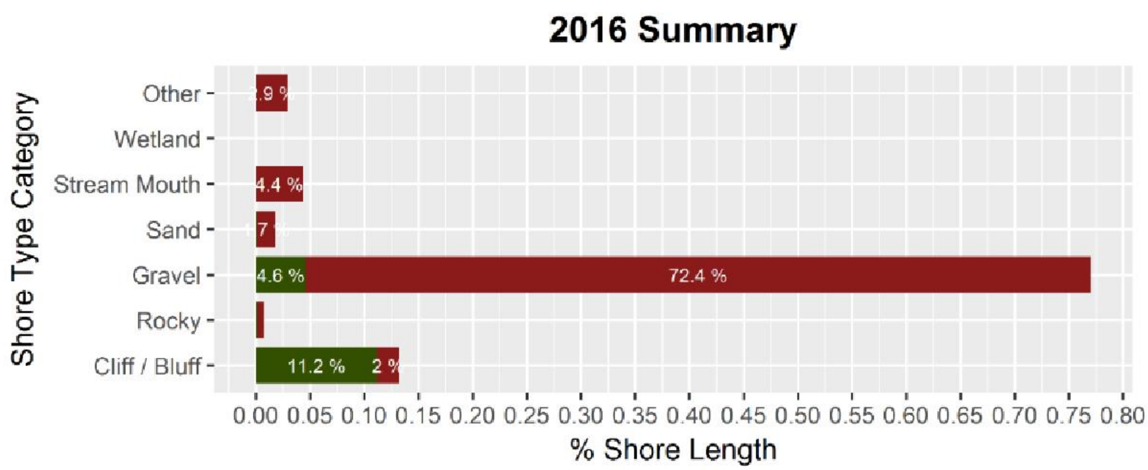

2009 Summary
% Natural
16.31 %
% Disturbed
83.69 %
0.0
0.2
0.4
0.6
0.8
% Shore Length

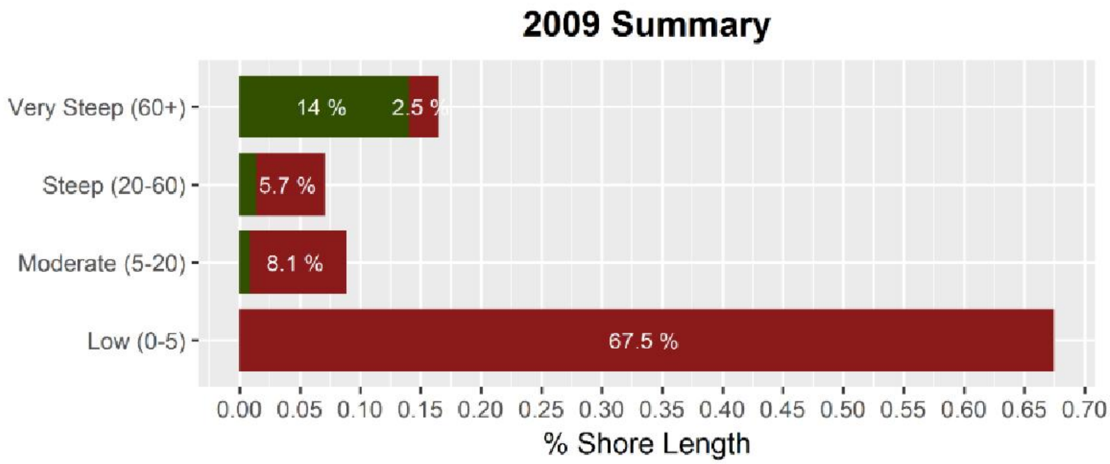

2016 Summary
% Natural
16.1 %
% Disturbed
83.9 %
0.0
0.2
0.4
0.6
0.8
% Shore Length

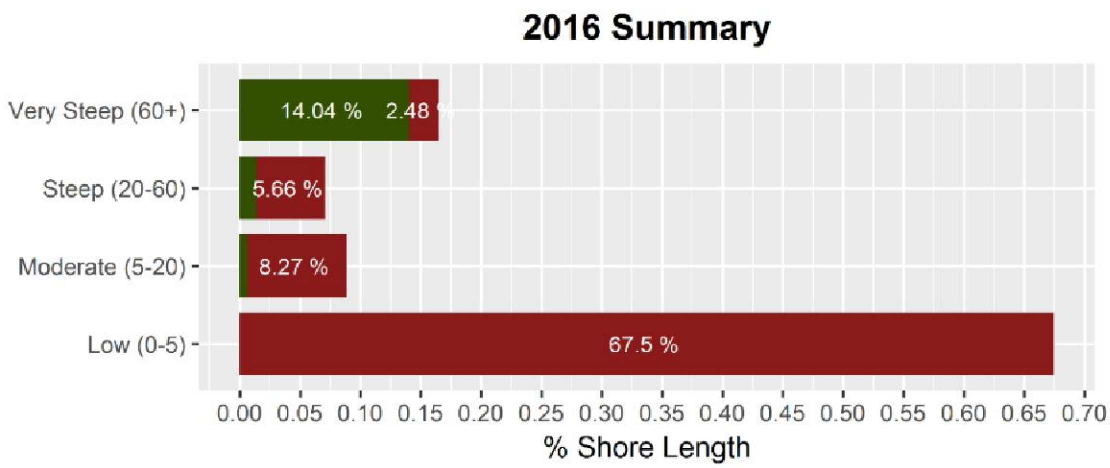

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
39.9 %
3.5 %
7.6 %
14.3 %
3.6 %
25.8 %
2.9 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

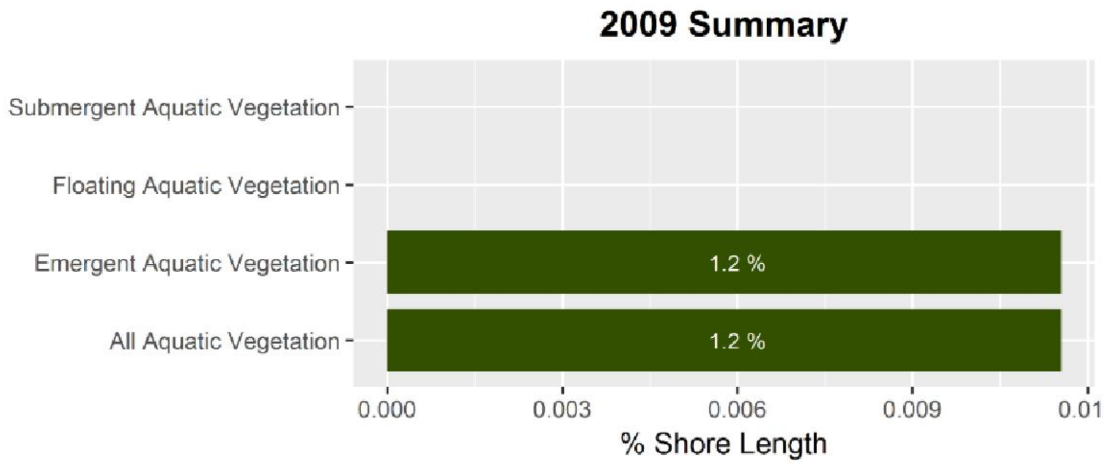

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
39.9 %
3.5 %
7.8 %
14.3 %
3.6 %
25.8 %
2.9 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
% Shore Length

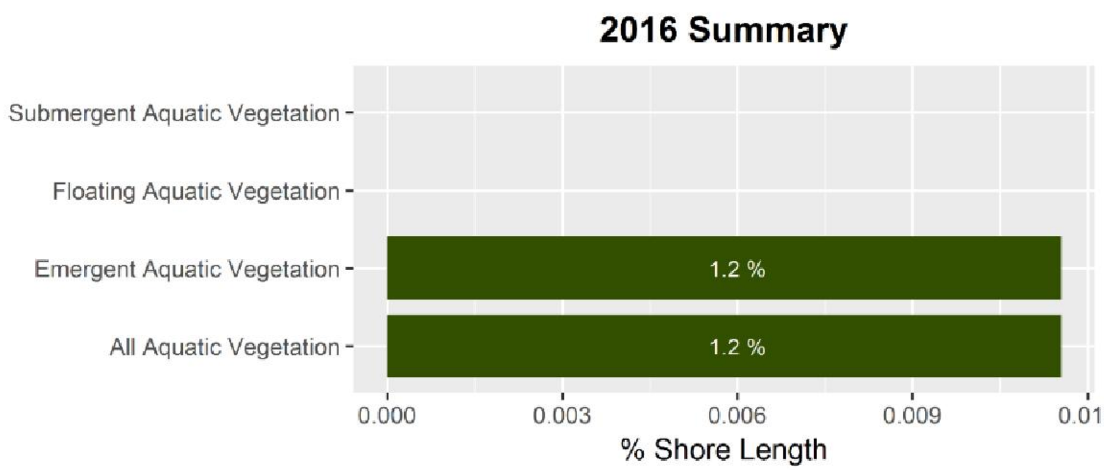

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
4.4 %
4.8 %
72.3 %
11.2 %
2 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
% Shore Length

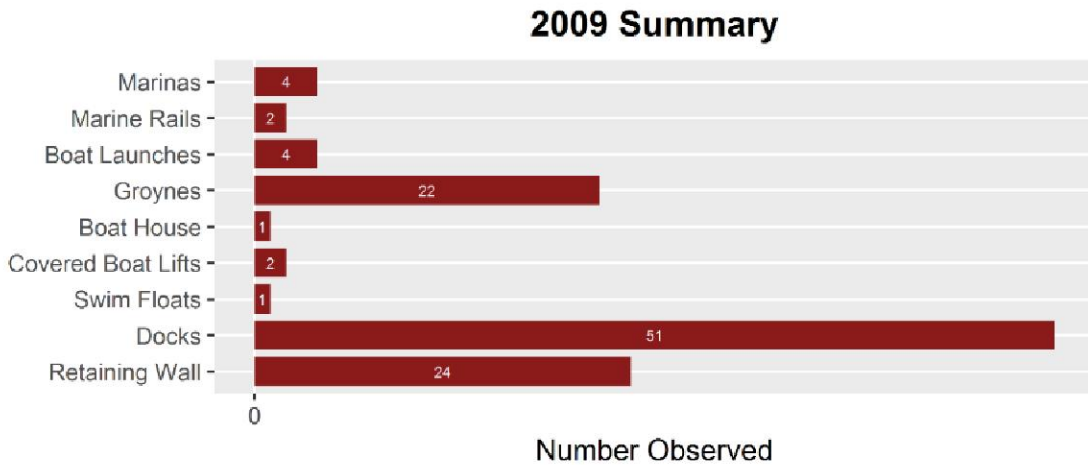

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
4.4 %
4.6 %
72.4 %
11.2 %
2 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80
% Shore Length

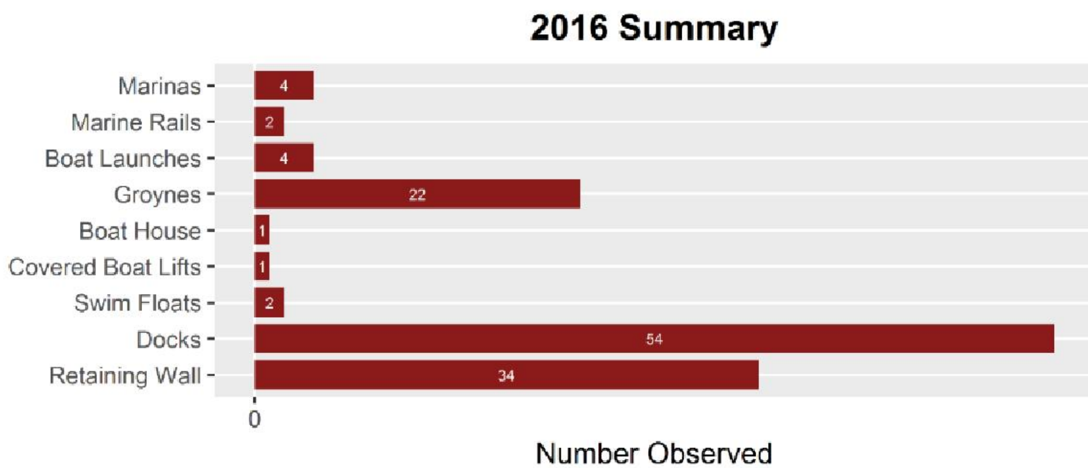

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
14 %
2.5 %
5.7 %
8.1 %
67.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70
% Shore Length

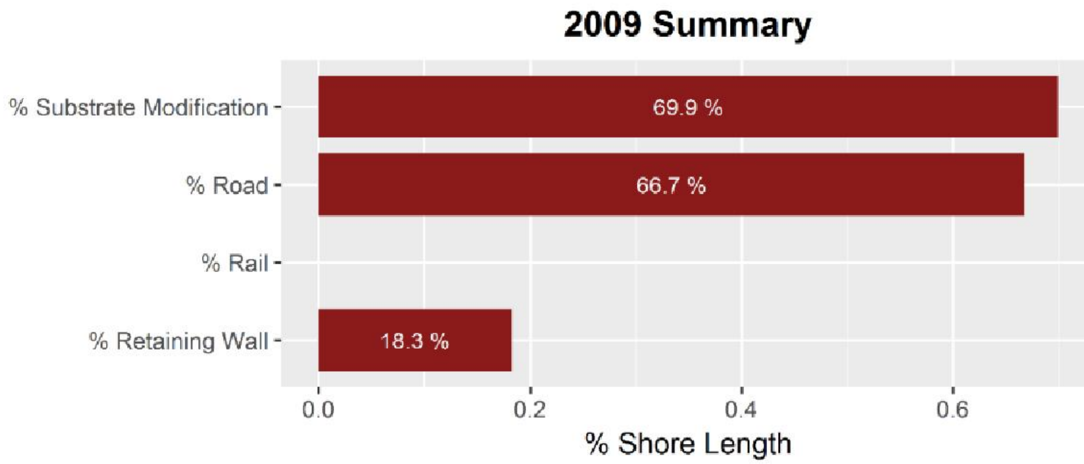

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
14.04 %
2.48 %
5.66 %
8.27 %
67.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70
% Shore Length

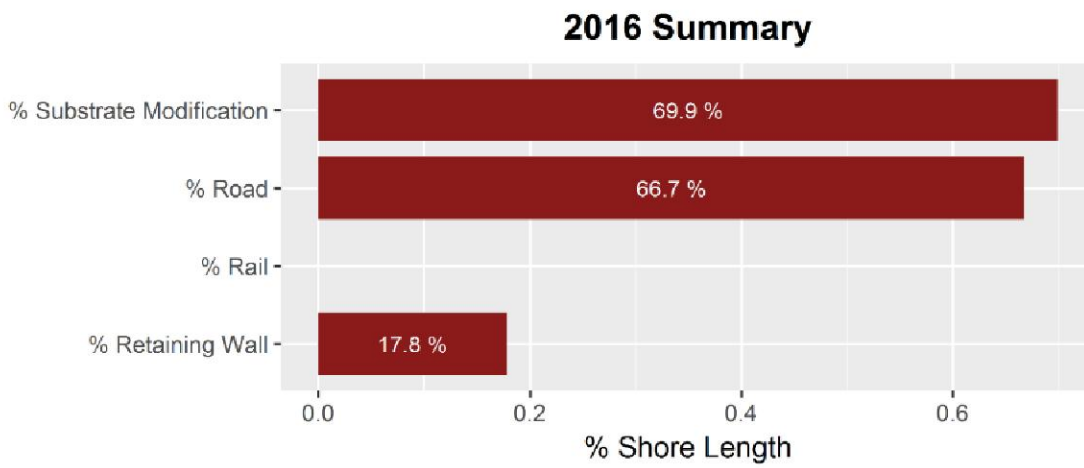

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
1.2 %
1.2 %
0.000
0.003
0.006
0.009
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
1.2 %
1.2 %
0.000
0.003
0.006
0.009
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
4
2
4
22
1
2
1
51
24
0
Number Observed


2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
4
2
4
22
1
1
2
54
34
0
Number Observed

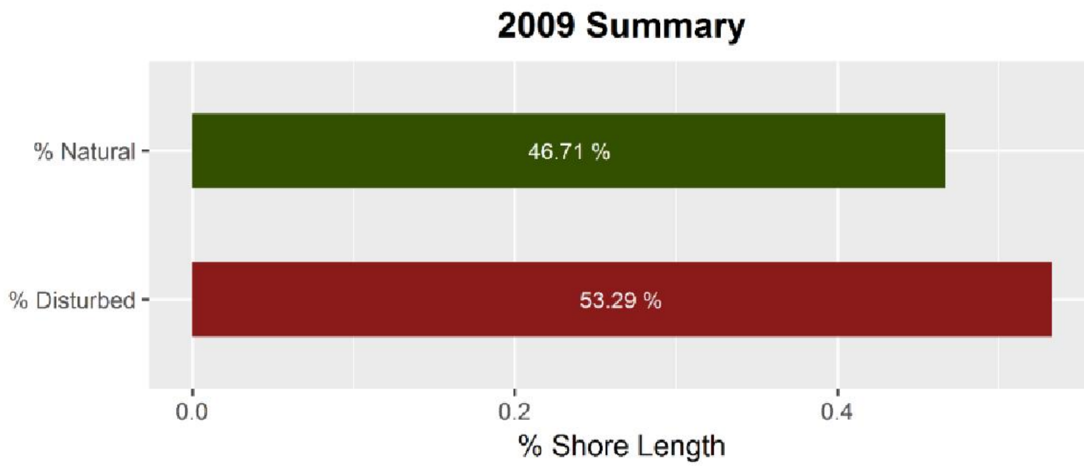

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
69.9 %
66.7 %
18.3 %
0.0
0.2
0.4
0.6
% Shore Length

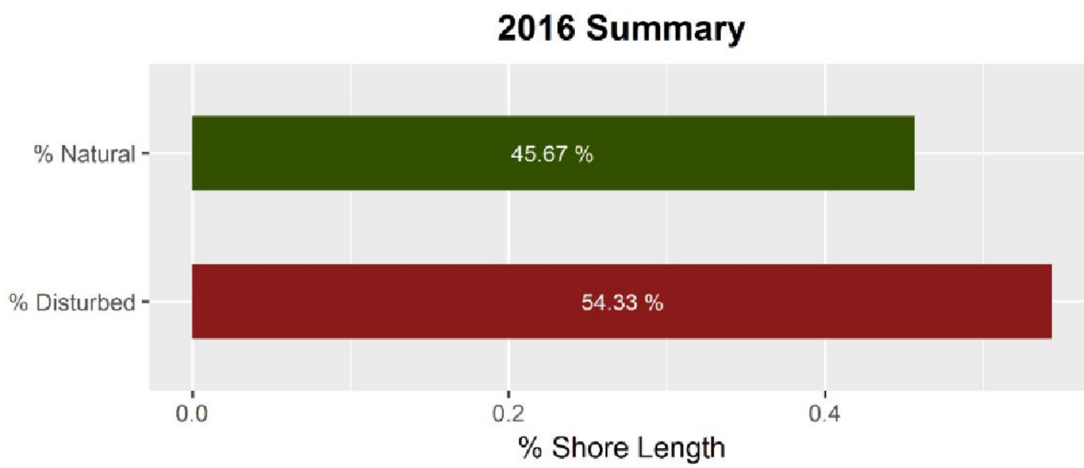

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
69.9 %
66.7 %
17.8 %
0.0
0.2
0.4
0.6
% Shore Length

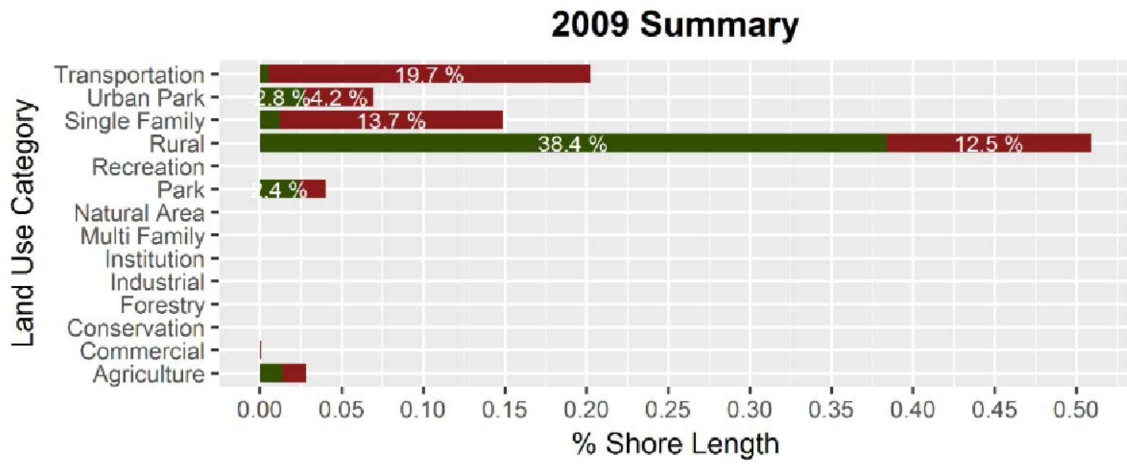
APPENDIX I

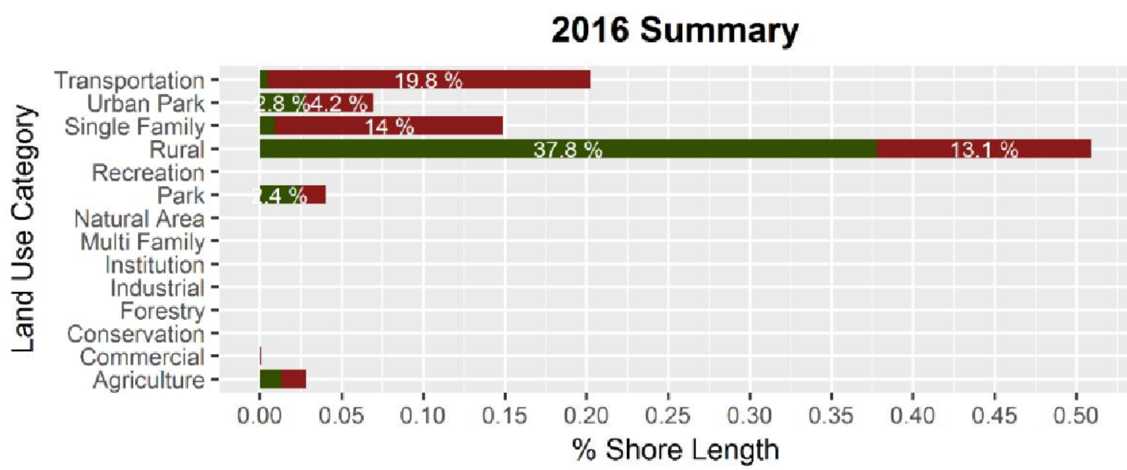
RDOS DATA SUMMARY

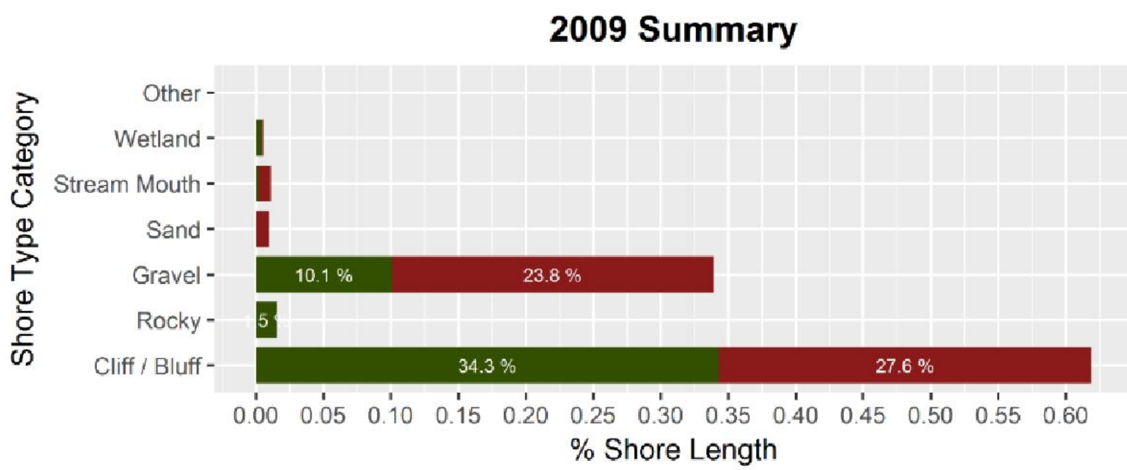
Note: Data only includes lands within the RDOS and not member municipalities.

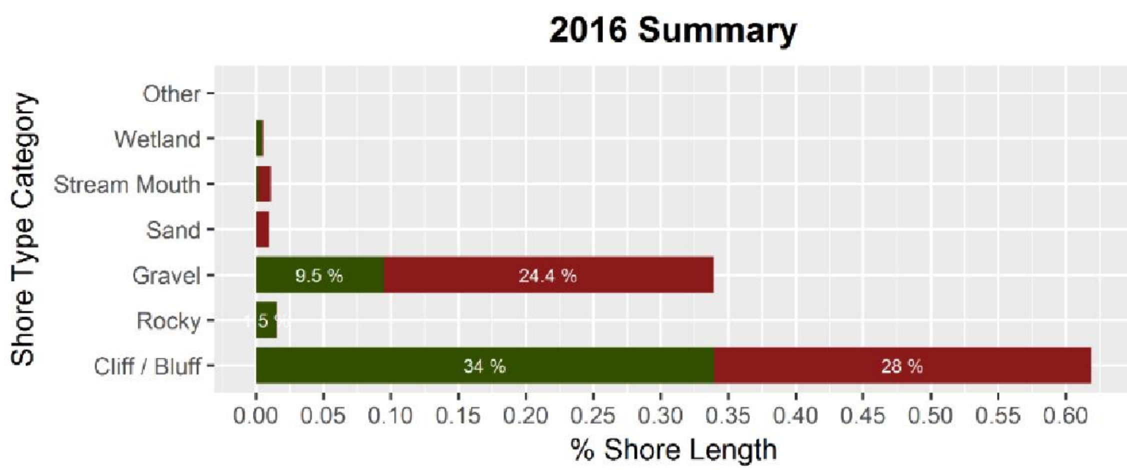

2009 Summary
% Natural
46.71 %
% Disturbed
53.29 %
0.0
0.2
0.4
% Shore Length

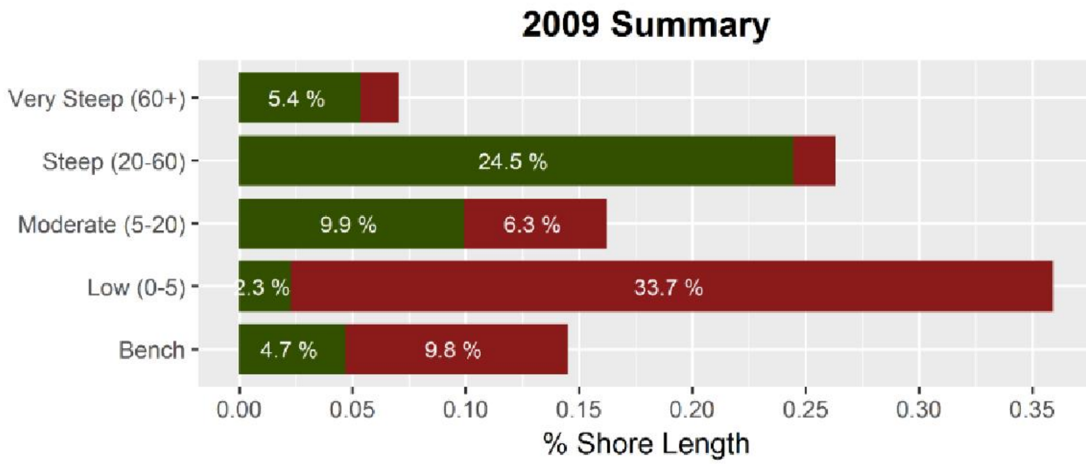

2016 Summary
% Natural
45.67 %
% Disturbed
54.33 %
0.0
0.2
0.4
% Shore Length

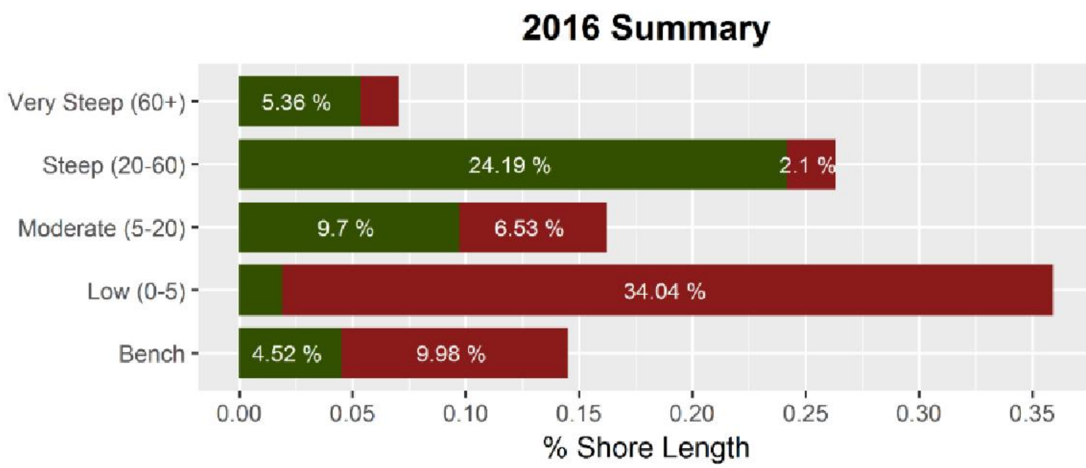

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
19.7 %
4.2 %
13.7 %
38.4 %
12.5 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
% Shore Length

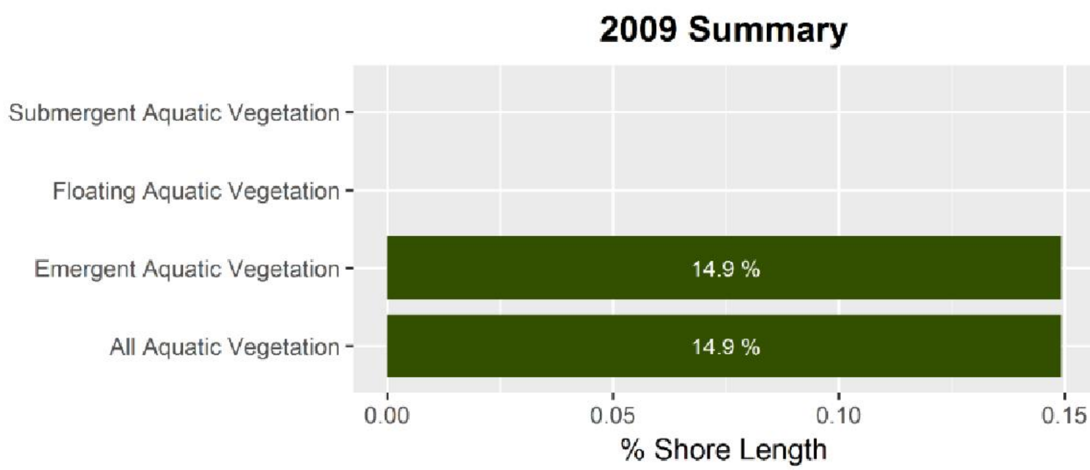

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
19.8 %
4.2 %
14 %
37.8 %
13.1 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
% Shore Length

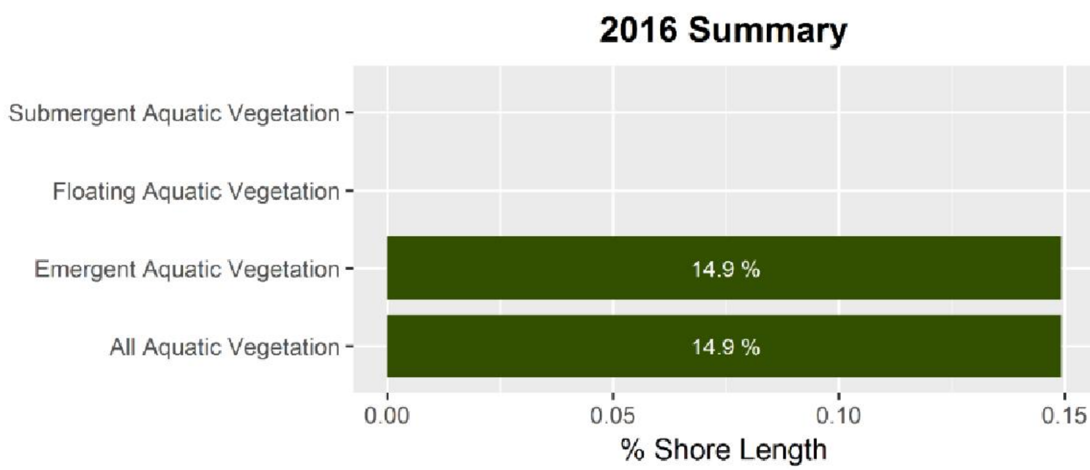

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
10.1 %
23.8 %
34.3 %
27.6 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

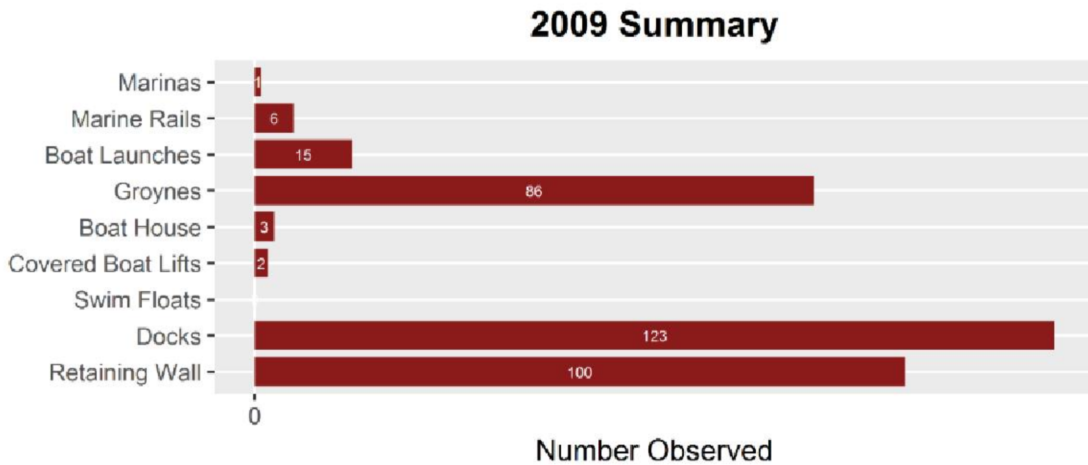

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
9.5 %
24.4 %
34 %
28 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

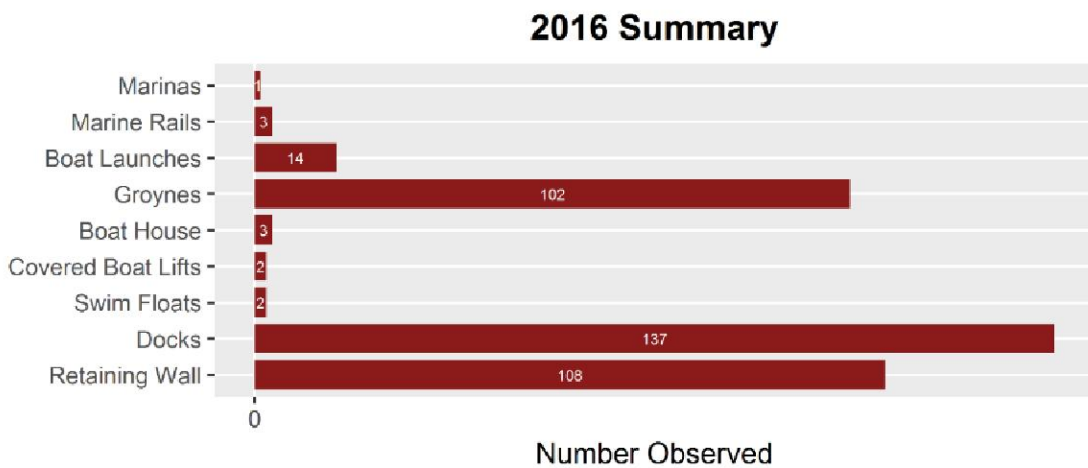

2009 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
5.4 %
24.5 %
9.9 %
6.3 %
2.3 %
33.7 %
4.7 %
9.8 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

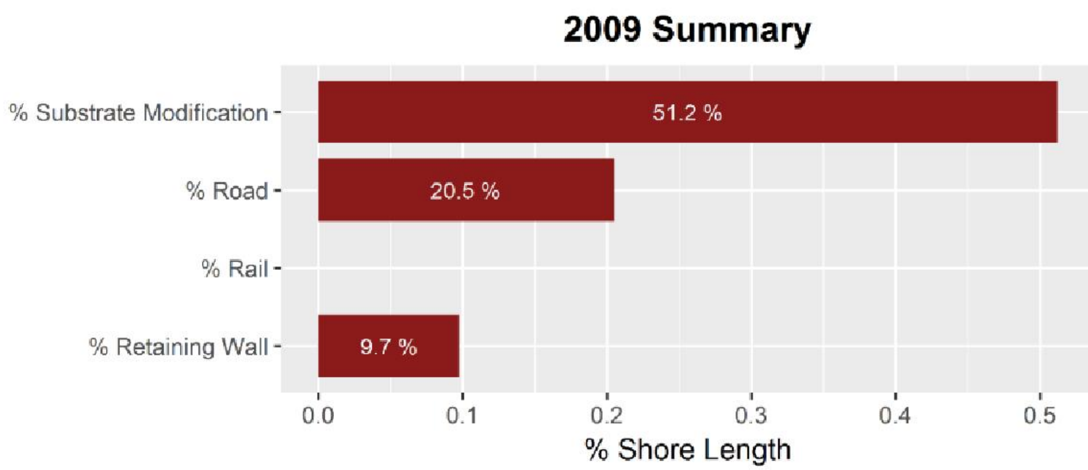

2016 Summary
Very Steep (60+)
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
5.36 %
24.19 %
2.1 %
9.7 %
6.53 %
34.04 %
4.52 %
9.98 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

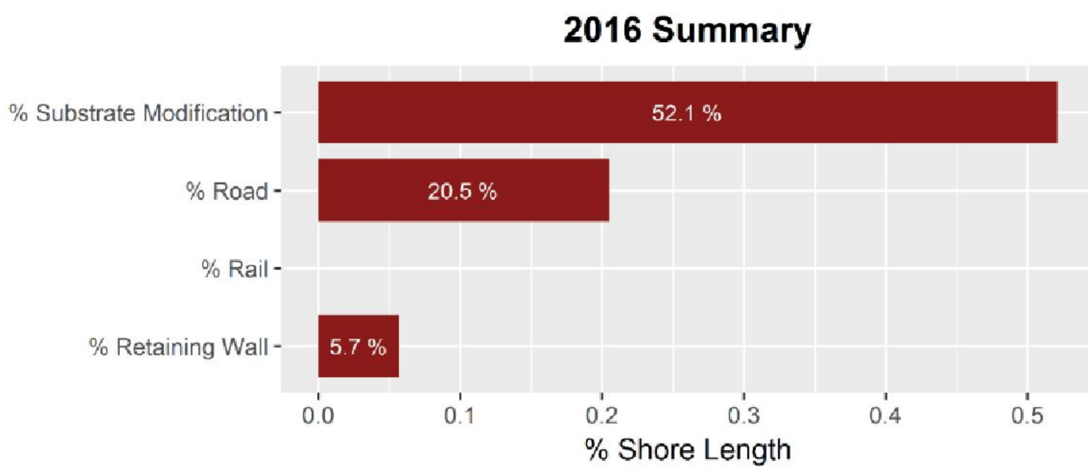

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
14.9 %
14.9 %
0.00
0.05
0.10
0.15
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
14.9 %
14.9 %
0.00
0.05
0.10
0.15
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
1
6
15
86
3
2
123
100
0
Number Observed

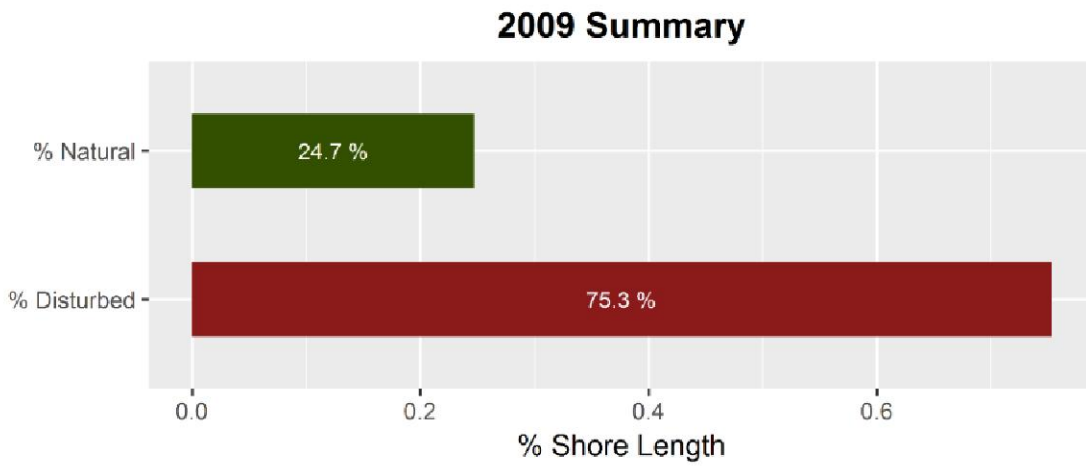

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
1
3
14
102
3
2
2
137
108
0
Number Observed

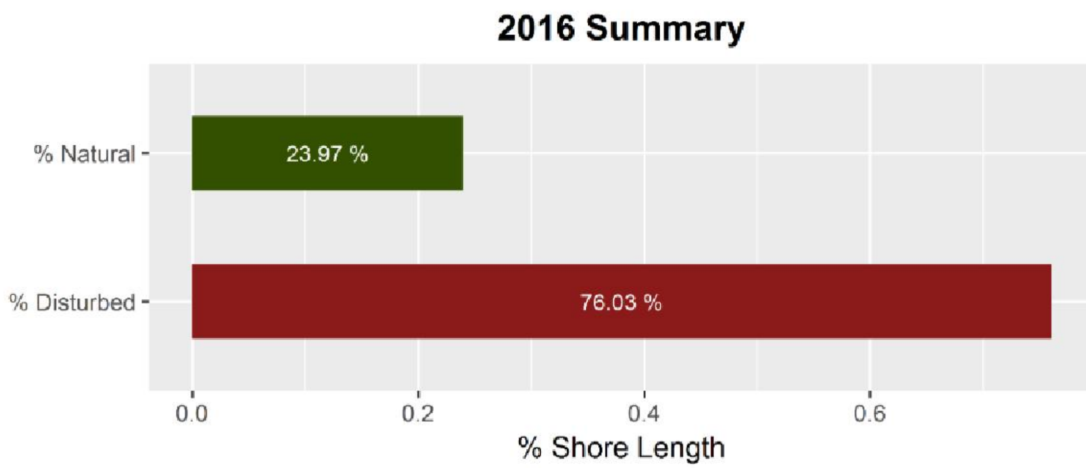

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
51.2 %
20.5 %
9.7 %
0.0
0.1
0.2
0.3
0.4
0.5
% Shore Length

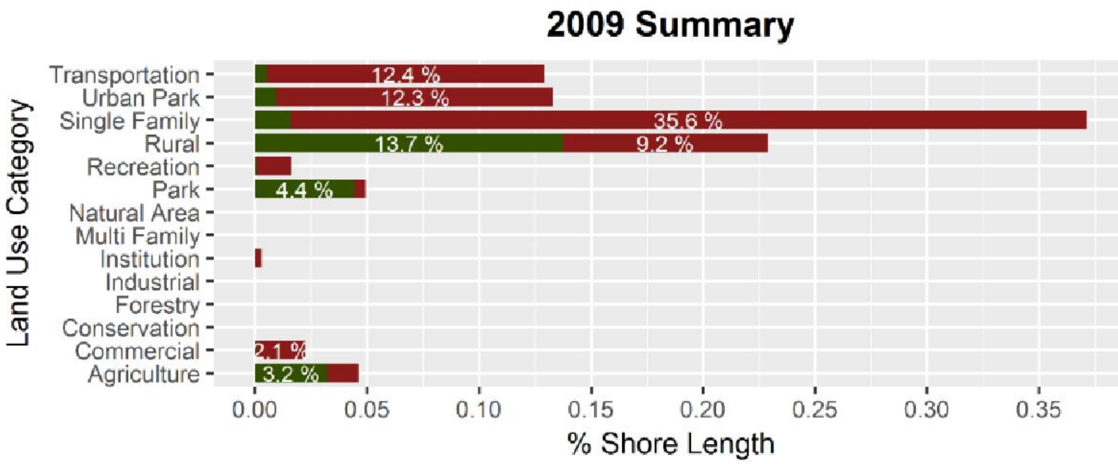

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
52.1 %
20.5 %
5.7 %
0.0
0.1
0.2
0.3
0.4
0.5
% Shore Length

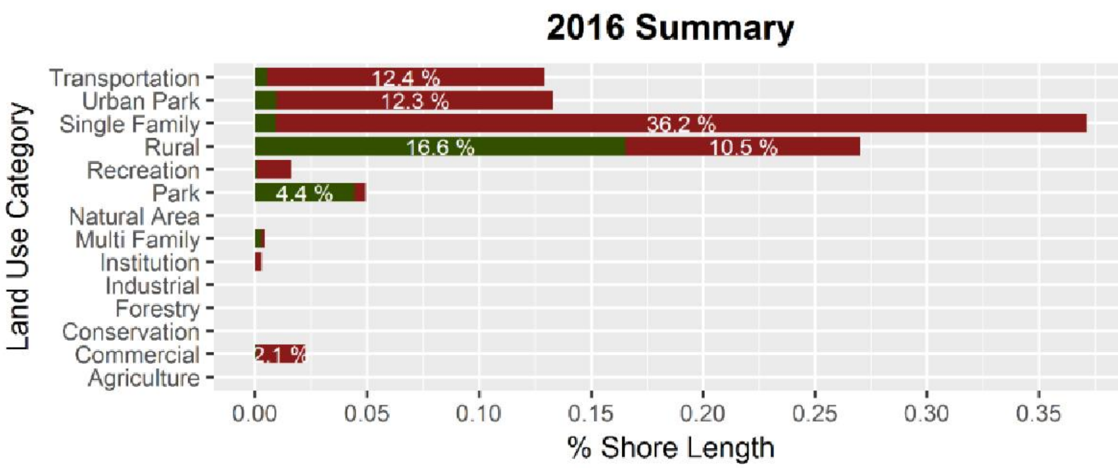
APPENDIX J

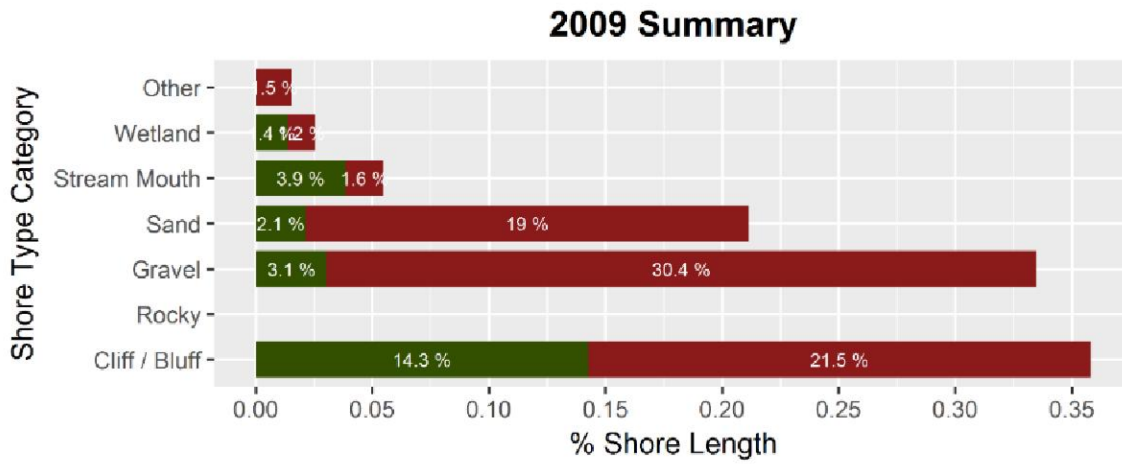
DISTRICT OF SUMMERLAND DATA SUMMARY

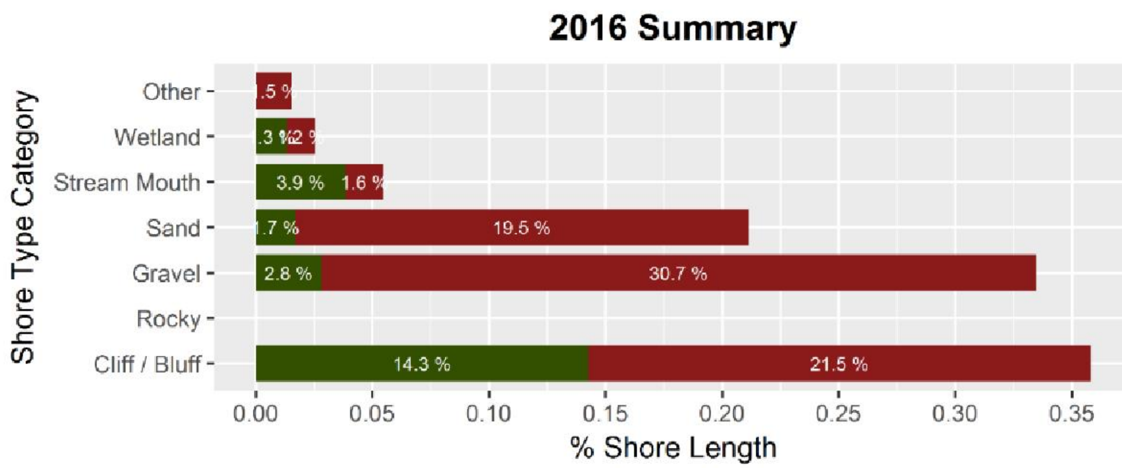

2009 Summary
% Natural
24.7 %
% Disturbed
75.3 %
0.0
0.2
0.4
0.6
% Shore Length

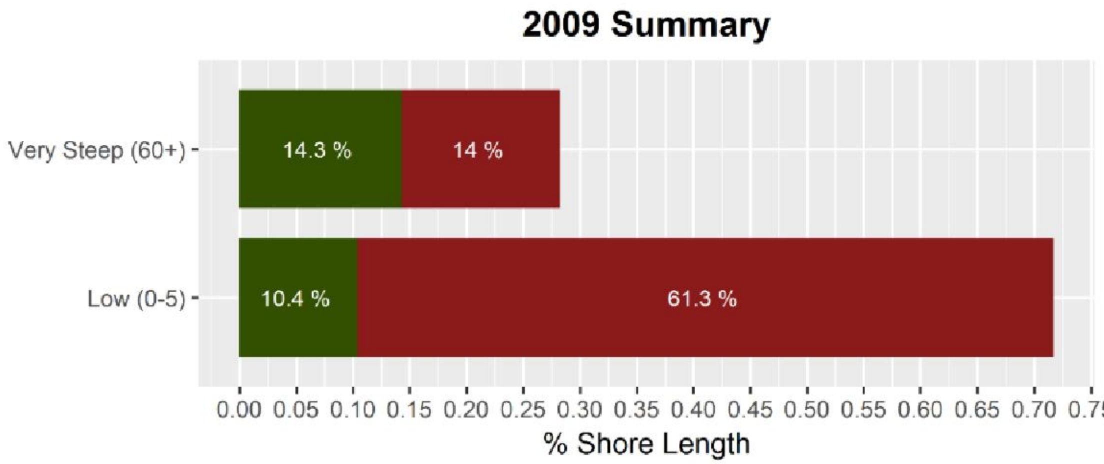

2016 Summary
% Natural
23.97 %
% Disturbed
76.03 %
0.0
0.2
0.4
0.6
% Shore Length

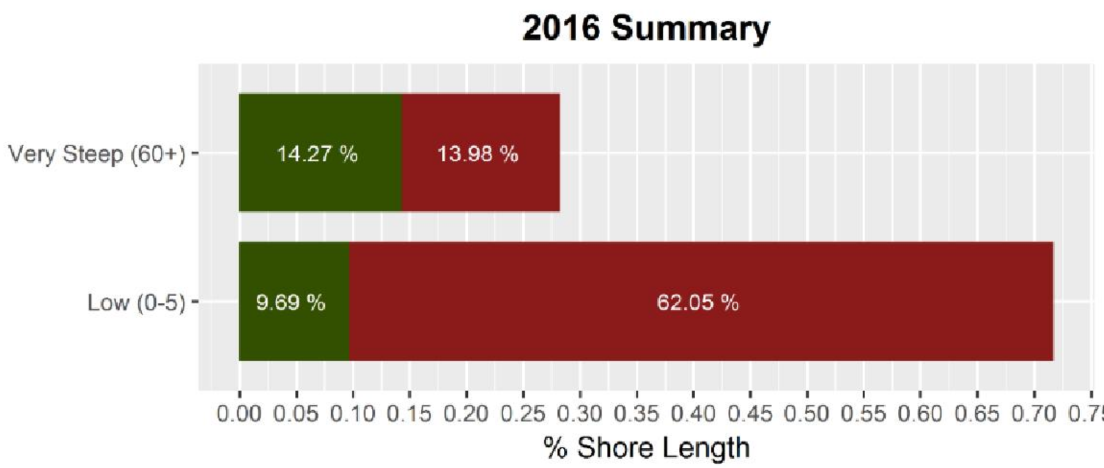

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
12.4 %
12.3 %
35.6 %
13.7 %
9.2 %
4.4 %
2.1 %
3.2 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

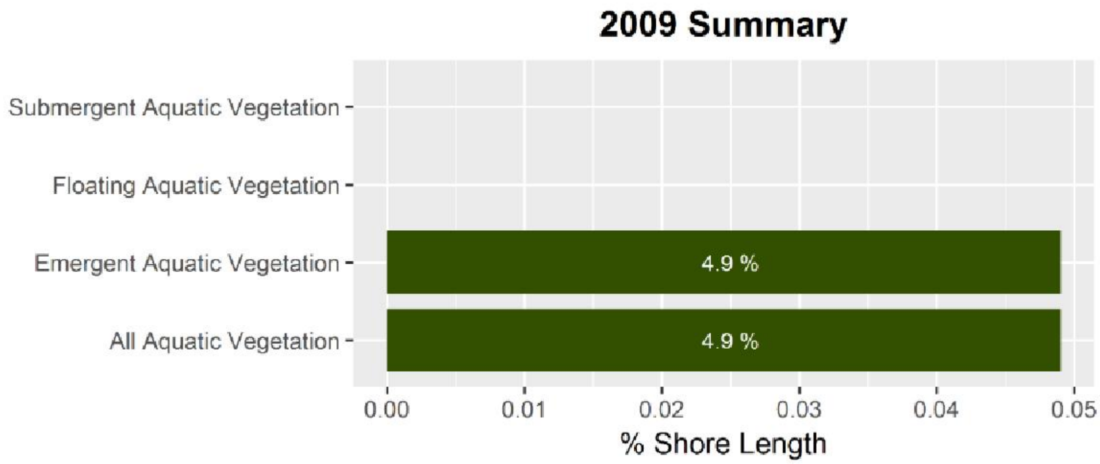

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
12.4 %
12.3 %
36.2 %
16.6 %
10.5 %
4.4 %
2.1 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

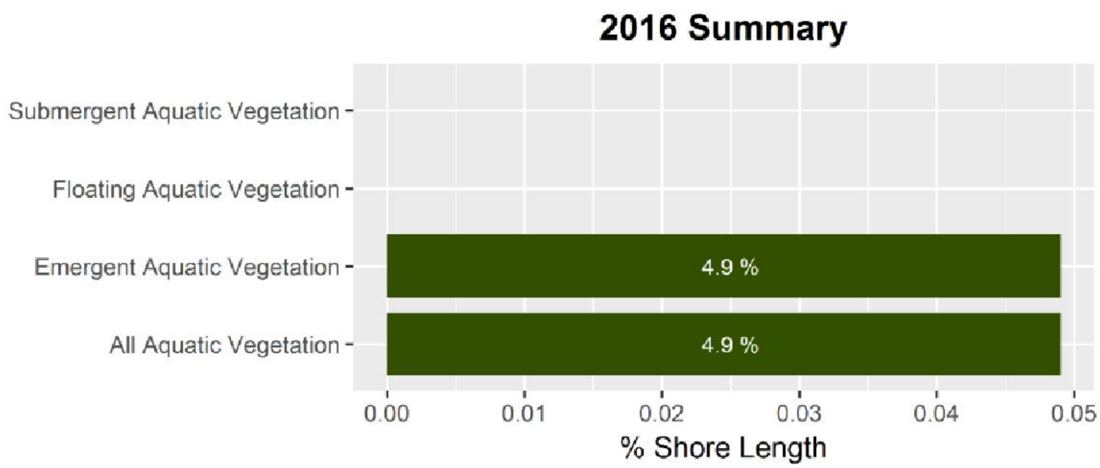

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
.5 %
3.9 %
1.6 %
2.1 %
19 %
3.1 %
30.4 %
14.3 %
21.5 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

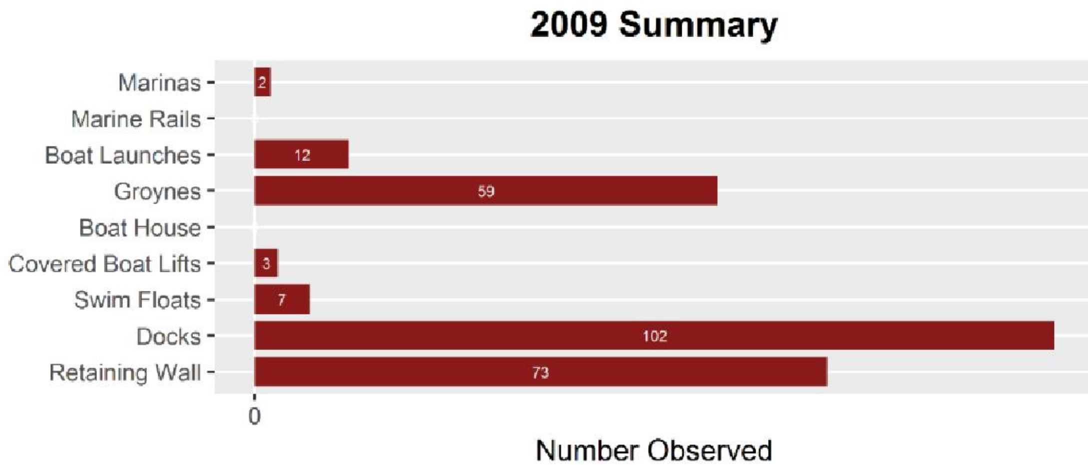

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
.5 %
3.9 %
1.6 %
.7 %
19.5 %
2.8 %
30.7 %
14.3 %
21.5 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

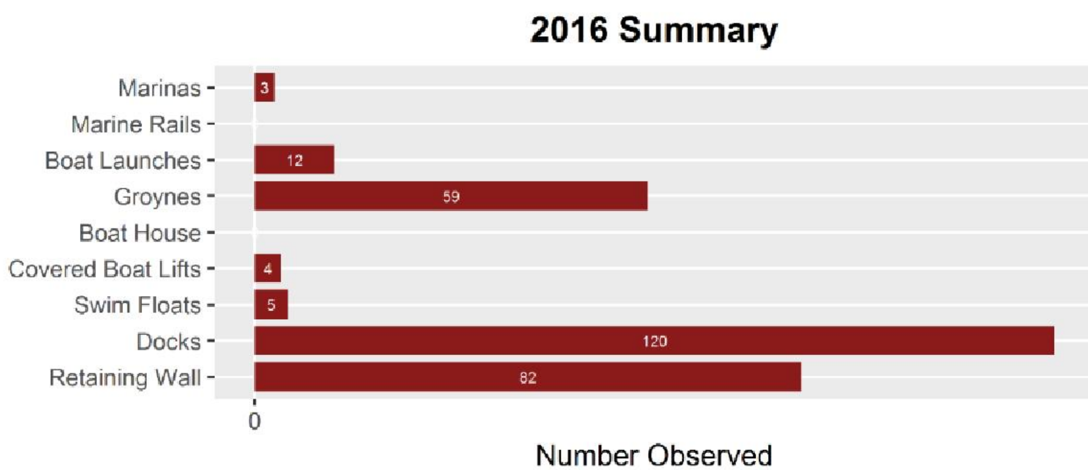

2009 Summary
Very Steep (60+)
Low (0-5)
14.3 %
14 %
10.4 %
61.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70
% Shore Length

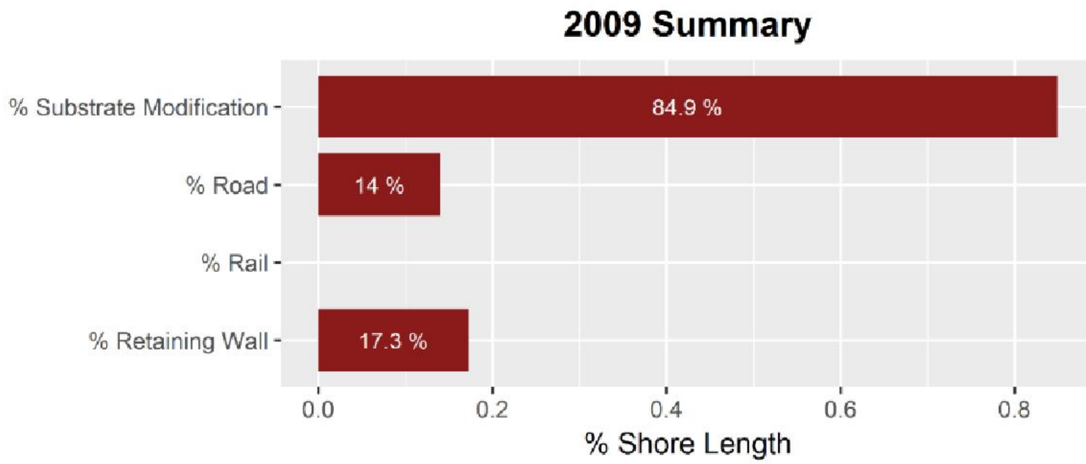

2016 Summary
Very Steep (60+)
Low (0-5)
14.27 %
13.98 %
9.69 %
62.05 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70
% Shore Length

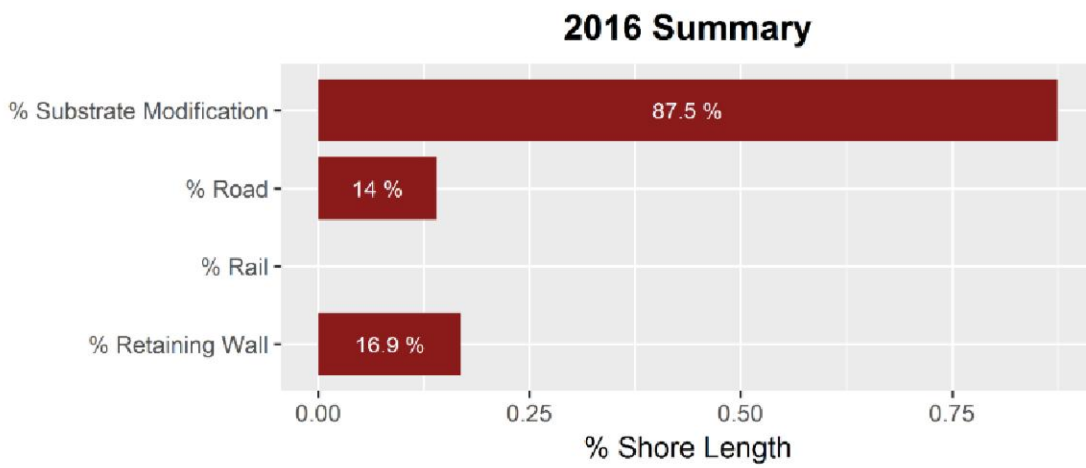

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
4.9 %
4.9 %
0.00
0.01
0.02
0.03
0.04
0.05
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
4.9 %
4.9 %
0.00
0.01
0.02
0.03
0.04
0.05
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
2
12
59
3
7
102
73
0
Number Observed

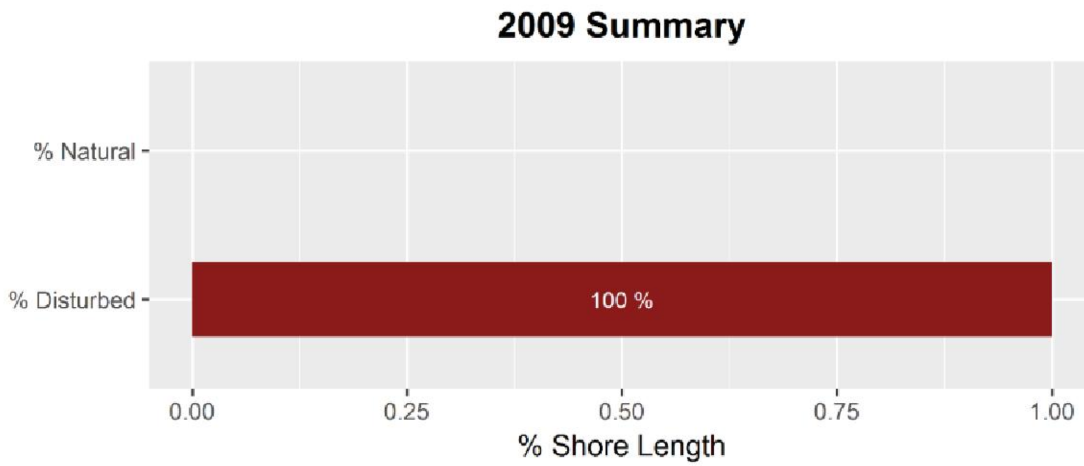

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
3
12
59
4
5
120
82
0
Number Observed

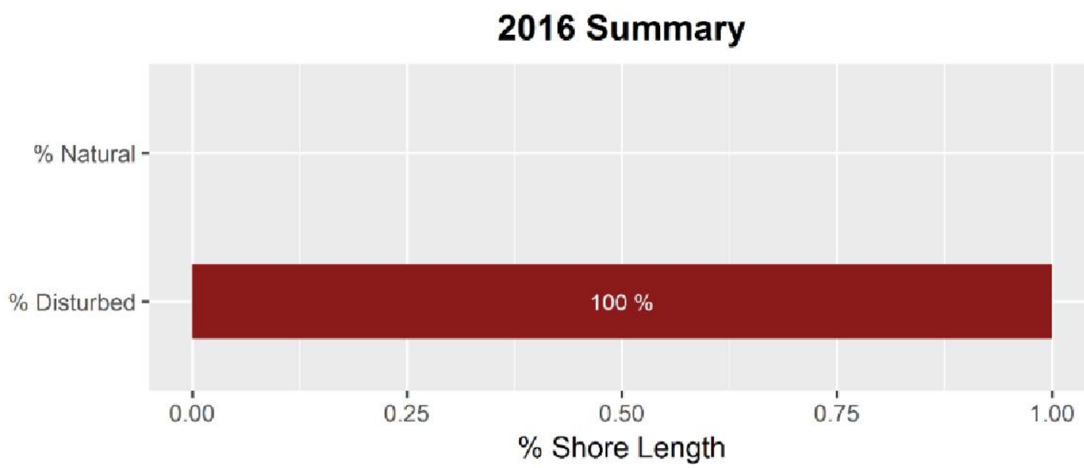

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
84.9 %
14 %
17.3 %
0.0
0.2
0.4
0.6
0.8
% Shore Length

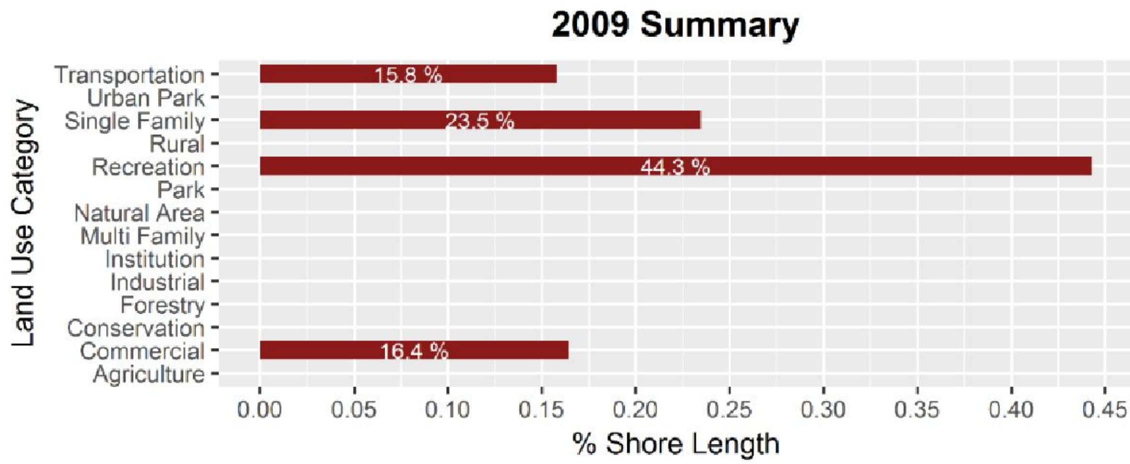

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
87.5 %
14 %
16.9 %
0.00
0.25
0.50
0.75
% Shore Length

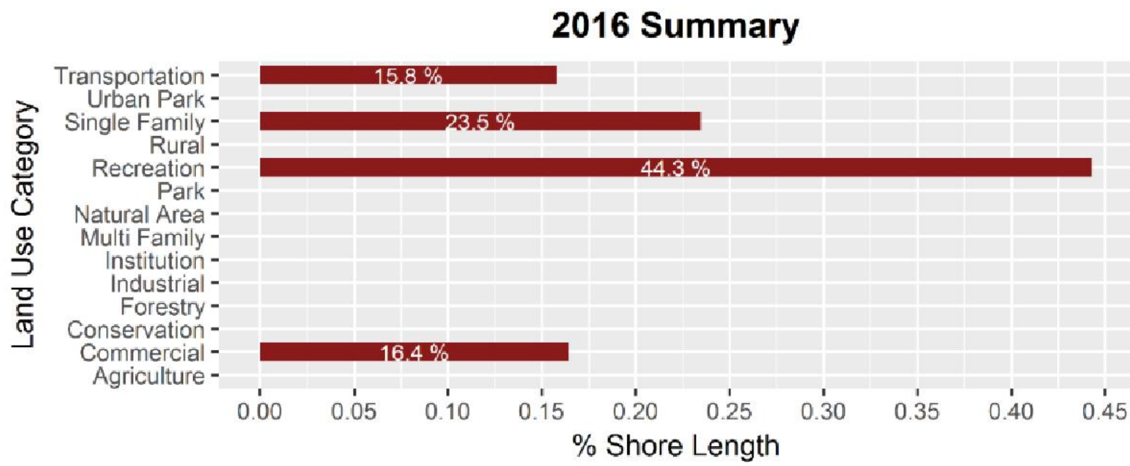
APPENDIX K

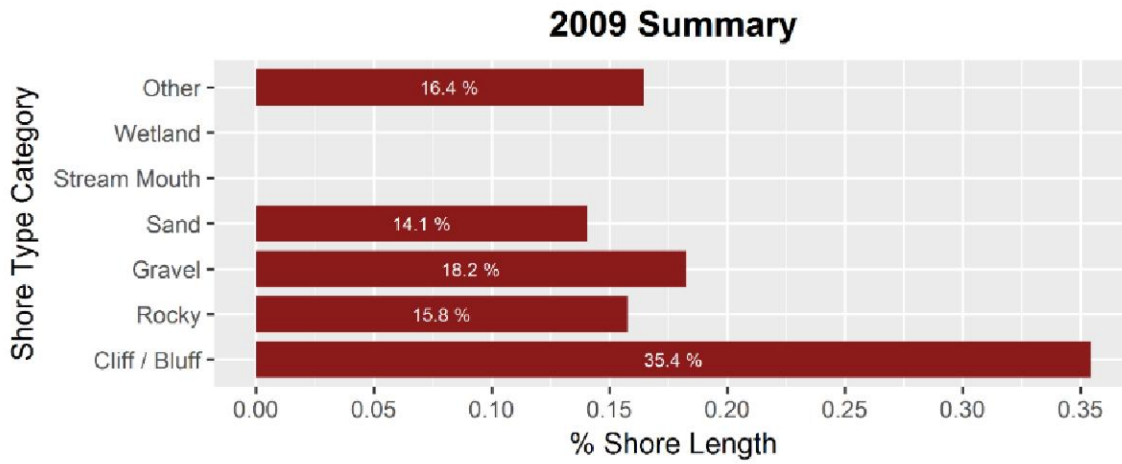
WESTBANK FIRST NATION DATA SUMMARY


2009 Summary
% Natural
% Disturbed
100 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

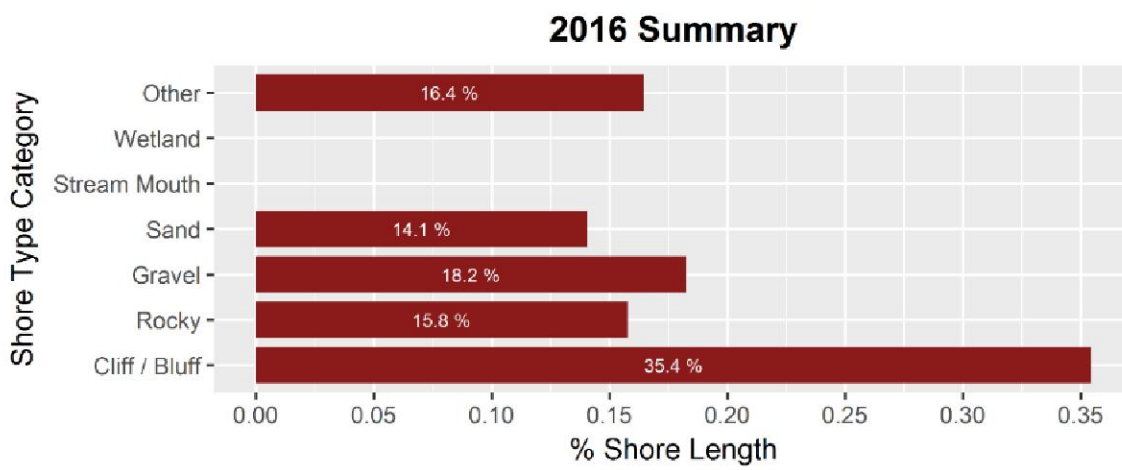

2016 Summary
% Natural
% Disturbed
100 %
0.00
0.25
0.50
0.75
1.00
% Shore Length


2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
15.8 %
23.5 %
44.3 %
16.4 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

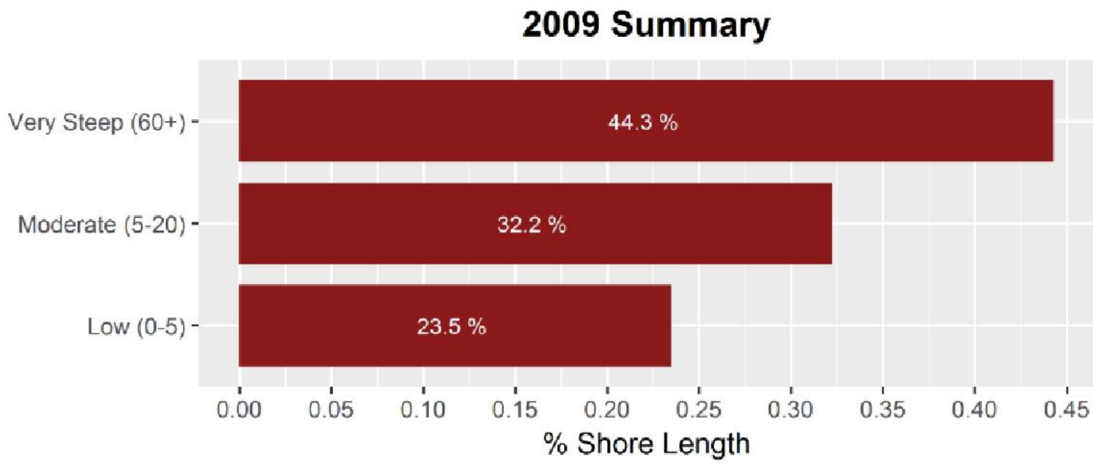

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
15.8 %
23.5 %
44.3 %
16.4 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

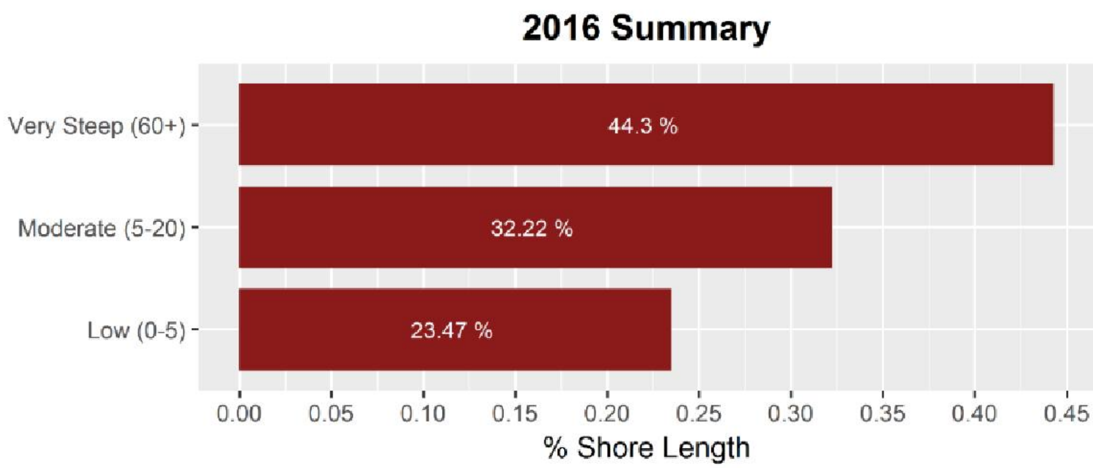


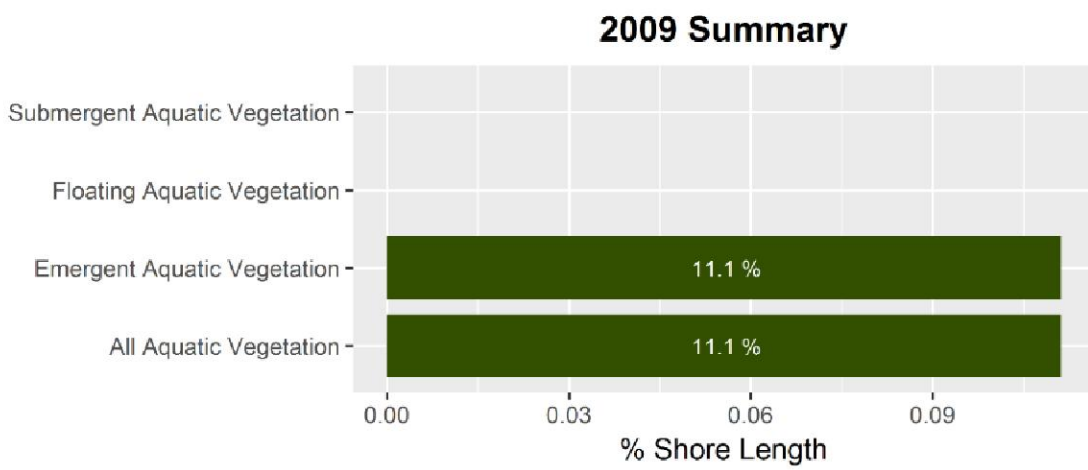
2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
16.4 %
14.1 %
18.2 %
15.8 %
35.4 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

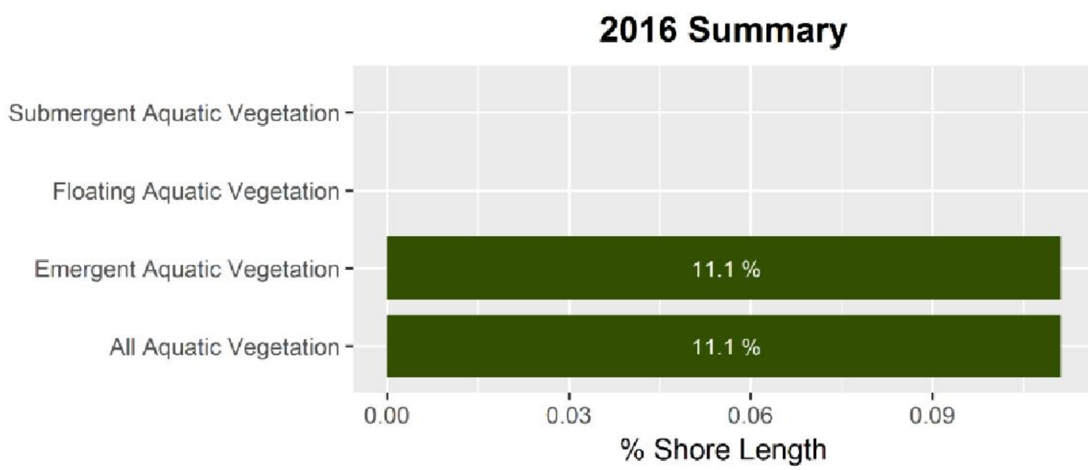


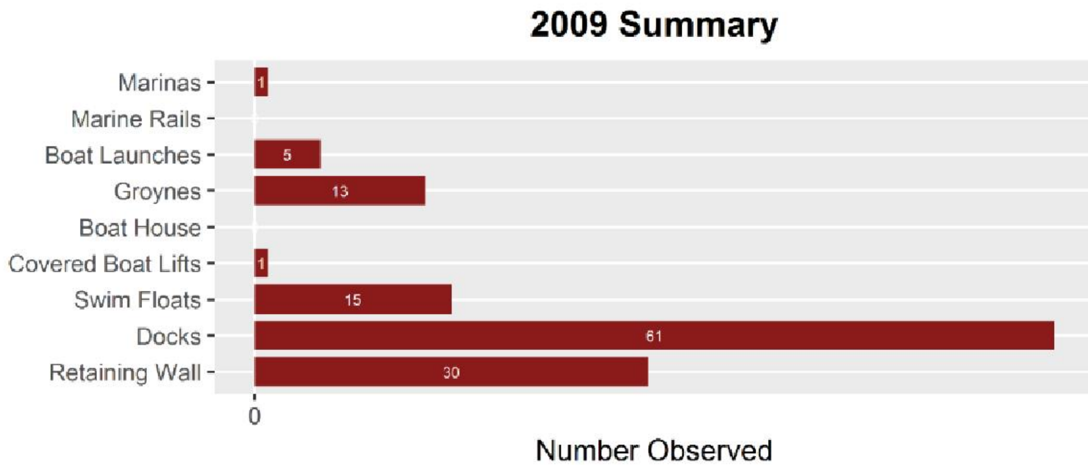
2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
16.4 %
14.1 %
18.2 %
15.8 %
35.4 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
% Shore Length

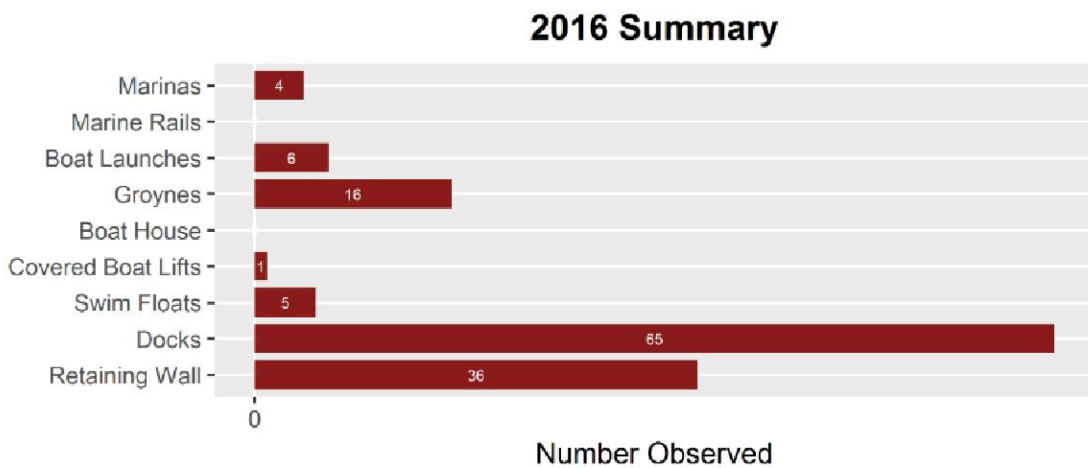

2009 Summary
Very Steep (60+)
Moderate (5-20)
Low (0-5)
44.3 %
32.2 %
23.5 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

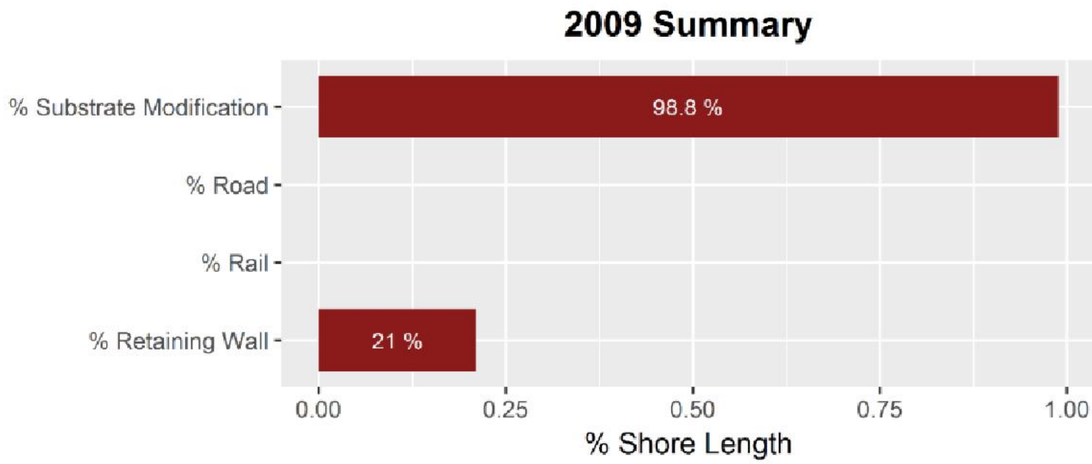

2016 Summary
Very Steep (60+)
Moderate (5-20)
Low (0-5)
44.3 %
32.22 %
23.47 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45
% Shore Length

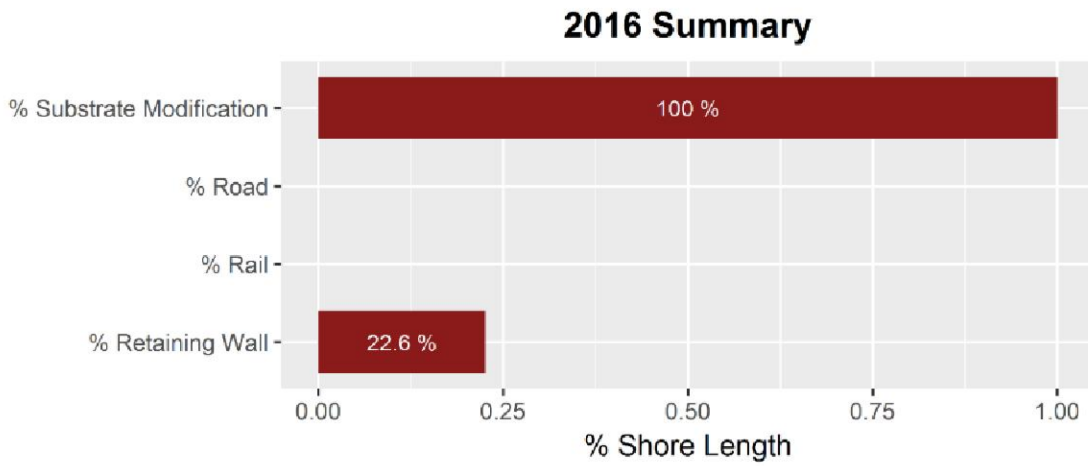

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
11.1 %
11.1 %
0.00
0.03
0.06
0.09
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
11.1 %
11.1 %
0.00
0.03
0.06
0.09
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
1
5
13
1
15
61
30
0
Number Observed

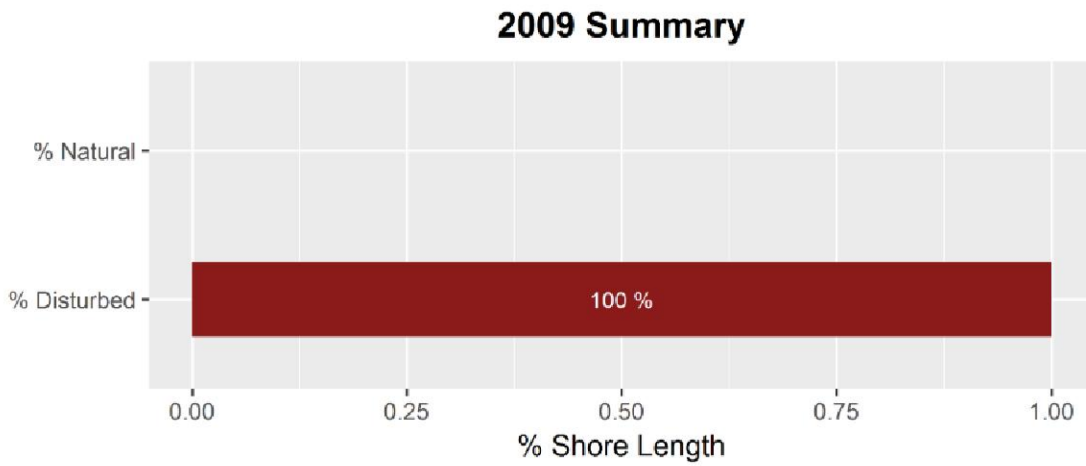

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
4
6
16
1
5
65
36
0
Number Observed

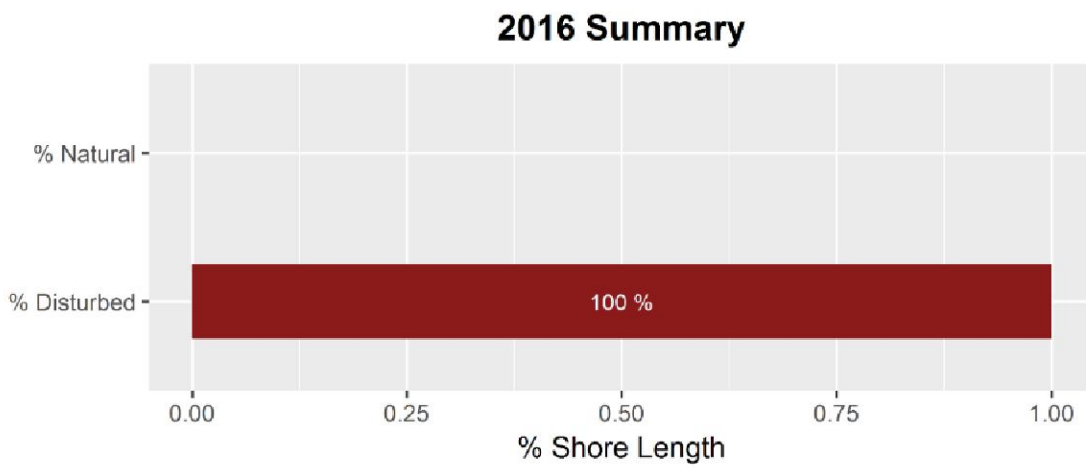

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
98.8 %
21 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

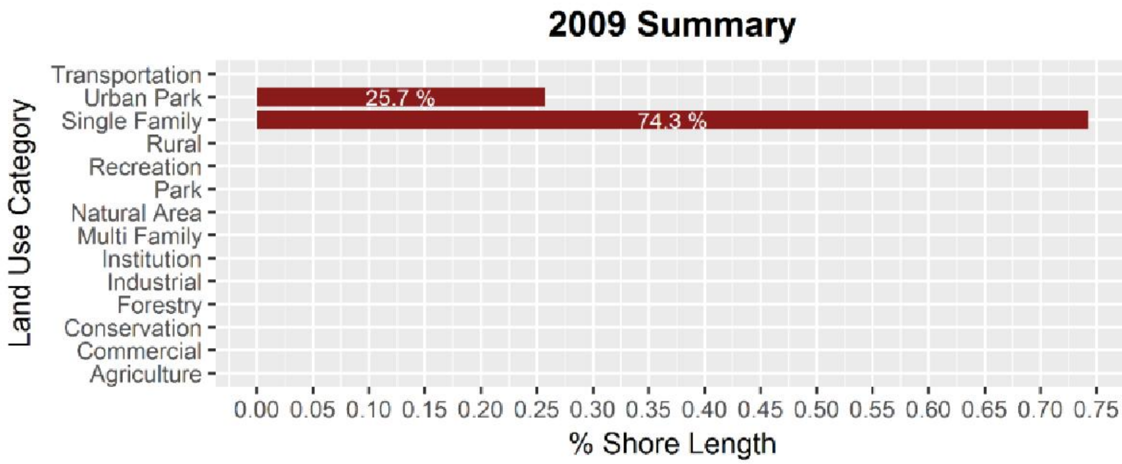

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
100 %
22.6 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

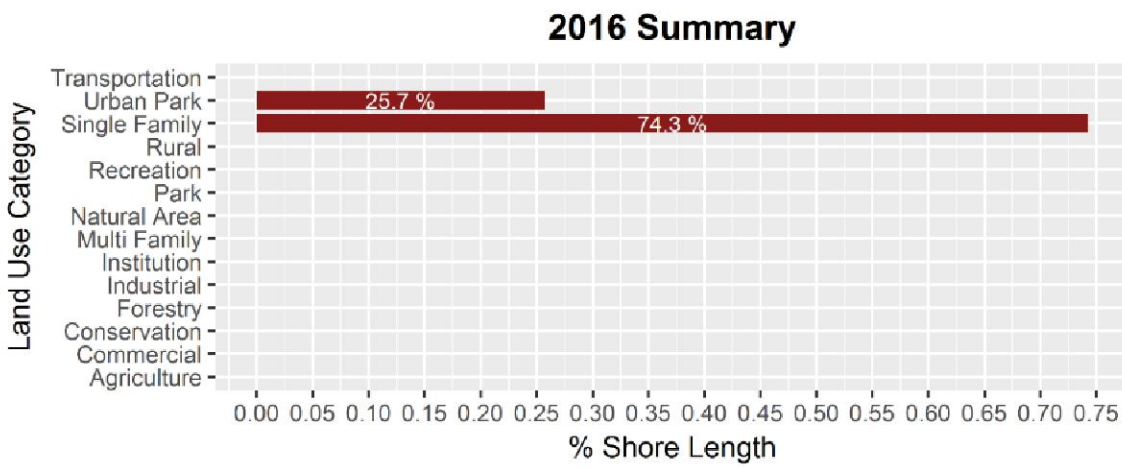
APPENDIX L

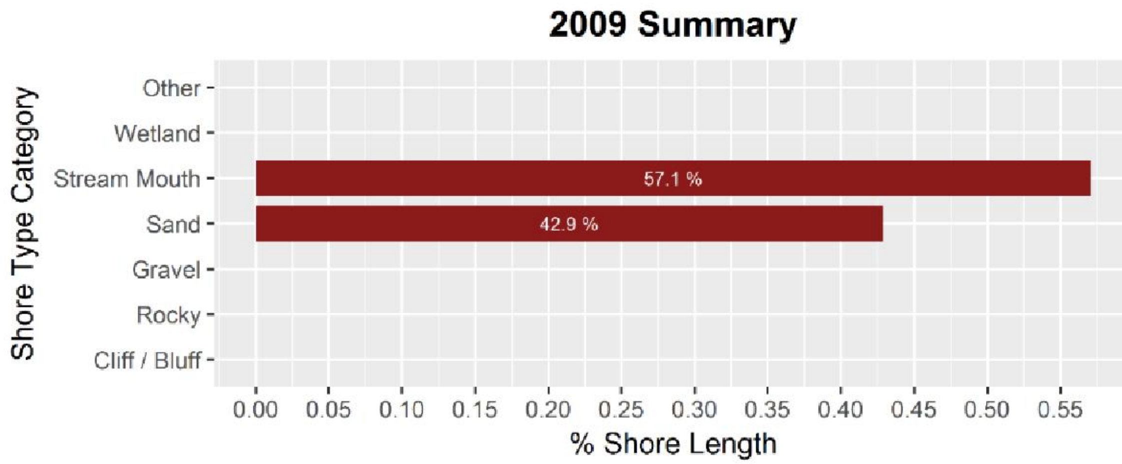
PENTICTON INDIAN BAND DATA SUMMARY

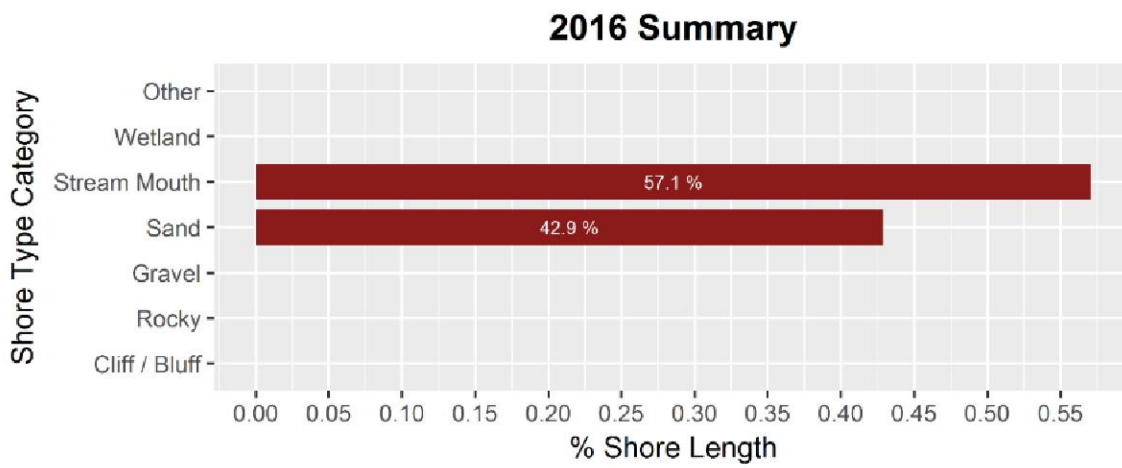

2009 Summary
% Natural
% Disturbed
100 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

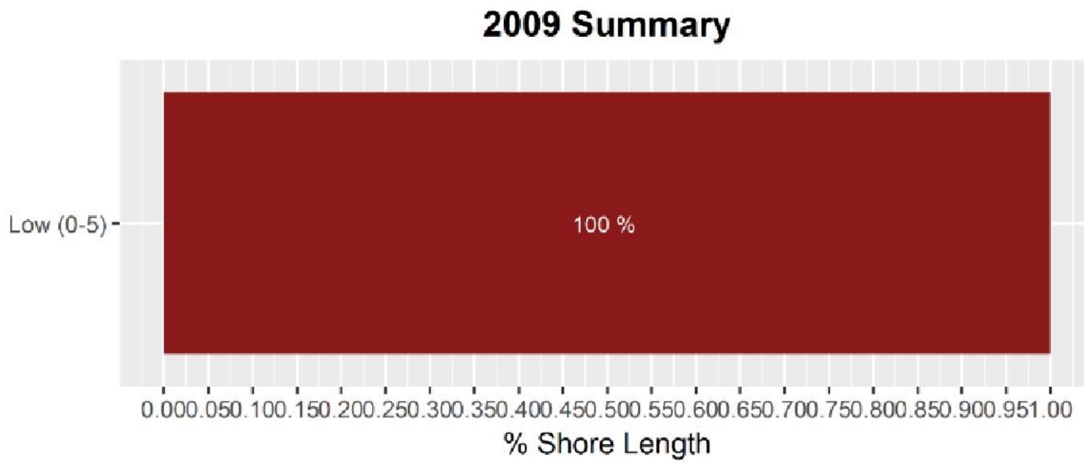

2016 Summary
% Natural
% Disturbed
100 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

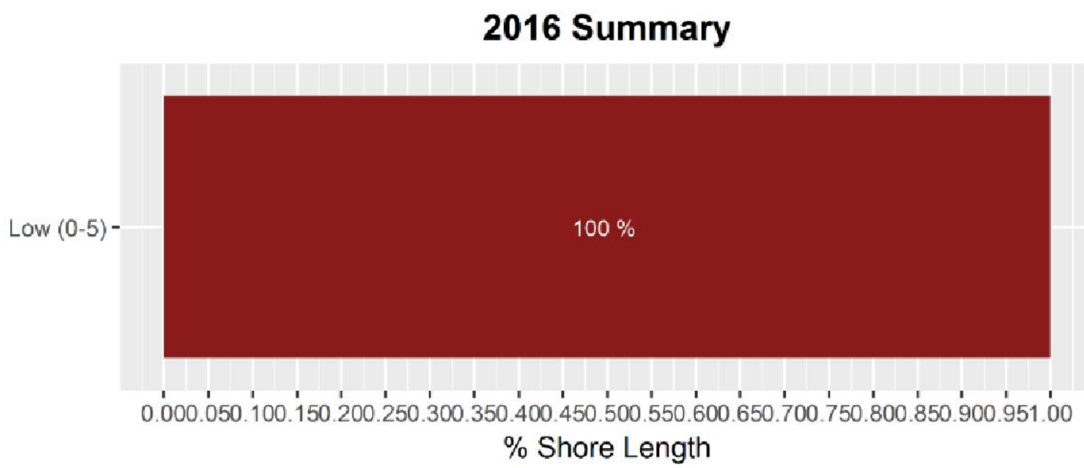

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
25.7 %
74.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

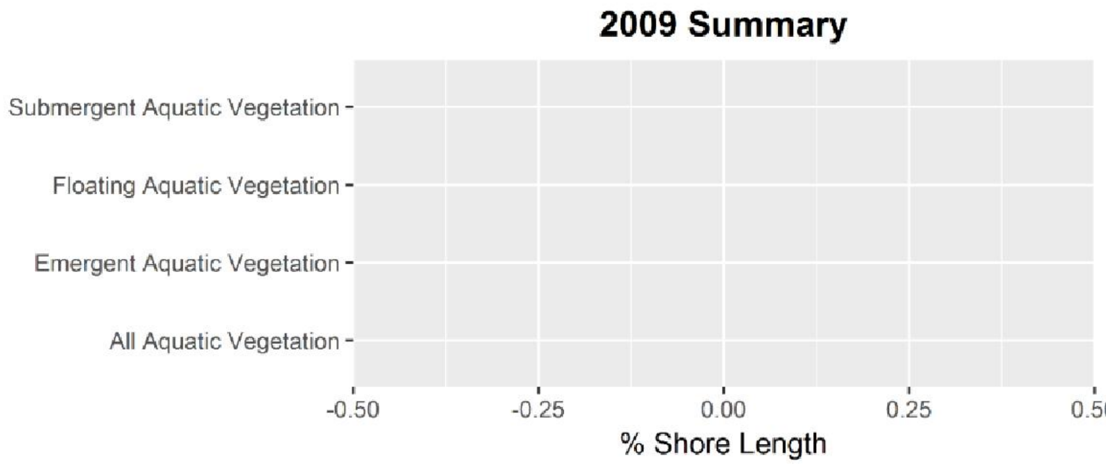

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
25.7 %
74.3 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75
% Shore Length

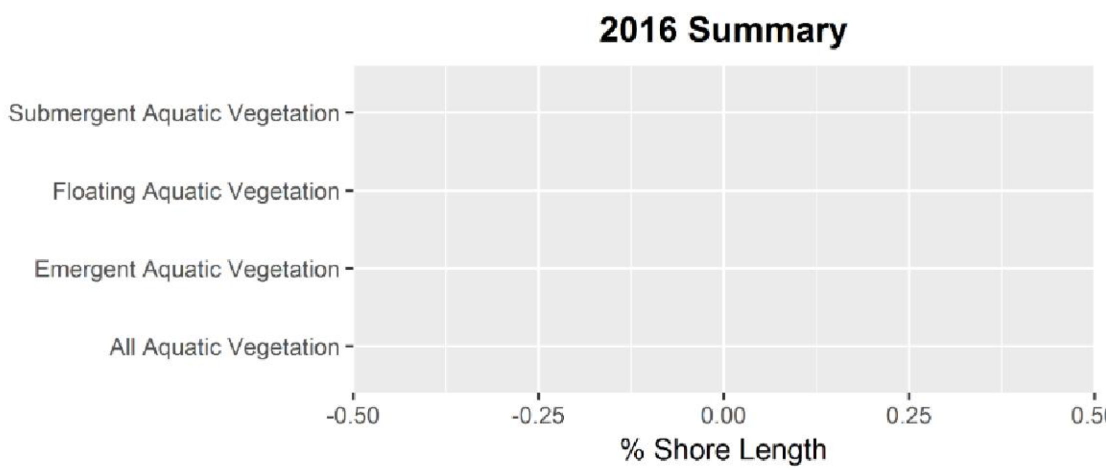

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
57.1 %
42.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

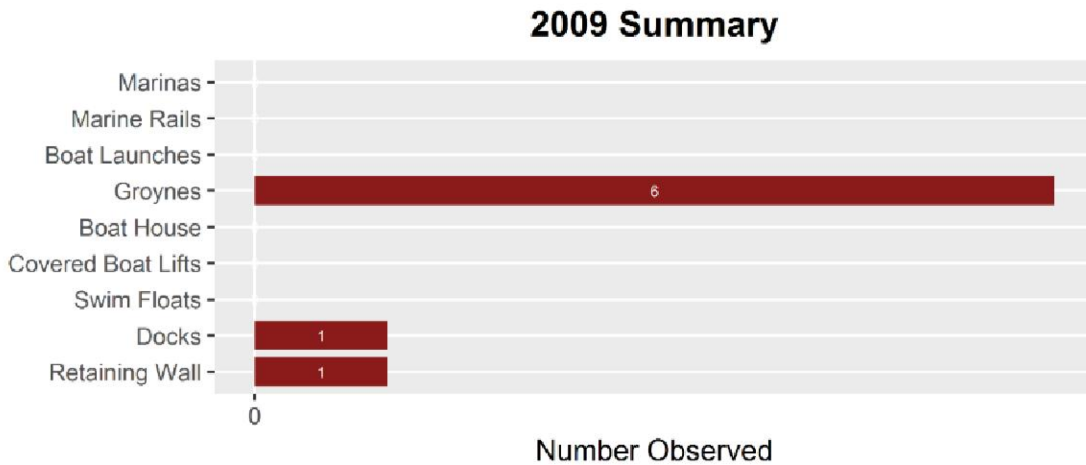

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
57.1 %
42.9 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

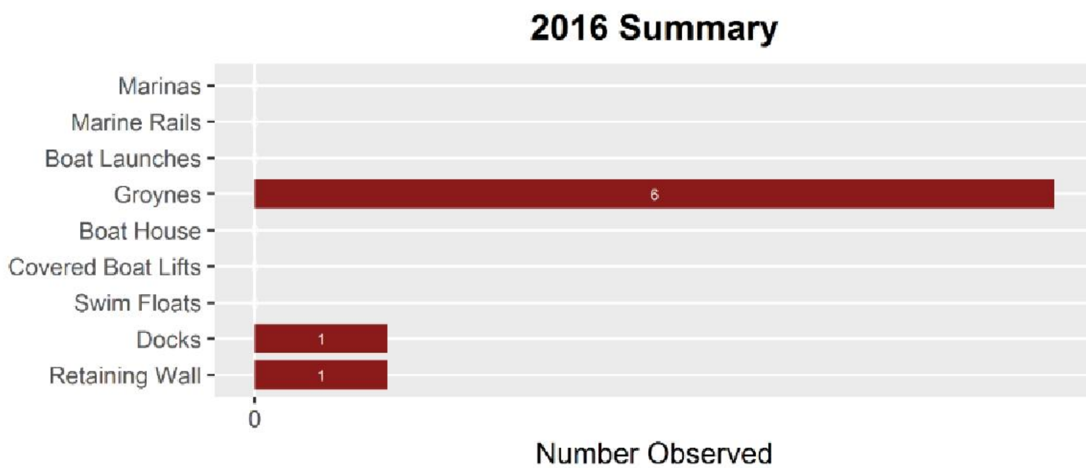

2009 Summary
Low (0-5)
100 %
0.000.050.100.150.200.250.300.350.400.450.500.550.600.650.700.750.800.850.900.951.00
% Shore Length

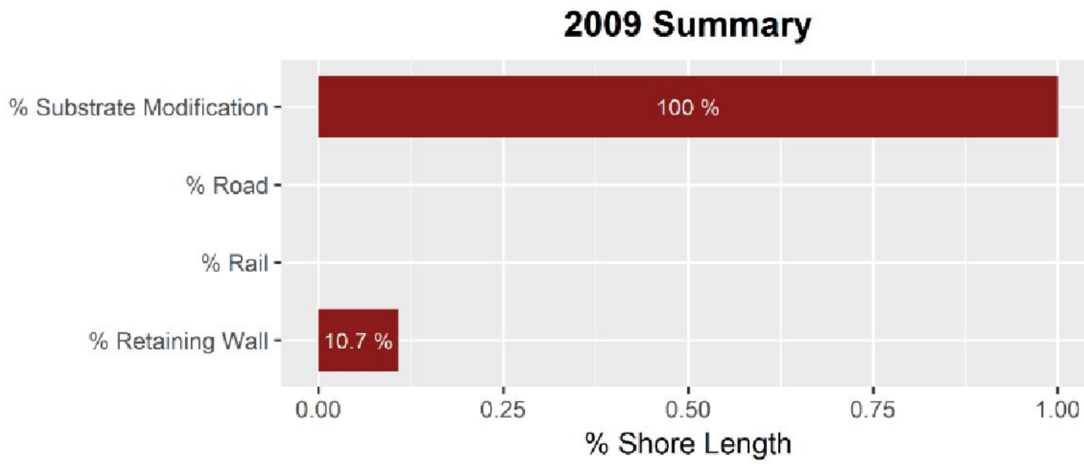

2016 Summary
Low (0-5)
100 %
0.000.050.100.150.200.250.300.350.400.450.500.550.600.650.700.750.800.850.900.951.00
% Shore Length

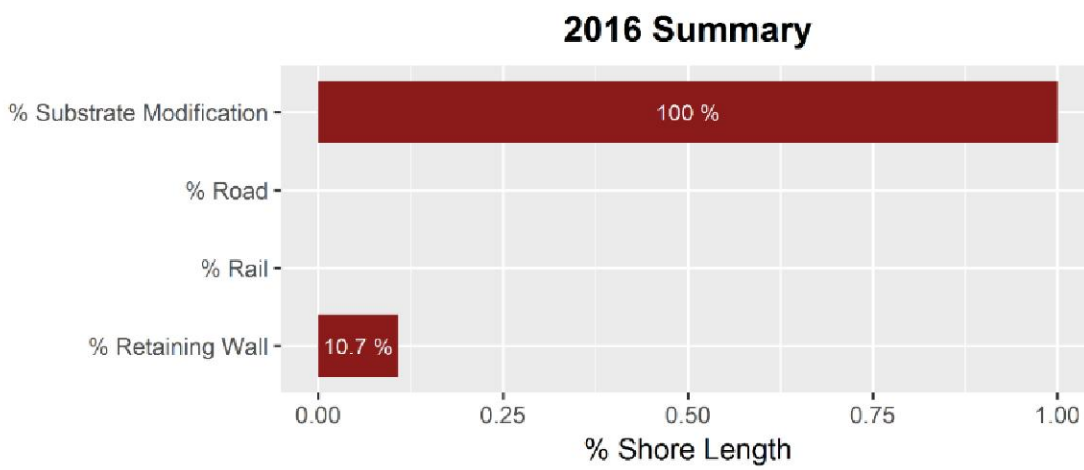

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
-0.50
-0.25
0.00
0.25
0.50
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
-0.50
-0.25
0.00
0.25
0.50
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
6
Boat House
Covered Boat Lifts
Swim Floats
Docks
1
Retaining Wall
1
0
Number Observed

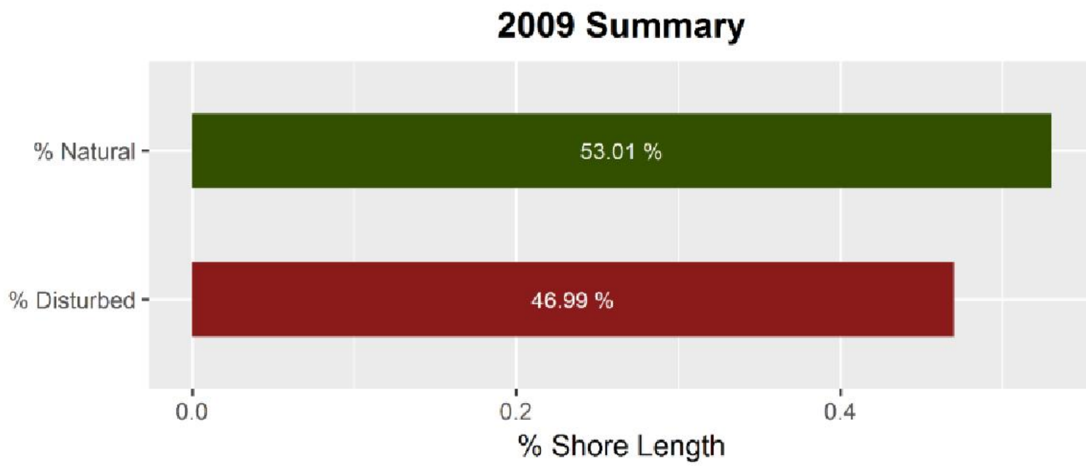

2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
6
Boat House
Covered Boat Lifts
Swim Floats
Docks
1
Retaining Wall
1
0
Number Observed

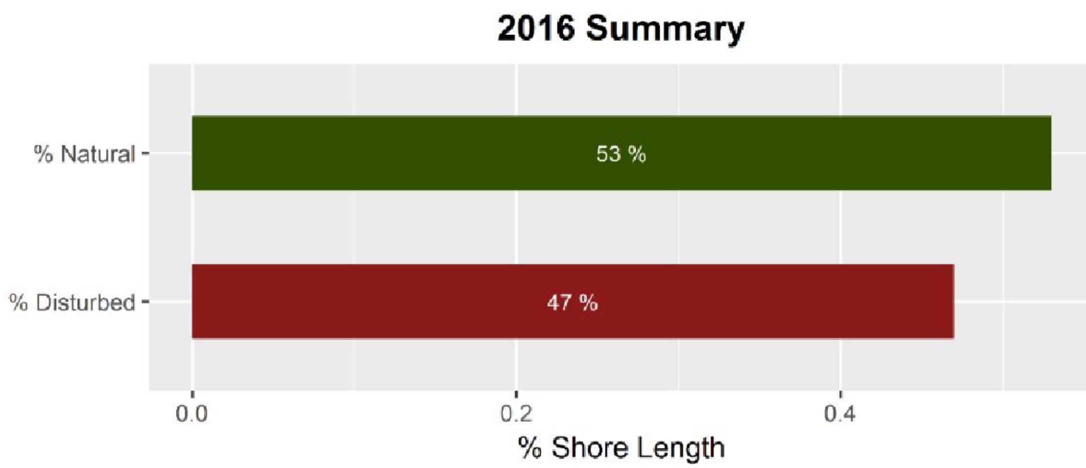

2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
100 %
10.7 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

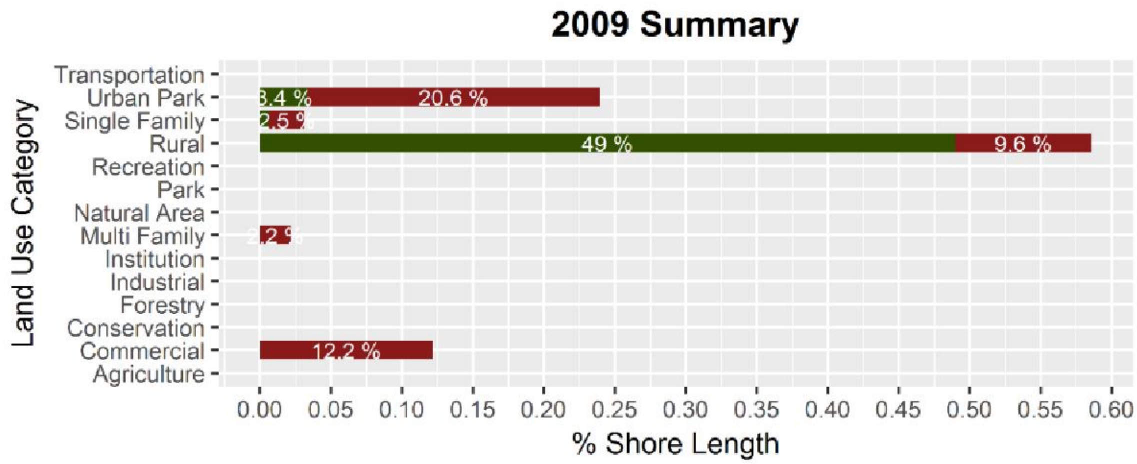

2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
100 %
10.7 %
0.00
0.25
0.50
0.75
1.00
% Shore Length

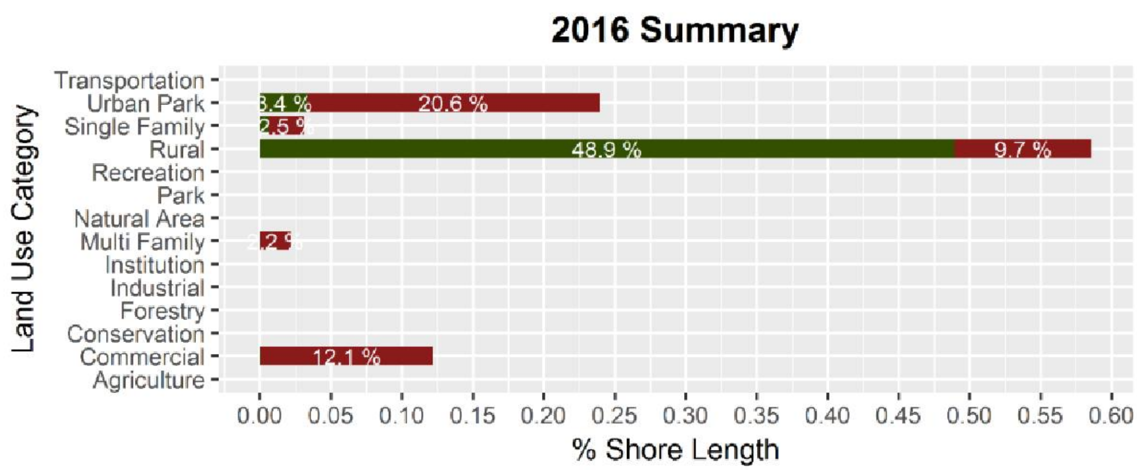
APPENDIX M

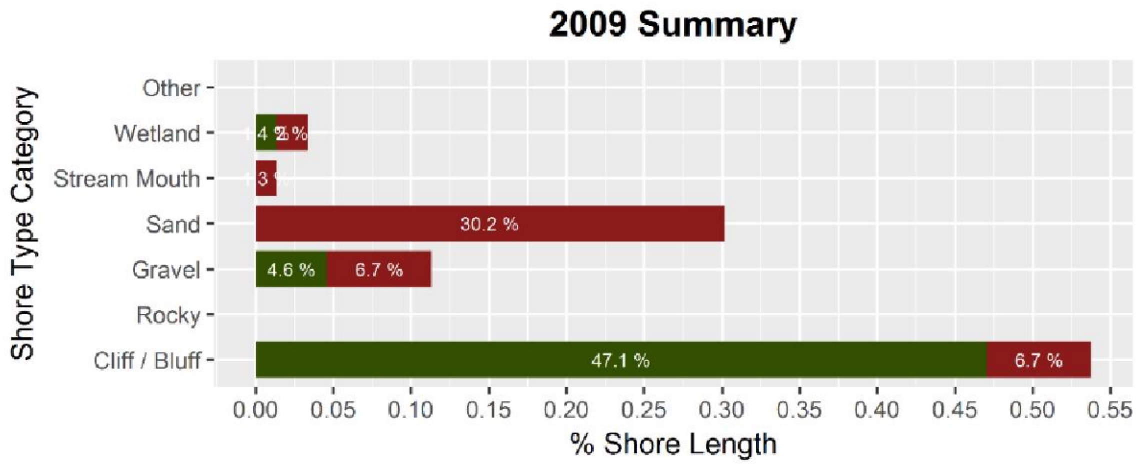
CITY OF PENTICTON DATA SUMMARY

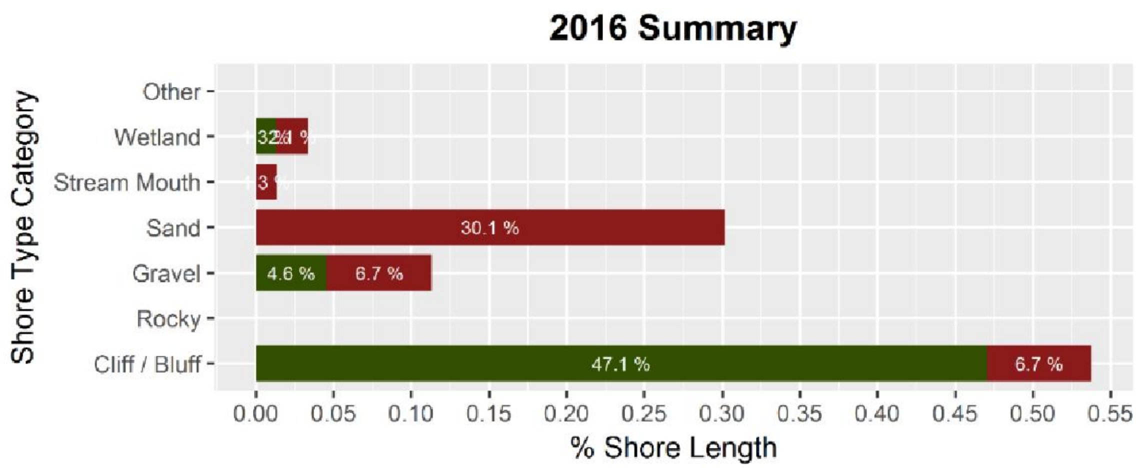

2009 Summary
% Natural
% Disturbed
53.01 %
46.99 %
0.0
0.2
0.4
% Shore Length

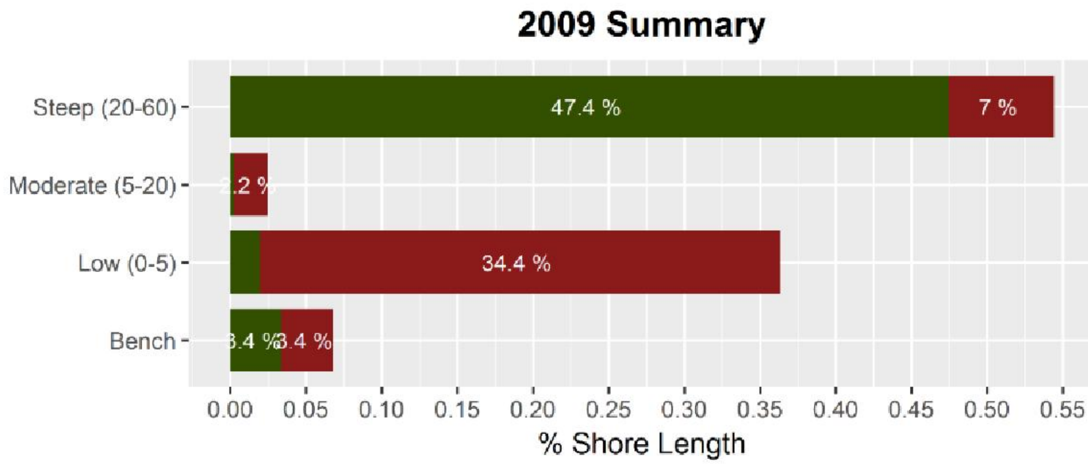

2016 Summary
% Natural
% Disturbed
53 %
47 %
0.0
0.2
0.4
% Shore Length

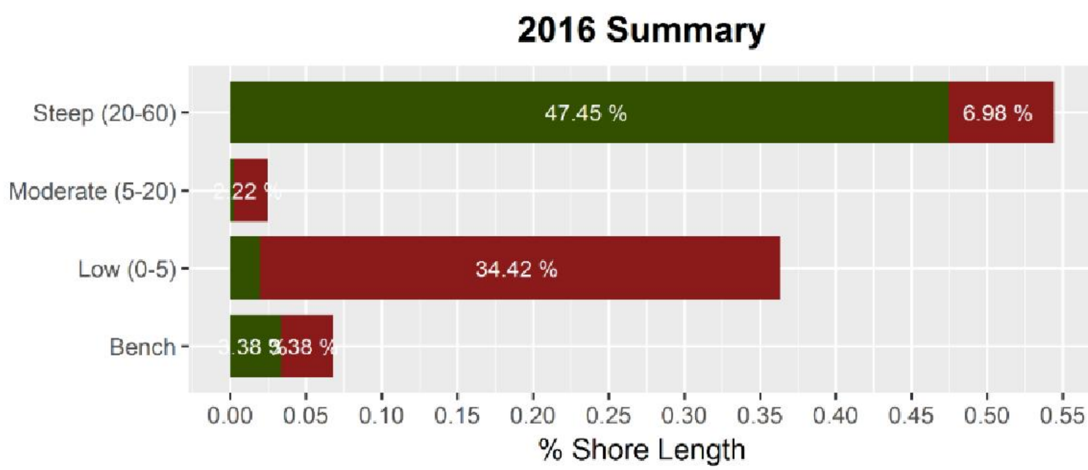

2009 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
20.6 %
49 %
9.6 %
12.2 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

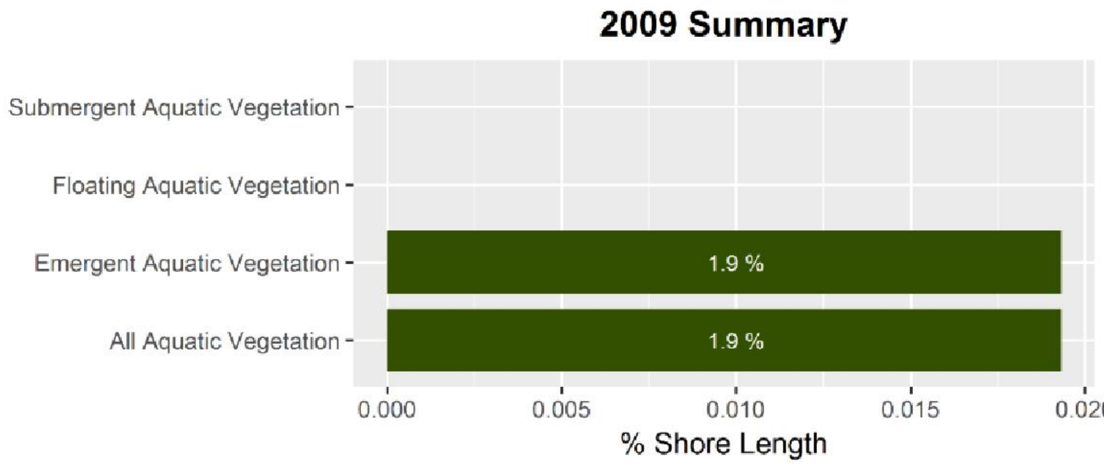

2016 Summary
Land Use Category
Transportation
Urban Park
Single Family
Rural
Recreation
Park
Natural Area
Multi Family
Institution
Industrial
Forestry
Conservation
Commercial
Agriculture
20.6 %
48.9 %
9.7 %
12.1 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60
% Shore Length

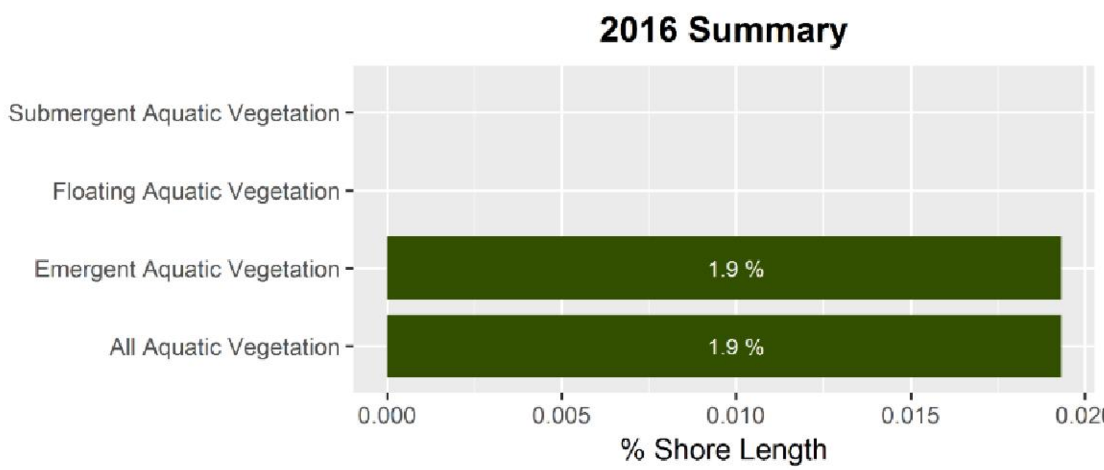

2009 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
30.2 %
4.6 %
6.7 %
47.1 %
6.7 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

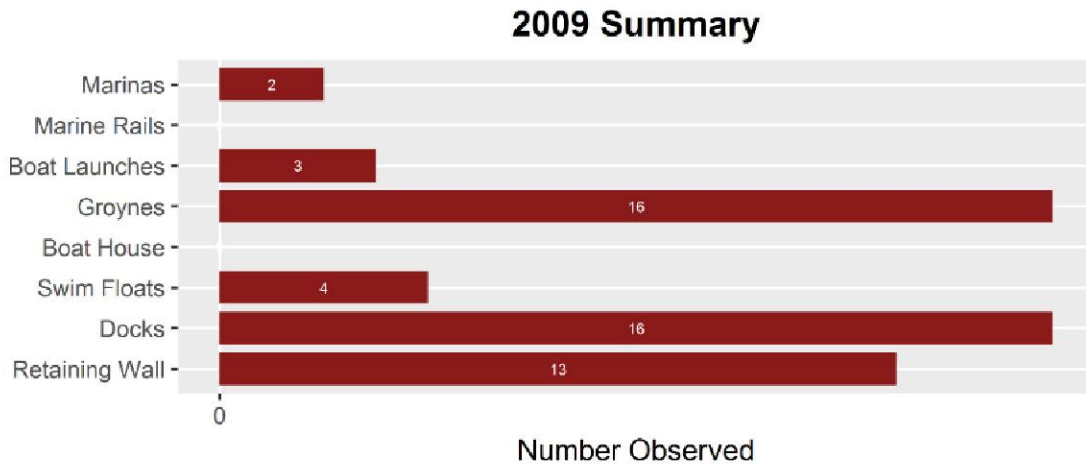

2016 Summary
Shore Type Category
Other
Wetland
Stream Mouth
Sand
Gravel
Rocky
Cliff / Bluff
30.1 %
4.6 %
6.7 %
47.1 %
6.7 %
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55
% Shore Length

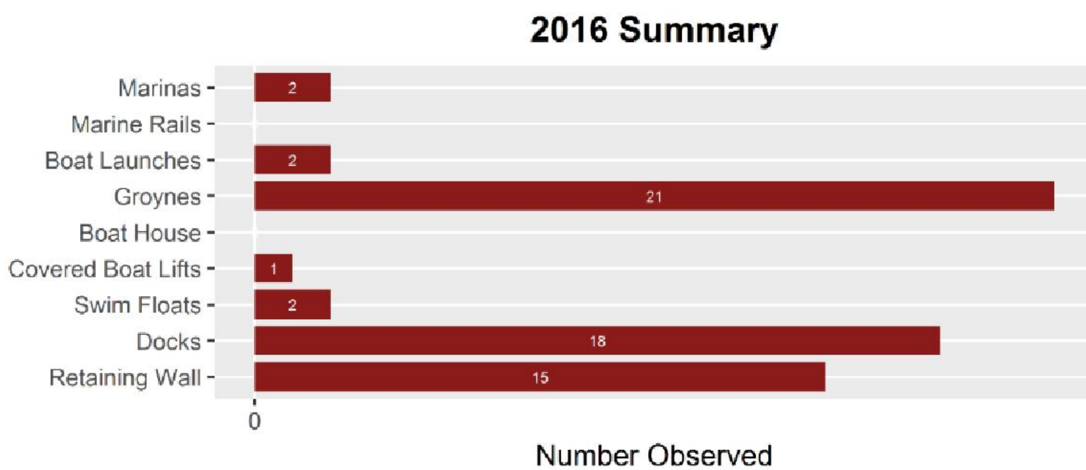

2009 Summary
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
47.4 %
7 %
34.4 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
% Shore Length

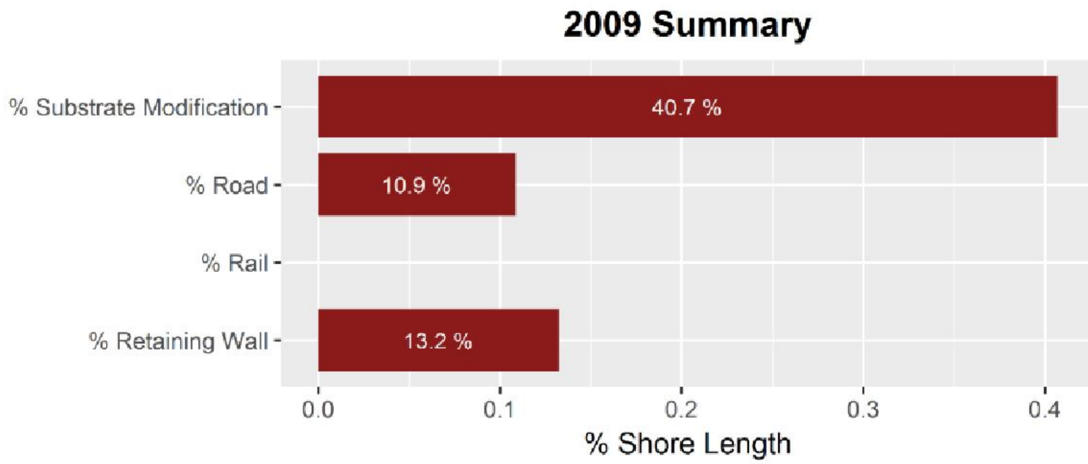

2016 Summary
Steep (20-60)
Moderate (5-20)
Low (0-5)
Bench
47.45 %
6.98 %
34.42 %
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
% Shore Length

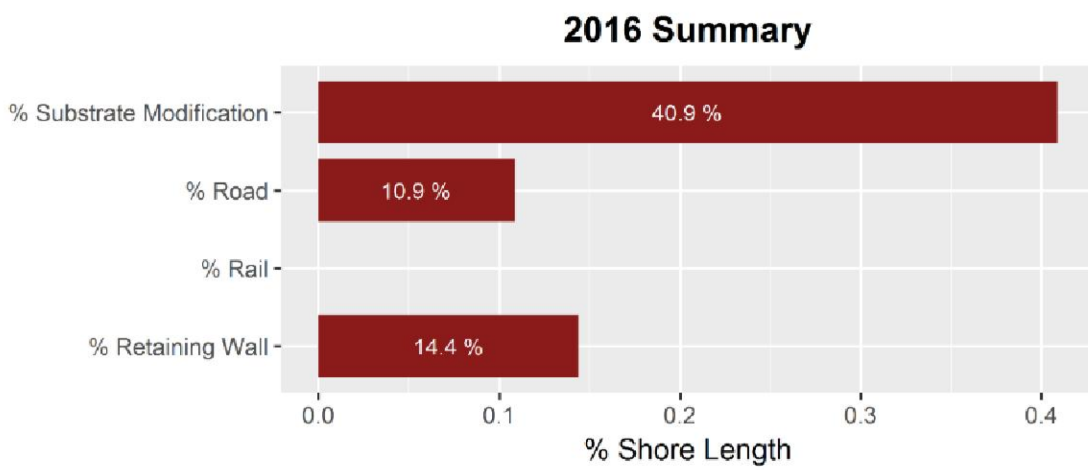

2009 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
1.9 %
1.9 %
0.000
0.005
0.010
0.015
0.020
% Shore Length


2016 Summary
Submergent Aquatic Vegetation
Floating Aquatic Vegetation
Emergent Aquatic Vegetation
All Aquatic Vegetation
1.9 %
1.9 %
0.000
0.005
0.010
0.015
0.020
% Shore Length


2009 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Swim Floats
Docks
Retaining Wall
2
3
16
4
16
13
0
Number Observed


2016 Summary
Marinas
Marine Rails
Boat Launches
Groynes
Boat House
Covered Boat Lifts
Swim Floats
Docks
Retaining Wall
2
2
21
1
2
18
15
0
Number Observed


2009 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
40.7 %
10.9 %
13.2 %
0.0
0.1
0.2
0.3
0.4
% Shore Length


2016 Summary
% Substrate Modification
% Road
% Rail
% Retaining Wall
40.9 %
10.9 %
14.4 %
0.0
0.1
0.2
0.3
0.4
% Shore Length