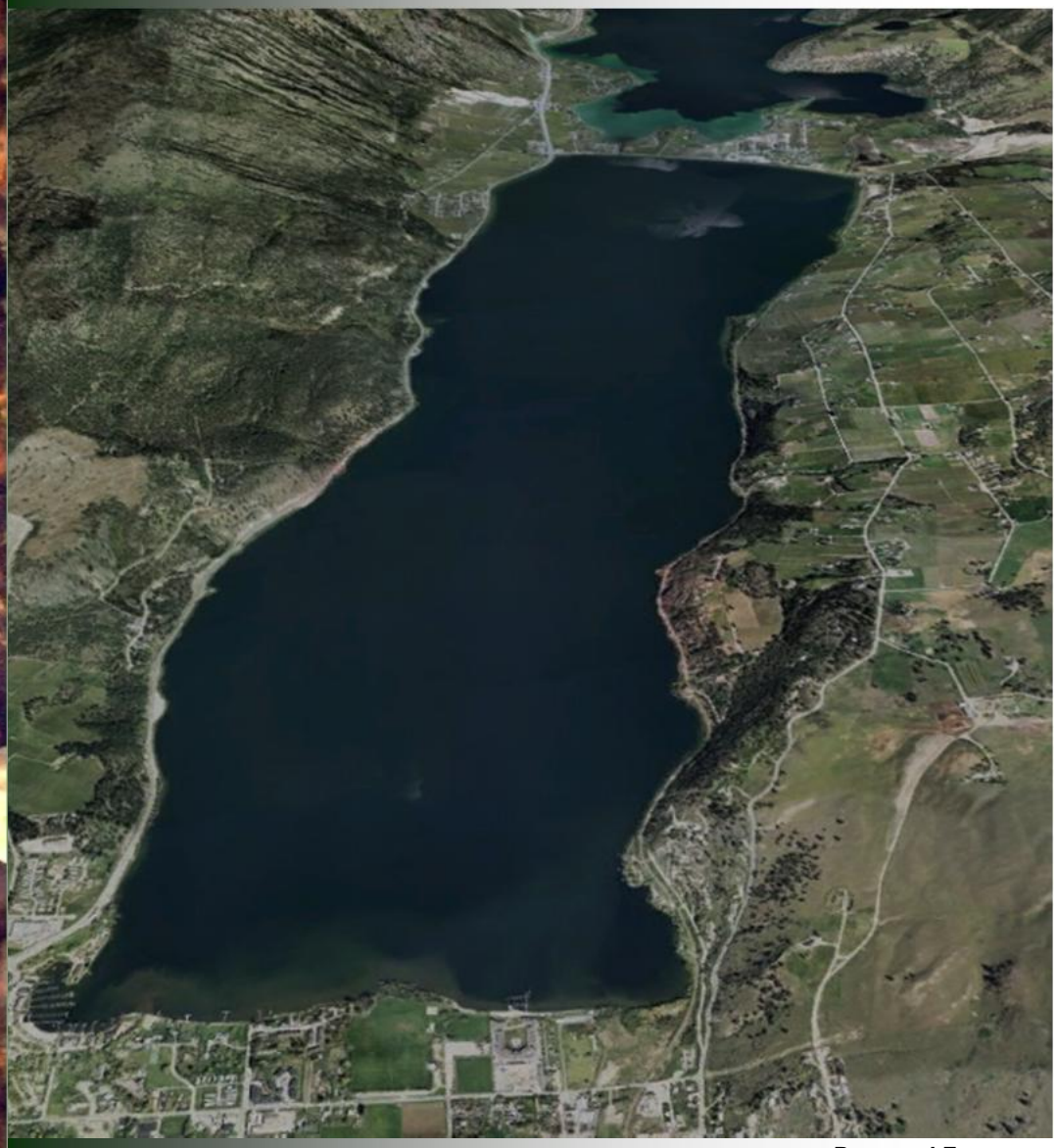
Wood Lake
Aquatic Habitat Index



Prepared For:
Okanagan Collaborative Conservation Program

Prepared By:
ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.

December 2012
File No.: 12-950

AQUATIC HABITAT INDEX

Okanagan Collaborative Conservation Program

Wood Lake

Prepared For:

OKANAGAN COLLABORTIVE CONSERVATION PROGRAM

Prepared By:

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

December, 2012

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EXECUTIVE SUMMARY

Throughout the first years of the new millennium, the Okanagan Basin, including Wood Lake, has experienced intensive development activity. As the population within the Central Okanagan region has grown, development has spread to more rural areas. It is becoming readily apparent that the increased development is degrading shoreline areas along the lake, which is known for its natural beauty and high recreational values. Wood Lake is arguably the most popular lake among sport fisherman for kokanee and rainbow trout in the Okanagan Valley. Development pressure has resulted in impacts to fish and wildlife habitat, important terrestrial communities, wetlands, and water quality. The spread of development to more remote areas is the result of an increasing demand for lakeside property and year round residences with better overall servicing. For less developed areas, now is an opportune time to address lakeside development concerns to better manage future shoreline impacts.

In response to the need for better and more collaborative lake planning and management, the Okanagan Conservation Collaborative Program, with support of local governments, non-governmental organizations (NGO's) and the Okanagan Basin Water Board, initiated a process to document the current condition of the foreshore and to help develop a more integrated approach to watershed management. This work was a continuation of previous projects initiated in the Central Okanagan. This report has been prepared based upon the belief that it is possible to manage this shoreline and the natural areas surrounding it in a sustainable manner.

Wood Lake contains numerous fish stocks that are important public resources. The most important fish stock is kokanee, a land-locked sockeye salmon. This fish is considered a keystone species because of its many interactions with other species. Kokanee are a critical fall food source for bears, eagles, Osprey, and other species and the carcasses of spawning adults provide fertilizer for terrestrial and aquatic ecosystems. Salmon are also an indicator species for the overall health of the ecosystem because they are highly sensitive to changes in their habitat (e.g., reductions in water quality). Other important fish stocks include rainbow trout and lake trout.

Currently, many lake management projects in the province of BC follow a three step process described below. For this project, step 1 was completed previously and a separate report was prepared. Step 2 is the focus of this report:

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 resources such as previous fisheries inventories, recent orthophotos, and other information. FIM has already been completed for Wood Lake and was described in a summary report completed in March 2010.

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 and Okanagan Lake and is similar to other ongoing assessments along lakes in the Kootenays. The AHI 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 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. The AHI categorizes 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 Wood Lake to each other and not to other lakes (e.g., Kalamalka or Okanagan Lake). The AHI is the focus of this report.

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 AHI 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, marinas, etc.) in the different shore segments. The Shoreline 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. These management guidelines would integrate management objectives and provide a unified framework for future development proposals along the shoreline.

At this time, there are different shoreline policy documents that have been prepared in response to significant development pressure. At the provincial level, the Okanagan Large Lakes Protocol was prepared and this document provides a framework for management of kokanee and the Western ridged mussel. Other guidance is provided in the District of Lake Country Official Community Plan and environmental policy from the Central Okanagan Regional District (RDCO). Currently, there is not a unified framework or policy that is being utilized by local, provincial, and federal governments in management systems.

Aquatic Habitat Index

The Aquatic Habitat Index (AHI) for WoodLake provides valuable information regarding the estimated habitat values of different shoreline areas. The AHI is a categorical scale of relative habitat value that ranks shoreline segments in a range between Very High and Very Low (Very High, High, Moderate, Low, and Very Low). The index is relative, because it only assesses the sensitivity of one shoreline area relative to another within Wood Lake and is not directly transferable to other lake systems. The following provides a definition for each AHI ranking:

1. Very High - Areas classified as Very High are considered integral to the maintenance of fish and wildlife species and these areas generally occur in either important floodplain locations, areas adjacent to salmonid spawning, or wetland habitats. These areas should be considered the highest priority for conservation and protection.

2. High Value Habitat Areas - Areas classified as High Value are considered to be very important to the maintenance of fish and wildlife species around the lake; these areas can be ranked as high for a variety of reasons. The priorities for High Value areas should be to maintain current conditions and to promote conservation of these areas.

3. Moderate - Areas classified as Moderate are common around the lake, and have likely experienced some habitat alteration. These areas may contain important habitat areas, such as shore spawning kokanee habitats, but overall moderate areas are generally considered more appropriate for development. Because areas of high habitat value may be present, caution should be taken when considering changes in land use to avoid unnecessary harm or degradation to existing habitat values.

4. Low - Low value habitat areas are generally highly modified. These areas have been impaired through land development activities. Development within these areas should be carried out in a similar fashion as Moderate shoreline areas. However, restoration objectives should be set higher in these areas during redevelopment.

5. Very Low - Very Low habitat areas are extremely modified segments that are not adjacent to any known important habitat characteristics.

The following summarizes the results of the AHI analysis:

- Approximately 62% of the combined shoreline is ranked as High or Very High. Many of these areas occur adjacent to important kokanee spawning areas, stream confluences or wetlands, or were associated with gravel and rocky shorelines with aquatic vegetation in a natural state. The abundant high value habitat present is related to the significance and high proportion of rare communities and sensitive fish habitats in the lake.

- Approximately 27% of the shoreline was Moderate habitat value. Moderate habitat value areas are typically associated with sand or gravel shorelines that have experienced some level of habitat alteration due to previous development.

- Approximately 11% of the shoreline is ranked as Low or Very Low Habitat Value. These areas occur in most intensely developed areas that are not adjacent to any known values of importance.

- All shoreline types are considered salmonid habitat (e.g., staging areas, rearing areas, spawning habitats, or general living). For instance, segments identified as having low juvenile habitat suitability still contribute to overall salmonid production in the lake. Further, there are some instances where high value habitats are embedded within shore line areas of moderate value (e.g., a kokanee Black Zone in a segment ranked as Moderate by the AHI) and these critical habitat areas must be considered independently of the AHI ranking because of their high value. The Okanagan Large Lakes Protocol is a provincial guidance document that addresses color zones on large lakes in this region.

- The AHI highlights the importance of the connection between our diverse streamside, wetland and lakeshore habitats, and important terrestrial upland areas. Stream confluences and their adjacent features (e.g., shore marshes, large woody debris, and diverse riparian vegetation communities) are areas that tend to contain the highest fish and wildlife diversity. These areas are extremely important for maintaining viable populations, and most importantly are water quality buffers that are required to preserve source drinking waters.

- A restoration analysis was completed by removing instream features. This analysis was accomplished by removing negative habitat parameters in the index and assessing which segments increased in relative habitat value. The restoration analysis does not assess how changes in riparian condition would improve relative habitat value, but does indicate opportunities to repair impacted instream habitats. Habitat restoration opportunities include removal of groynes, bioengineering retaining walls, planting native riparian vegetation, etc. Habitat improvements will help reverse the current trends of habitat degradation that were observed. It is recommended that habitat restoration opportunities be pursued as part of any development or redevelopment applications.

Recommendations have been presented that are intended to aid foreshore protection, guide future data management, and for future biophysical inventory works. A key recommendation is that:

- Shoreline Management Guidelines are the final step in the three step shoreline management process. This inventory and cumulative analysis of Wood Lake provides the framework for development of management policies that can be integrated between local, provincial, and federal governments. Shoreline Management Guidelines are currently in place for Wood Lake (Okanagan Large Lakes Protocol (OLLP)), but these guidelines generally only consider critical kokanee shore spawning areas, Western Ridge mussel locations, and a few other items (e.g., stream deltas and rare plants). Numerous local governments also have shoreline policies, but these policy documents are not integrated with the OLLP resulting in proponent confusion. Within the Shuswap system, the AHI, and layers such as those in the OLLP (e.g., Kokanee spawning layers) are used together to develop shoreline guidelines. The results of this assessment could be considered an important addition as a data layer to the OLLP. These guidelines can be used to develop shoreline policies and regulations that are integrated between different levels of government. Once adopted, the guidelines will assist decision makers when making land use decisions across multiple agencies. Guidelines will also streamline the permitting and regulatory processes by focusing limited resources on areas or activities that pose the greatest risk by allowing lower risk activities to proceed without the involvement of Fisheries and Oceans Canada.

The analysis completed as part of this study is expected to aid in the protection of important shoreline resources around Wood Lake. The AHI is intended as a landscape level protection tool for planning purposes rather than a site specific tool. Although many impacts were observed along the lake shoreline, it is important to note that there are extremely important habitats present that are in good to excellent condition. The value of this work will be especially important in any shoreline land use and marine development proposals because it will help ensure appropriate management of the vast biodiversity of the Wood Lake shoreline.

ACKNOWLEDGEMENTS

This project was made possible through funding from the Okanagan Basin Water Board (OBWB) and both funding and in kind donations of partners within the Okanagan Collaborative Conservation Program (OCCP)

The OCCP Action team formed from OCCP partners and affiliates to coordinate this project and other FIM projects underway within the Okanagan Valley. The OCCP FIM/AHI Coordinator Member contractor was Susan Latimer. The Action team members included representatives of District of Lake Country (Carie Liefke), Society for the Protection of Kalamalka Lake (Trina Koch), Regional District of the North Okanagan (Anna Page), District of Lake Country, Community Mapping Network/ Fisheries and Oceans Canada (Brad Mason), the OBWB and the Okanagan Indian Band (Keith Louis). Lora Nield of the Ministry of Forests, Lands and Natural Resource Operations and Bruce Runciman of Fisheries and Oceans Canada were advisors on the AHI.

The following parties carried out or organized fieldwork for the FIM assessment and the FIM data has been used for this project:
Ministry of Environment Kristina Robbins, Ecosystems Biologist, Brian Robertson, Ecosystems Biologist, & Brent Smith, Conservation Officer
Community Mapping Network/ Fisheries and Oceans Canada (DFO), Brad Mason & Kevin Tai
District of Lake Country, Shane Cote, Planner
Regional District North Okanagan, Jennifer de Groot

The following Sensitive Ecosystem Inventory (SEI) reports were referenced during the AHI analysis:

Iverson, K. and P. Uunila. 2008. Sensitive Ecosystems Inventory: Coldstream – Vernon, 2007.
Iverson, K. and P. Uunila. 2006. Sensitive Ecosystems Inventory: Lake Country, 2005.

The author of this report was:
Jason Schleppe, M.Sc., R.P.Bio. (Ecoscape)

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

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

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DISCLAIMER

The results contained in this report are based upon data collected during field surveys occurring over a short duration. Biological systems respond differently both in space and time and exhibit extreme variability. For this reason, conservative assumptions have been used and these assumptions are based upon field results, previously published material on the subject, and air photo interpretation. Due to the inherent problems of brief inventories (e.g., property access, GPS/GIS accuracies, air-photo interpretation concerns, etc.), professionals should complete their own detailed assessments of shore zone areas to understand, evaluate, classify, and reach their own conclusions regarding them. Data in this assessment was not analyzed statistically and no inferences about statistical significance should be made if the word significant is used. Use of or reliance upon conclusions made in this report is the responsibility of the party using the information. Neither Ecoscape Environmental Consultants Ltd., project partners, nor the authors of this report, are liable for accidental mistakes, omissions, or errors made in preparation of this report because best attempts were made to verify the accuracy and completeness of data collected and presented.

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1.0 INTRODUCTION

The Okanagan Valley has a long history of being a popular location for both tourism and settlement. Wood Lake, located centrally in the valley in the community of Lake Country and the Central Okanagan Regional District, is one of the significant large lakes that are present in the region. As a result, the natural environment surrounding the Wood Lake sub basin has been subject to pressure from various types of land use including: residential and rural development, recreation, regional infrastructure and agriculture. The Okanagan Collaborative Conservation Program (OCCP) and project partners have undertaken a number of planning initiatives to facilitate better information sharing and develop land use policies in the Okanagan Valley. Through these planning processes and initiatives, it can be concluded that past development along Wood Lake has impacted fish, wildlife, rare plants and terrestrial communities, and/or water quality. As a result of these impacts, project partners are working cooperatively to prevent future impacts to the lake and foreshore.

A complex relationship exists between development pressure, the natural environment, and social, economic and cultural values. In an effort to balance these various community values, a solid understanding of aquatic and riparian resources, land use interests, and community concerns is needed to formulate long-term planning and policy objectives. Development of long-term planning objectives at the local, provincial and federal levelis also required so that our aquatic resources are effectively managed in a collaborative framework. Detailed shoreline inventories increase our knowledge and inventory of the environmental resources that are present, allowing stakeholders to gain a better understanding of how development may affect these habitat features. This information can result inbetter informed land use planning decisions.

Of particular importance and the focus of this report, is the link between the aquatic and terrestrial environments along Wood Lake. The foreshore – that part of the shore between the high and low water marks – provides a number of social, environmental and economic benefits and is important to several different interest groups. In this report, foreshore and shoreline are used somewhat synonymously. The shoreline, or the area that occurs in proximity to the lake (e.g., within 50 m) through the foreshore to the end of the littoral zone (area of greatest biological productivity), is also extremely important.

Regulators at all levels of government are becoming increasingly aware of the importance of managing our watersheds in a sustainable manner. Landowners and the general public are often concerned about local watersheds and may not understand how these environments are being managed. Current management practices being implemented in the Shuswap and Kootenay regions use a three step process. The goal of this process is to help integrate available environmental data (both quantitative and qualitative) with land use planning information to facilitate review and decision making processes at all levels of government. The specifics for implementation vary by region, but generally utilize this process.This study has resulted in two of three steps having been completed with the third and final step outstanding at this time. The three steps include:

1. Foreshore Inventory and Mapping (FIM) – FIM is a broad scale inventory process that defines and describes the shoreline condition of large and small lake systems. The inventory provides baseline information regarding the current condition, natural features of the shoreline, and its level of development or impact (e.g., # of docks, groynes, etc.). Data collection allows managers and the public to monitor shoreline changes over time and to measure whether proposed land use decisions are meeting their intended objectives. FIM was completed for Wood Lake earlier this year and the results of the FIM project have already been discussed under separate cover (Ecoscape 2010). This baseline inventory provides sufficient information to facilitate identification of sensitive shoreline segments as part of step 2 below.

2. Aquatic Habitat Index or Ecological Sensitivity Index (AHI) – The AHI utilizes data collected during the FIM, additional field reviews, and other data sources (e.g., Land and Resource Data Warehouse, previously published works, etc.) to develop and rank the sensitivity of the shoreline using an index. An index is defined as a numerical or categorical scale used to compare variables with one another or with some reference point. In this case, the index is used to compare the sensitivity of the different shoreline areas around the lake to other shoreline areas within the lake (i.e., the index compares the ecological or aquatic sensitivity of different shoreline areas within the lake system to each other rather than to other lake shorelines).While the index does provide an indication of the relative value of one shoreline area to another, it does not compare these shorelines with shorelines on other lake systems and is not directly transferable. The AHI index is the focus of this report.

3. Development of Shoreline Management Guidance Documents - Guidance documents are the final step in the process. Guidance documents are intended to help land managers at all levels of government quickly assess development applications. They are intended to be the first step for review, planning, and prescribing shoreline alterations (i.e., land development) by applicants and review agencies. At this time, the Okanagan Region Large Lakes Foreshore Protocol (OLLP) is the guidance document for Wood Lake at the provincial level. This document identifies known kokanee spawning areas, known western ridge mussel locations, and stream deltas as sensitive features. This policy document is only applicable to works occurring below the high water level (HWL). Local governments also have a variety of different policy documents that govern land uses above the HWL, including Official Community Plans and Bylaws. At this time, there is not a common understanding of lakeshore sensitivity, which makes the development of integrated governmental policy difficult. The works contained within this assessment provide a framework for an integrated shoreline policy document. The outcomes of this assessment should be integrated into the OLLP and local government policies when time and budgeting permits in a

formal guidance document. It is expected that implementing this work into a new guidance document will facilitate better decision making across all levels of government because the OLLP is not currently used in local government policies as it pertains largely to structure below the HWL. Another benefit is that this study considers numerous other biological criteria (e.g., wetlands and shore marshes, aquatic vegetation, adjacency to sensitive terrestrial features as identified by the Sensitive Ecosystem Inventory (SEI), migration and staging areas, etc.) that are not currently being considered in the OLLP or within a regional approach to shoreline management. Thus, incorporation of this assessment will be more inclusive of sensitive shoreline areas if it can be integrated into the existing OLLP in some fashion. A biodiversity strategy is currently being developed for the Okanagan Region; the AHI could be incorporated into the biodiversity strategy at the landscape planning level.

This report presents Step 2 for Wood Lake. Development of a Lake Shoreline Guidance document will help facilitate integration of this work with the OLLP for Wood Lake. In the absence of a formal shoreline guidance document, the OLLP is considered the guiding policy document for features below the HWL (instream).

2.0 PROJECT OVERVIEW

Wood Lake serves an important function ecologically and is considered the most productive wild kokanee lakes in the province of British Columbia (D. Sebastian as cited in Askey and Andrusak 2010). Wood Lake supports a popular sport fishery for both kokanee (*Oncorhynchus nerka*) and rainbow trout (*O. mykiss*). Species known to occur in Wood Lake include kokanee, rainbow trout, cutthroat trout (*O. clarki*) and lake trout (*Salvelinus namaycush*), among others. Many wildlife species also use the lake and associated riparian habitat; for these reasons, protection of the various environmental values is extremely importantand integral to a functional lake and watershed.

Despite the value of Wood Lake to local sport fisherman, there is a lack of information on the sustainability of a kokanee fishery in Wood Lake. According to the Okanagan Region Large Lakes Fisheries Operational Management Plan (Redfish Consulting Ltd. 2007), there is a need for data to manage the lake and its fish population as potential overharvest of kokanee is a concern. Wood Lake reportedly suffers from water quality and water supply issues because of pressure from agriculture, residential development and water consumption. Both Wood and Okanagan Lake were ranked as a high priority in the management plan with respect to critical issues but Wood Lake was regarded as the highest priority overall because funding already exists to address some of the more critical issues at Okanagan Lake (Redfish Consulting Ltd. 2007).

The methodology employed for this assessment is discussed in detail below and is consistent with provincial standards being used to map and evaluate other shorelines in the province. The mapping protocol will allow stakeholders to understand current

shoreline conditions, set objectives for better shore management, and measure and monitor changes in the shoreline over time.

This project is a two part process:

- Gather information from existing FIM completed in 2009/2010 and other data sources (Okanagan Large Lakes Protocol mapping and Sensitive Ecosystem Inventory) and organize the data so that it can be input into an AHI; and
- Develop an AHI and rank the relative sensitivity of the shoreline of Wood Lake.

2.1 Project Partners

Numerous parties have contributed to the success of this project. FIM and AHI protocols have been developed over the last 7 years and have become a standardized approach to shoreline inventory that has been used in numerous watersheds and lakes in the southern interior of BC (e.g., Shuswap, Mabel, Moyie, Monroe, Jimsmith, Windermere, etc.). Numerous local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the AHI and each of these agencies and professionals acknowledge that the concept and method should continue to be developed and improved as part of an adaptive management program.

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

1. Okanagan Collaborative Conservation Program;
2. Okanagan Basin Water Board (OBWB);
3. Society for the Protection of Kalamalka Lake;
4. District of Coldstream;
5. District of Lake Country; and
6. Regional District of North Okanagan.

2.2 Objectives

The following are the objectives of this project:

1. Reference existing resource information for Wood Lake that was summarized in previous FIM (Ecoscape 2010);
2. Foster collaboration among the local governments (Regional District of North Okanagan, District of Lake Country, District of Coldstream), DFO local staff, MFLNRO, Non-governmental organizations (NGO), First Nations Groups, and nearby communities;

3. Provide a summary of foreshore habitat condition on the lake;

4. Collect information that will aid in prioritizing critical areas for conservation and or protection and lakeshore development;

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

6. Develop an AHI that ranks the sensitivity of shoreline areas relative to each other;

7. Provide a "flagging tool" based upon information currently available;

8. Provide a framework and common understanding of the sensitive areas of Wood Lake as a whole to facilitate improved resource management;

9. Provide a baseline data set for Wood 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;

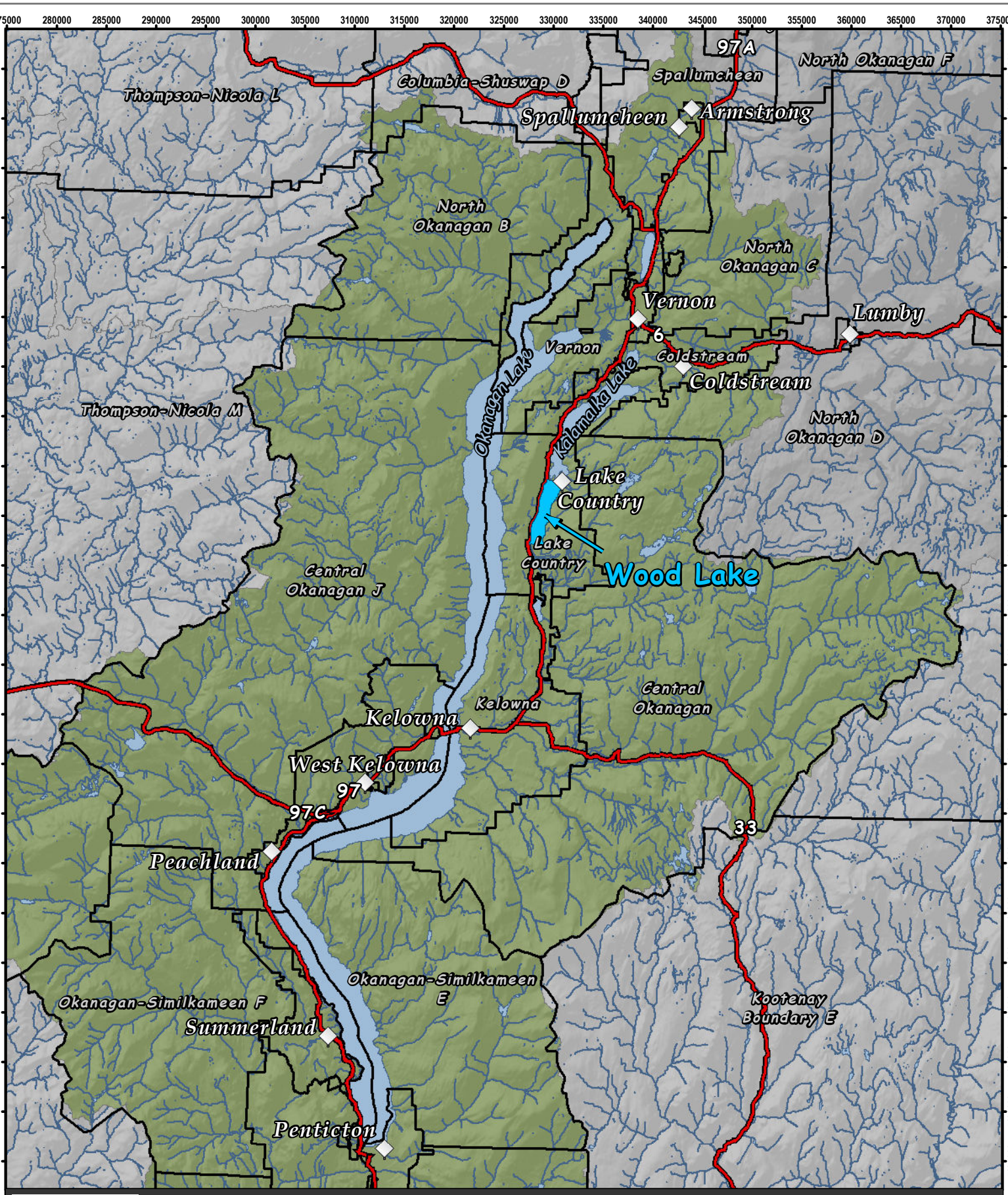
10. Provide a summary of potential locations where habitat improvements are possible along the shoreline based on habitat potential; and,

11. Provide a framework for integration of information with upland development planning in an effort to protect sensitive foreshore areas.

The AHI completed as part of this assessment will begin to address many of these objectives. Completion of Step 3, Shoreline Management Guidelines that integrates the OLLP and this data will provide more detailed and comprehensive guidelines to meet long term objectives for lake protection.

2.3 Study Location

The general location of the study area is found in Figure 1.



Wood Lake Foreshore Inventory and Mapping

Figure 1 - Project Location

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2.4 Important Fisheries and Wildlife Resource Information

Wood Lake contains numerous fish stocks that are important public resources. The most important fish stock is kokanee, a land locked sockeye salmon. This fish is considered a keystone species because of its many interactions with other species. Kokanee are a critical fall food source for bears, eagles, Osprey, and other species and the carcasses of spawning adults provide fertilizer for terrestrial and aquatic ecosystems. Salmon are also an indicator species for the overall health of the ecosystem because they are highly sensitive to changes in their habitat (e.g., reductions in water quality). Other important fish stocks in Wood Lake include rainbow trout and lake trout.

The focus of fisheries management is to further recover stocks of kokanee, which are increasing from historical lows several years ago. The Okanagan Region Large Lakes Fisheries Operational Management Plan 2007-2011 (Redfish Consulting, 2007) provides an excellent summary of important fisheries management objectives and concerns. Some of the key fisheries issues identified in the management plan included: 1) foreshore development, 2) impacts to lakeside riparian habitats, and 3) losses of kokanee shore and stream spawning habitats (Redfish Consulting, 2007).

Western floater (*Anodonta kennerlyi*) mussel has been found in Wood Lake. Mussels are often found in sandy or fine substrates. Mussels are sensitive to environmental conditions because of their limited mobility and their tendency to filter chemical contaminants from the environment. Mussels can be a good indicator of environmental conditions and change over time because they are typically long lived and are sensitive to changes in water quality, habitat and fish communities (Nedeau et al. date unknown)

Wood Lake also has important habitats for wildlife species (e.g., see SEI inventories, Conservation Data Centre information, etc.). The SEI inventory highlighted a number of important species that might make use of the lakeshore and associated habitat. Species selected for analysis in the SEI are meant to be a representation of the rare or endangered wildlife that potentially occur in the North Okanagan (Haney and Sarell 2006). Great basin spadefoot (*Spea intermontana*) and western painted turtle (*Chrysemys picta bellii)* are two species that might use the aquatic habitat present along the lake margin, although smaller ponds or flooded areas present locally are often more suitable than the lake itself. Painted turtle use aquatic habitat for general living and hibernation, and migrate to nearby upland areas for nesting. The aquatic habitat present instream on Wood Lake might not be as valuable to some species such as Swainson's Hawk (*Buteo swainsoni*) or Western Screech Owl (*Otus kennicottii macfarlanei*), however there are habitats, including riparian habitats, present along the lake margin that are critical to these species. The lake is used by avian species including raptors and waterfowl for foraging and other life requisites and is also used by a number of small mammal species including certain types of shrews, bats, beaver and muskrat. Riparian areas are known to contain a unique assembly of species and provide a transitional aquatic-to-terrestrial habitat type that is unique and important for both ecosystem health and species survival. Maintaining connectivity between upland and aquatic habitats is important to wildlife in general. Biodiversity Conservation Strategy Mapping and Conservation Ranking as well as least

resistance connectivity mapping are additional data sources that may be used in conjunction with the AHI for landscape level planning.

This brief overview highlights the importance of fisheries and wildlife resources along Wood Lake and provides a clear rationale for completion of this shoreline inventory project. The concerns discussed above are but a few of the many that have been, or will continue to be identified in the coming years along the lake.

3.0 FORESHORE INVENTORY MAPPING AND THE RELATIONSHIP TO AHI

Foreshore Inventory Mapping (FIM) was completed for Wood Lake in 2010. The report entitled *Foreshore Inventory and Mapping Kalamalka and Wood Lake* (Ecoscape 2010) summarizes the results of the FIM project and describes some of the key habitat types that are commonly found along Wood Lake.

A brief summary of the FIM data is provided below. The FIM is used to populate the AHI and determine the relative habitat value of the shoreline at Wood Lake. Key findings of the FIM report for Wood Lake are as follows:

- It is estimated that 88% (15.2 km) of the shoreline has a high level of impact. Areas of moderate and low impact account for 5.7% (1.0 km) and 5.6% or (1.0 km) of the shoreline respectively. Impacts along the shoreline include lakebed substrate modification, riparian vegetation removal and construction of retaining walls, boat launches and other anthropogenic features. Road and railway fill were significant in terms of shoreline alteration and substrate modification on this lake;

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

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

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

The following summarizes habitat modifications observed:

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

4.0 AQUATIC HABITAT INDEX METHODOLOGY

An Aquatic Habitat Index (AHI) is a tool thatcan be used to assess the relative habitat value of a shoreline relative to other areas within the lake. An index is a numerical or categorical scale used to compare variables with one another. An index to assess shoreline sensitivity has been completed on Okanagan Lake, Osoyoos, Shuswap Lake, and Mabel Lake, as well as numerous lakes in the Kootenays. The purpose of the AHI is to facilitate land use planning around shorelines by identifying the relative value of shoreline areas within a lake system. The relative habitat value of an area can then be used to infer the environmental sensitivity of the shoreline (i.e., areas of higher relative value typically have greater environmental sensitivity).

The AHI utilizes a number of parameters collected during the FIM. The index uses a points based mathematical index to assign the relative habitat value to each different parameter. Thus, features with higher estimated significance are assigned higher relative values by increasing the weight applied to them within the index. Features impairing the habitat value (e.g., groynes) are assigned negative scores to better reflect the current condition of the shoreline. Values are assigned and calibrated using professional opinion and the index generated is not considered a statistical model predicting productivity. Rather, the intent of the index is to identify key habitat parameters and assign a value to them using the best available data and judgement to assess the relative value of the shoreline areas.

Subsequent analysis assesses the habitat potential of a segment. This analysis involves removing ALL negative habitat parameters to determine if shoreline restoration could achieve a measurable benefit. The Habitat Potential Index can be used to help assess where instream restorative efforts are best directed. The habitat potential analysis did *not include effects of riparian restoration* due to the extent of database and predictive mapping that would be required to facilitate such an analysis. More detailed habitat restoration analyses are required.

The index generated has only utilized information that is currently available or that can be safely inferred from previous works. In many instances, data gaps have been identified and assumptions have been made. As more information becomes available regarding shoreline areas of Wood Lake, the AHI may need to be updated.

4.1 Parameters

The parameters of the index each reflect a certain type of habitat found along the shoreline. The parameters were broken down into five categories as follows:

1. Biophysical;
2. Fisheries;
3. Shoreline Vegetation;
4. Terrestrial; and,
5. Modifications.

The following table identifies the parameters and logic used in the index.

Table 1: Parameters and Logic Used for the AHI of Wood Lake

Category	Criteria	Maximum Point	Percent of the Category[1]	Percent of the Total[1]	Logic	Uses Weighted FIM Data	Value Categories
Biophysical	Shore Type	15	31.3	8.8	% of Segment * Maximum Point	Yes	Stream Mouth = Wetland (15) > Gravel Beach = Rocky Shore (12) > Sand Beach (8) = Cliff /Bluff (8), Other (5)
	Substrate	12	25.0	7.0	% Substrate * Maximum Point	Yes	Cobble (12) > Gravel (10) > Boulder = Organic = Mud = Marl = Fines (8), Sands (4) > Bedrock (2)
	Percent Natural	5	10.4	2.9	% Natural * Maximum Point	Yes	
	Aquatic Vegetation	8	16.7	4.7	% Aquatic Vegetation * Maximum Point	Yes	
	Overhanging Vegetation	4	8.3	2.3	% Overhanging Vegetation * Maximum Point	Yes	
	Large Woody Debris	4	8.3	2.3	# of Large Woody Debris/km * Relative Value * Maximum Point	Yes	**Relative Value** >15 LWD/km (1) > 10 to 15 LWD/km (0.8) > 5 - 10 LWD/km (0.6) > 0 - 5 LWD/km (0.4) > 0 LWD/km (0)
Fisheries	Kokanee Spawning	20	29.4	11.7	% Shore Length of Colour Zone * Score	Yes	Black Zone = 20, Red Zone = 10, Yellow Zone 5, No Colour Zone = 0
	Juvenile Rearing	10	20.8	5.8	High (12), Moderate (6), Low (3)	No	High (12), Moderate (6), Low (2)
	Migration Corridor	8	21.1	4.7	Present (8), Absent (0)	No	Present (5), Absent (0)
	Staging Area	8	26.7	4.7	Present (8), Absent (0)	No	Present (5), Absent (0)
	Mussel	12	54.5	7.0	Present (12), Absent (0)	No	Present (12), Absent (0)
Shoreline Vegetation[2]	Band 1	8	66.7	4.7	Vegetation Bandwidth Category * Vegetation Quality * Maximum Point	Yes	**Vegetation Bandwidth Category** 0 to 5 m (0.2) < 5 to 10 m (0.4) < 10 to 15 m (0.6) < 15 to 20 m (0.8) < 20 m (1) **Vegetation Quality Category** Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)
	Band 2	4	33.3	2.3	Vegetation Bandwidth Category * Vegetation Quality * Maximum Point	Yes	
Terrestrial	Conservation Core Areas	10	28.6	5.8	% Shore Length of Colour Zone * Score	Yes	% Length of Conservation Area * Value
	Conservation Buffer Areas	3	8.6	1.8	High (12), Moderate (6), Low (3)	Yes	% Length of Buffer Area * Value
	Wildlife Corridor	8	22.9	4.7	Present (8), Absent (0)	Yes	% Length of Wildlife Corridor * Value
	Other	8	22.9	4.7	Present (8), Absent (0)	Yes	% Length of Other Area * Value
	N/A	1	2.9	0.6	Present (8), Absent (0)	Yes	% Length of N/A Area * Value
Modifications	Retaining Wall	-2.00	25.1	-1.2	% Retaining Wall * (-2)	Yes	% Retaining Wall * (-2)
	Docks	-1.76	22.0	-1.0	# Docks/km * (-0.05)	Yes	# Docks per Kilometer * (-0.05)
	Groynes	-1.71	21.4	-1.0	# Groynes/km * (-0.1)	Yes	# Groynes per Kilometer * (-0.1)
	Boat Launch	-0.50	6.3	-0.3	# Launches * (-0.25)	No	# Launches * (-0.25)
	Marina	-2.00	25.1	-1.2	# Marina * (-1)	No	# Marina * (-1)

1. Numbers have been rounded to the nearest whole number. All calculations were completed without rounding.

2. The Shoreline Vegetation category has been calculated to include an estimate of quantity (i.e., bandwidth) and quality (i.e., relative value). In cases where two bands are present, there is a higher diversity which is more productive, resulting in a higher score.

The parameters selected for the index were similar to the other indices developed. A description of each is found below.

4.1.1 Biophysical Parameters

The following summarizes the biophysical parameters of the index:

1. Shoretype – A shoreline type is related to many aspects of productivity. Previous habitat indices (e.g., Schleppe and Arsenault, 2006) have used a habitat specificity table to determine the value of a shoreline. This similar approach was used for Windermere Lake (McPherson and Hlushak, 2008). However, in these previous versions, wetlands were difficult to account for utilizing the fish habitat specificity approach originally developed for Okanagan Lake (Schleppe and Arsenault, 2006). Wetlands are considered to be highly valuable shoreline areas for several reasons, including their contributions to biodiversity, biomass, and water quality. Other aspects of the fish habitat specificity approach developed for Okanagan and Windermere Lakes are appropriate for, and have been utilized in, this assessment. The general habitat specificity for Wood Lake follows that of the original assessment for the central regions of Okanagan Lake, except that wetlands have been accorded the highest shore value possible (i.e., equivalent to a stream confluence). This is because of the rarity of wetlands on the lake, the habitat diversity present in wetland areas, and their contributions to biomass and water quality.

2. Substrate – Substrates also relate directly to productivity. In general, there are two types of productive substrate, those utilized for spawning and those that produce more biomass. The substrate values and parameters used for Wood Lake are similar to those used for Shuswap and Mabel and are originally based upon species habitat matrices developed for Okanagan Lake in the Kelowna Shorezone Assessment (Schleppe and Arsenault, 2006). Substrates utilized for spawning were given higher weighting than those for foraging. Areas of bedrock were considered the least valuable because they are not utilized for spawning and do not provide good foraging areas for fish.

3. Percent Natural –Areas of natural shoreline have a relative habitat value that is greater than disturbed shoreline areas because the condition of the habitat is better. The value of this parameter in the index is the same as the value in the Shuswap and Mabel index but is still less than the original AHI for central regions of Okanagan and Windermere Lakes. This value was given less weighting from the original AHI within the City of Kelowna limits on Okanagan Lake (Schleppe and Arsenault, 2006) because the devaluing effects of disturbance are believed to be less than originally inferred in the AHI for the City of Kelowna areas.

4. Aquatic Vegetation – In more recent versions of the FIM database, more detailed information regarding aquatic vegetation was collected. On Wood Lake, all vegetation below the HWL is considered productive. Since the FIM now allows analysis of this parameter, it was added to the index following the same methods as Shuswap Lake. The benefits of aquatic vegetation are many and include forage, biomass production, cover, etc. For Wood Lake, the relative value of aquatic vegetation was increased slightly from Mabel and Shuswap because impacts to historical vegetation areas are considered to be greater. The remaining vegetation areas have a slightly higher relative value because of the historical impacts (e.g., many shoreline areas have had almost all large woody debris and emergent floodplain areas affected reducing the cover of aquatic vegetation).

5. Overhanging Vegetation – In the more recent FIM database versions, more detailed information regarding overhanging vegetation was collected. Along Wood Lake, overhanging vegetation was documented infrequently, likely due to the dry arid climate, steep shorelines in many areas, and past historical development along floodplain areas within the Central Okanagan. Since it provides nutrients and opportunities to forage, it was added to the index.

6. Large Woody Debris – The detailed large woody debris information collected was used in the index because it has importance for salmonid and other species. Large Woody Debris was not present in many areas. Woody debris was absent for several reasons, including proximity and quantity associated with sources such as large rivers, and removal from "beach grooming" activities by residents in areas where shore drop would typically occur. Since large woody debris provides nutrients, cover, and opportunities to forage, it was added to the index. Numerous studies have identified the importance of large woody debris to salmonids in lake and stream systems.

4.1.2 Fisheries Parameters

The fisheries parameters used for the AHI were based upon those described above in the Table 1 in Section 4.1. These different parameters are considered important for fish production in the Wood Lake system and were prioritized in the AHI accordingly. The list below includes the fisheries parameters that were added to the AHI. For the categories of mussel presence and kokanee shore spawning, where the data indicate a "no" rating at the site, this does not mean that mussels or kokanee are not likely to be present there it only means that none have been detected to date.

1. Juvenile Rearing shoreline habitat value (High, Moderate, and Low) was prepared for this assessment. Juvenile rearing values were prepared using an index similar to the AHI. The index was based upon original surveys of Shuswap Lake by Graham and Russell (1979) and Russell et al (1981) who documented juvenile utilization along the shoreline. In these assessments, habitat criteria similar to those collected in the FIM were utilized to assess areas as High, Moderate, or Low Juvenile Rearing Value. Similar to Russell's approach, a Juvenile Habitat Suitability Index was developed for Wood Lake (without a field sampling confirmation component) and uses data from previous work completed in Okanagan Lake to help inform professional opinion (see Schleppe and Arsenault, 2006). The values of Sand shore types and sand substrates was increased in the Wood Lake index (when compared to Mabel) to account for the increased substrate modification and impacts to historical floodplain shores that would have been classified as wetlands. The following criteria were used in the Juvenile Rearing Habitat Suitability Index for Wood Lake (as well as the AHI completed previously for Okanagan Lake).

Table 2: Parameters and Logic for the Juvenile Rearing Habitat Suitability of Wood Lake.

Category	Criteria	Maximum Point	Percent of the Category[1]	Logic	Uses Weighted FIM Data	Value Categories
Criteria	Shore Type	12	22.6	% of Segment * Maximum Point	Yes	Stream Mouth (12) > Wetland (8) = Sand Beach (8)> Gravel Beach = Rocky Shore (6) = Cliff /Bluff (4), Other (1)
	Substrate	9	17.0	% Substrate * Maximum Point	Yes	Organic(9) = Mud (9) = Marl (9) = Fines (9) > Boulder (8) > Cobble (7) > Gravel (7) > Sands (6) > Bedrock (4)
	Aquatic Vegetation	5	9.4	Aquatic Vegetation Category Score	No	**Aquatic Vegetation Category Score** Aq. Veg > 80% = 5, Aq. Veg 50% to 80% = 3. Aq. Veg < 50% = 1
	Littoral Width	12	22.6	Littoral Width Category Score	No	**Littoral Width Category** Wide (>50m) = 12, Moderate (10 to 50 m) = 8, Narrow (<10m) = 3
	Overhanging Vegetation	1	1.9	% Overhanging Vegetation * Maximum Point	No	
	Large Woody Debris	4	7.5	Large Woody Debris Category Score * Maximum Point	No	**Large Woody Debris Category Score** >15 LWD/km (1) > 10 to 15 LWD/km (0.8) > 5 - 10 LWD/km (0.6) > 0 - 5 LWD/km (0.4) > 0
	Migration Corridor	5	9.4	Present / Absent	No	Present (5), Minor (0)
	Salmonid Spawning Stream Present	5	9.4	Present / Absent	No	Present (5), Minor (0)

1. Numbers have been rounded to the nearest whole number. All calculations were completed without rounding.

2. The Shoreline vegetation category has been calculated to include an estimate of quantity (i.e., bandwidth) and quality (i.e., relative value). In cases where two bands are present, there is a higher diversity which is more productive, resulting in a potentially higher rating.

The juvenile rearing suitability is only one fishery criteria and only comprises 5.8% of the overall Wood Lake AHI. The above index has not been field confirmed using a sufficient sampling protocol but is consistent with best estimates of productive juvenile areas in Wood Lake based upon the assumptions made (e.g., juvenile fish emigrating from spawning streams will inevitably occupy rearing areas closer to their natal stream, etc.). Duplicate parameters between the AHI and the Juvenile Rearing suitability index occur because of correlations that exist between the different parameters (i.e., the estimate of shore type productivity is correlated with juvenile rearing habitat suitability for example). Because duplicates can only account for less than 3% of index as a whole (i.e., Shore Type in AHI (13.8%) X Shore Type Juvenile Rearing (22.6%)), they do not represent a significant enough duplication to significantly alter the outcome of the analysis. Further data collection is required to better understand correlations

between the different criteria in the index and to help address these in future iterations.

2. Migration – Juvenile fish migration routes are the most important migration corridors and these were prepared based upon proximity to known spawning areas in streams. Areas classified as Migration routes encompass shoreline areas where adult of juvenile fish must either migrate out into or out of a river or stream system. These areas overlap extensively with Staging Areas. Migration routes consider only resident species (e.g., rainbow and kokanee). The value of migration areas was increased from the Mabel Lake assessment because the development intensity around key spawning streams (e.g., Middle Vernon Creek) was greater, increasing the importance of this habitat requisite.

3. Staging – Staging areas were prepared based upon data collection on spawning streams,the spatial extent of shore segments, and professional judgment of what constitutes important staging areas. The staging areas generally only encompass shoreline segments where fish must either migrate out from or into a river or stream system. These areas overlap extensively with Migration areas since fish must migrate into staging areas. Staging areas were also increased in value from Mabel Lake, to adjust for the increased development pressure around key salmonid spawning streams.

4. Mussels –The Western Ridged Mussel is the most important mussel species in the lake. Shoreline areas considered to be suitable to mussels were included in the index.

5. Kokanee Shore Spawning Zones - Kokanee shore spawning significance, determined by the MoE OLLP, was used in the index. Kokanee shore spawning zones have been assigned along the lake based on the aggregation of spawning kokanee as well as a number of other factors including the presence of western ridged mussel, presence of select aquatic macrophytes, and the location and presence of stream mouths. The zones range from higher to lower value and are assigned a corresponding color value. The highest value areas are black zones, followed by red, yellow and finally, low value, no color zones. Zones cover a specific portion of the shoreline which usually includes the location of the kokanee spawning or mussel location along with a pre-determined buffer. The MoE updates this information as new records on kokanee spawning and mussel presence become available. The index assigns a value to each color zone and the length of shoreline and associated color zone determine the overall kokanee shore spawning zone's contribution to the index.

4.1.3 Shoreline Vegetation Parameters

The riparian parameters added to the index were similar to those added in the Okanagan, Mabel, Shuswap and Windermere Lakes. The FIM provides a distinction between lakeside vegetation (Band 1/Riparian) and the areas behind (Band 2/Upland). To address this data, the index included a factor assessing vegetation quality (i.e., tall shrubs thickets or wetland areas have a higher quality than landscaped properties). As with the other indices, vegetation bandwidths were categorized and points were assigned to assess quantity. Vegetation bandwidth categories included 0 to 5 m, 5 m to 10 m, 10 m to 15 m, 15 m to 20 m and greater than 20 m. The Band 1 vegetation, directly adjacent to the lake is assigned more points than the Vegetation Band 2 because of its direct proximity to aquatic habitats which is presumed to have increased allochthonous inputs (i.e., leaf litter drop) and insect drop.

Rare plant species are sometimes present along the lakeshore and, in the case of previous AHI analyses such as that completed for Okanagan Lake, this information was been incorporated into the index. No documented occurrences of rare plant species were found for Wood Lake and as a result this component did not contribute materially to the index.

4.1.4 Terrestrial Parameters

The terrestrial data fields discussed above were included in the habitat index. The following were criteria that were added:

1. Core Conservation Areas are extremely important terrestrial areas because they are critical to wildlife and sensitive terrestrial communities. This criteria was included as a weighted parameter in the index. The criteria was incorporated by using the percentage length of shoreline where these areas occur.

2. Buffers are important to the maintenance of important core conservation areas. This parameter was included in the index as a weighted parameter using the percentage length of the segment where corridors are present.

3. Wildlife Corridors are important linkage areas between upland terrestrial areas and aquatic habitats. The SEI identified important corridors which were included as weighted parameters using the percentage length that they occur along a segment.

4. Other Important Conservation Areas are places of moderate conservation value. These areas were incorporated into the index as a weighted parameter by using the percentage length they occupy along the shoreline.

4.1.5 Habitat Modifications

Habitat modification parameters are described by Schleppe and Arsenault (2006). These descriptions provided a strong rationale for inclusion of these different parameters in the AHI. Other habitat modification parameters, such as percent substrate modification or percent roadway, were not included in the analysis because they may compound (i.e., groynes are typically constructed by shoreline substrate modification, therefore this effect would be counted twice). The following is an excerpt (shown in italics) from Schleppe and Arsenault (2006) completed by EBA Engineering Consultants Ltd. The City of Kelowna provided permission to utilize data from their assessment. Further information on these parameters can also be found in the Windermere Lake assessment (McPherson and Hlushak, 2008). Non-italicized text that is included below amongst the italicized text has been added to the wording of Schleppe and Arsenault because it specifically applies to this project.

Retaining Walls

Retaining walls are considered to be negative habitat features for a variety of reasons. These structures are generally constructed to armour or protect shorelines from erosion. Kahler et al (2000) summarized the effects of piers, docks, and bulkheads (retaining walls) and suggested that these structures may reduce the diversity and abundance of near shore fish assemblages because they eliminate complex habitat features that function as critical prey refuge areas. Kahler et al. (2000) found evidence of positive effects for armouring structures along a shoreline in the published literature. Carrasquero (2001) indicated in his review of overwater structures that retaining walls might also reduce the diversity of benthic macroinvertebrate communities more than other structures such as riprap shoreline armouring because they reduce the habitat complexity.

Natural erosion along a shoreline can be the result of removal of riparian or lakeside vegetation, which may have been the cause of the erosion in the first place. In other cases, retaining walls have been constructed to hold up soil material, possibly reclaiming land, so that lawns can be planted or for other landscaping purposes. As indicated in the FIM report by the RDCO, the construction of structures by residents, may lead to neighbours imitating their neighbours. Also, construction of one retaining wall may lead to energy transfer via waves resulting in erosion somewhere else. The above arguments highlight the consequences of retaining wall construction and the potential negative habitat effects that they have.

On the Wood Lake system, retaining walls have been constructed to create level building areas or level areas for turf and other landscaping. This construction has resulted in significant impacts to riparian vegetation and foreshore substrates.

Docks

The negative effects of docks on fish habitat are controversial. On one hand docks may provide areas of hiding from ambush predators, reductions in large woody debris inputs, and these structures are often associated with other anthropogenic disturbances such as retaining walls (Kahler et al. 2000; Carrasquero 2001). On the other hand, docks also provide shaded areas that can attract fish and provide prey refuge, and pilings can provide good structure for periphyton growth (Carrasquero 2001). Numerous factors, such as the scale of study and the cumulative effects of these structures, are also important and should be considered when discussing overwater structures (Carrasquero 2001).

Docks have also been documented to increase fish density due to fish's general congregation around structure, but decrease fish diversity in these same areas (Lange 1999). Coupled with this result, Lange also found that fish diversity and density were negatively correlated with increased density and diversity of shoreline development, meaning that increases in dock density may reduce fish abundance and diversity. Chinook salmon have been documented to avoid areas of increased overwater structures (e.g., docks) and riprap shorelines, and therefore, construction of these structures may affect juvenile migrating salmonids (Piaskowski and Tabor, 2000).

Regardless of the controversy, it is apparent that docks do affect fish communities and the degree of effects are most likely related to the intensity of the development, the scale of the assessment, and fish assemblage life history requirements. Different fish assemblages may respond differently to increased development intensity, and fish assemblages containing salmonids may be more sensitive than southern or eastern fish assemblages (e.g., bass, perch, and sunfish, etc.). It is for these reasons that dock density was included in the index, and that docks were treated as a negative parameter, with increasing dock density considered as having more negative effects than lower dock densities.

On Okanagan Lake, it has been observed that kokanee avoid spawning under large shaded areas (e.g., docks in excess of 3 or 4 m in width that area close to current water level, J. Schleppe and K. Hawes, personal observation during shore spawning surveys on Okanagan Lake) and this is expected to be the case in Wood Lake also.Impacts from land use activities such as shading and propeller scour pose unique challenges to site specific and lake wide land use practices on this lake system.

Groynes

Groynes are structures that are constructed to reduce or confine sediment drift along a shoreline. These structures are typically constructed using large boulders, concrete, or some other hard, long lasting material. Reducing the movement of sediment materials along the shoreline can have a variety of effects on fish habitat, including increasing the embeddedness of gravels. Published literature regarding the specific

effects of groynes on fish habitat are few, but because these structures are often considered Harmful Alterations, and Disruptions of Fish Habitat (HADD) as defined under the federal Fisheries Act, they are believed to have negative effects, mostly associated with the loss of area available for fish (e.g., Murphy 2001)

Groynes are habitat modifications that result in localized impacts that are significant. Construction of groynes on other lakes in the Okanagan using natural lakebed substrates has resulted in significant degradation of habitat including loss of emergent vegetation zones, possible sediment deposition in suitable shore spawning zones (unconfirmed), destabilization of shoreline substrates, etc. Migration of juvenile fish may also be affected by groynes, whereby small fish must move to deeper waters to move along the shoreline. In moving to deeper water, there is increased potential for predation of these young fish (unconfirmed).

Boat Launches

Boat launches were considered to be a negative parameter within the AHI. Boat launches are typically constructed of concrete that extends below the high water level. The imperviousness of this material results in a permanent loss of habitat, which ultimately reduces habitat quality and quantity for fish. Concrete does not allow growth of aquatic macrophytes, and reduces foraging and/or refuge areas for small fish and macroinvertebrates. The extent of the potential effects of boat launches relates to their size. Thus, multiple lane boat launches tend to have a large effect on fish habitat than smaller launches with fewer lanes because there is more surface area affected. The AHI treated each different boat launch lane as one unit, and therefore one launch could have multiple boat ramps. The intent of using the data in this fashion was to incorporate the size of the structure (i.e., more ramps, decrease in available habitat).

Other impacts of boat launches include propeller scour of substrates in shallow water launches and the fact that they may also act as groynes affecting natural long shore drift patterns.

Marinas

Marinas are a concentration of boat slips, offering a place of safety to vessels. Marinas likely have a variety of effects, but there is very little literature investigating the positive or negative habitat consequences of marinas. Large marinas also tend to have breakwaters, which can further affect wave action, sediment scour and deposition, and circulation. In general, when marinas are constructed in the littoral zone there tends to be a large increase in shading, which reduces the potential for aquatic macrophyte growth and therefore reduces the productivity of a particular shoreline area. Also, marinas tend to have other activities associated with them, including extensive boat movements, which can reduce the use of an area by more timid species (e.g., rainbow trout). Other activities in marinas include fuelling stations, boat cleaning, bilge water, and sanitary waste disposal stations. Each of these

activities has the potential to alter benthic communities, possibility altering the fish assemblage (i.e., congregations of more tolerant species and displacement of less tolerant species) and potential resulting in a loss in biodiversity, which can ultimately affect fish and/or fish habitat. Marinas also tend to be associated with other high intensity land developments, which may have a variety of effects including reducing water quality through inputs of chemicals, etc., increases in water turbidity, reduction in oxygen concentration, etc.

Marinas are not a commonly observed shoreline modification on Wood Lake.

The above were common modifications that were observed that could be easily quantified and added to the habitat index. The devaluing effects of modifications were determined through a series of iterations and are consistent with other large lakes. Further research on the extents and magnitude of devaluation due to construction of these features is required.

4.2 Index Ranking Methodology

The AHI was used to analyze the relative habitat value of a segment compared to other segments on Wood Lake. The output of the index is a five class ranking system, ranging from Very Low to Very High. Two different runs of the index were completed as follows:

1. Current Value (AHI_CUR) – This is the current index value for each shore segment based upon the total biophysical, riparian, fisheries, and modifications parameters.

2. Potential Value (AHI_POT) – This is the value of habitat index when the modifications are removed. It is the total value based upon the biophysical, riparian, and fisheries parameters only. This highlights segments where instream restoration will result in the greatest potential benefit. This category does not consider riparian restoration because of the classification effort that is required to generate this parameter (i.e., a predictive mapping approach would be required).

4.2.1 Calculating the Index

The AHI consists of a variety of parameters and each parameter has a range in potential scores based upon the physical properties of each shore segment. Table 1 contains the logic and the maximum score possible for a particular habitat parameter. To calculate the index score, the score for a shore segment was applied based upon the physical characteristics in the FIM database for that segment. Weighted averages were used where possible to most accurately evaluate the score. Once the scores had been assigned to all parameters, the total scores for each different category (i.e. 1) Biophysical, 2) Fisheries, 3) Shoreline Vegetation; and, 4) Modifications) were summated for each segment. The total habitat value for each shoreline segment included all positive and all negative index parameters.

The five class ranking system reflects the current value of the shoreline relative to other areas within Wood Lake. The Mabel Lake and Okanagan Lake indices were used as a baseline because of the many similarities between these systems. To calibrate the index, numerous iterations were run (i.e., the index was run at least 50 times) and changes were made as necessary to reflect current conditions. For each iteration of the index, the minimum, maximum, median, and distribution of scores was reviewed. After reviewing the distribution of the data from the iterations, logical breaks in the scores were used to determine the AHI ranking from Very High through Very Low. The breaks created reflect the clustering of scores based upon the output of the results, which somewhat mimic a normal distribution (although an analysis of data distribution was not conducted). If required, additional segment breaks were added to the FIM database and the data was adjusted accordingly. Only a couple of segments were added to the AHI and were added to reflect high value pockets embedded within areas of more moderate value (e.g., some areas identified as redzones were embedded in large segments with no color zones). Ultimately, the value of habitat is a continuum, and there is room for some interpretation of this information. Further review, addition, and improvements to the index are encouraged and this database has been designed to allow inclusion and update of information. The ultimate purpose of the index is to act as a flagging tool based upon the information that is currently available.

The following is a description of the five AHI rankings:

1. Very High - Areas classified as Very High are considered integral to the maintenance of fish and wildlife species. Most areas identified as Very High occur in an important floodplain areas adjacent to a salmonid spawning stream, are important wetland habitats, or provide critical spawning for kokanee. These areas should be considered the highest conservation priority and development activities that are considered should only be low impact, low risk types.

2. High Value Habitat Areas - Areas classified as High Value are considered to be very important to the maintenance of fish and wildlife species around the lake. These areas may score high for a variety of reasons, including high rearing value, suitable Western Ridge mussel areas, extensive aquatic vegetation, or an important salmonid stream confluence area. These areas should be considered of high habitat value and priority should be given to the maintenance of these shoreline areas. Goals and objectives should be set to ensure the maintenance of existing values and the prioritization of habitat improvements where feasible.

3. Moderate - Moderate values areas are common around the lake, and have likely experienced some habitat alteration. These areas may contain important habitat sites, such as shore spawning kokanee habitats. These important habitat characteristics should be considered independently of the overall shoreline segment value (e.g., Black Zones within a moderate ranking segment).Proposed development should include some form of

habitat restoration, with priorities to return the shoreline to a more natural state (i.e., change the classifications from Landscaped to Broadleaf or Coniferous) and remove significant instream habitat impairments (e.g., groynes, dock/groynes, infills, substrate alterations, etc.)

4. Low - Low value habitat areas are generally highly modified. These areas have been impaired through previous land development activities. Development within these areas should be carried out in a similar fashion as Moderate shoreline areas. However, restoration objectives should be set higher in these areas during redevelopment.

5. Very Low - Very Low habitat areas are extremely modified segments that are not adjacent to any known important habitat characteristics. Development within these areas should be carried out in a similar fashion as Moderate shoreline areas. However, restoration objectives should be set highest in these areas during redevelopment.

For the most part, the criteria within this index was identical to Mabel, which was expected due to similarities between the systems. Some changes to the Mabel index were made, and have been described within the text.

4.3 Data Analysis

General data analysis and review was previously completed for the FIM database and associated reporting. Data collected was reviewed for this AHI report and analysis focussed on shore segment length.

A brief summary of the shoreline lengths and shore types is presented in the results section of this document. The summary provides information regarding the AHI results (Very High to Very Low) analyzed by shore type, including the percent of the shoreline that is within each of the AHI categories.

5.0 RESULTS

The following section provides an overview analysis of the Wood Lake system. Data is presented graphically and summarized in text for ease of interpretation. Data tables for the different analyses are presented in Appendix B.

5.1 Aquatic Habitat Index Results

The results of the Aquatic Habitat Index are best reviewed graphically. The attached Figure Binder presents the spatial results of the assessment. The figure binder has been prepared to show a summary of all the information contained within this report.

The Aquatic Habitat Index uses biophysical information to assess the relative value of a shoreline area. The AHI indicates that approximately 62% of the shoreline is ranked as

Very High and High. Twenty seven (27%) of the shoreline length is moderate, and the remaining 11% is ranked Low and Very Low (9% and 2% respectively). Areas of high and very high habitat value were typically located adjacent to important kokanee spawning areas, stream confluences, wetlands, or were associated with gravel and rocky shorelines with aquatic vegetation in a natural state. Most of the lower value sites were located in more developed areas where habitat function has been severely impaired (e.g., floodplain and wetland areas being converted to dense single family or multi-family development) or by anthropogenic impacts (road and railway corridors along the lake margin).

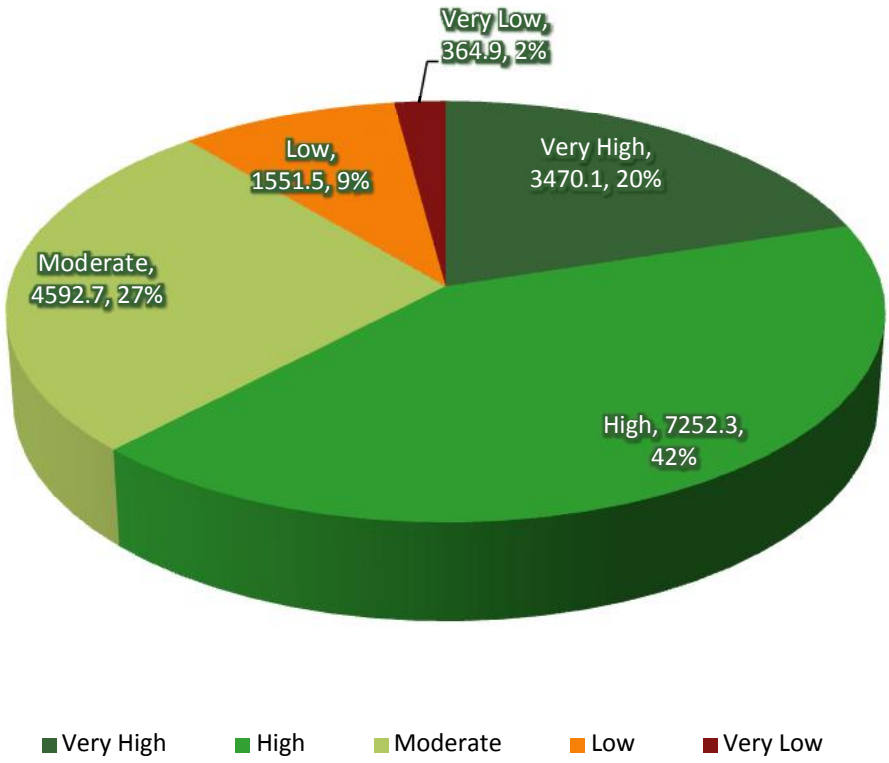


Figure 2 Shore Length and Percentage of Areas Classified as Very High to Very Lowby the Wood Lake AHI.

The table below provides further details on the breakdown of shorelines ranked as Very High through Very Low.

Table 3: Summary of the Current Value and Potential Value Shoreline Lengths, Number of Segments, and Percentage of the Shoreline for the Different Habitat Index Categories (Very High to Very Low)

Categories	Current Value			Potential Value		
	# of Segments	Shoreline Length (m)	% of Shoreline	# of Segments	Shoreline Length (m)	% of Shoreline
Very High	3	3470.1	20.1	3	3470.1	20.1
High	12	7252.3	42.1	12	7252.3	42.1
Moderate	5	4592.7	26.7	5	4592.7	26.7
Low	3	1551.5	9.0	4	1916.4	11.1
Very Low	1	364.9	2.1	0	0.0	0.0
Total	24	17231.6	100.0	24	17231.6	100

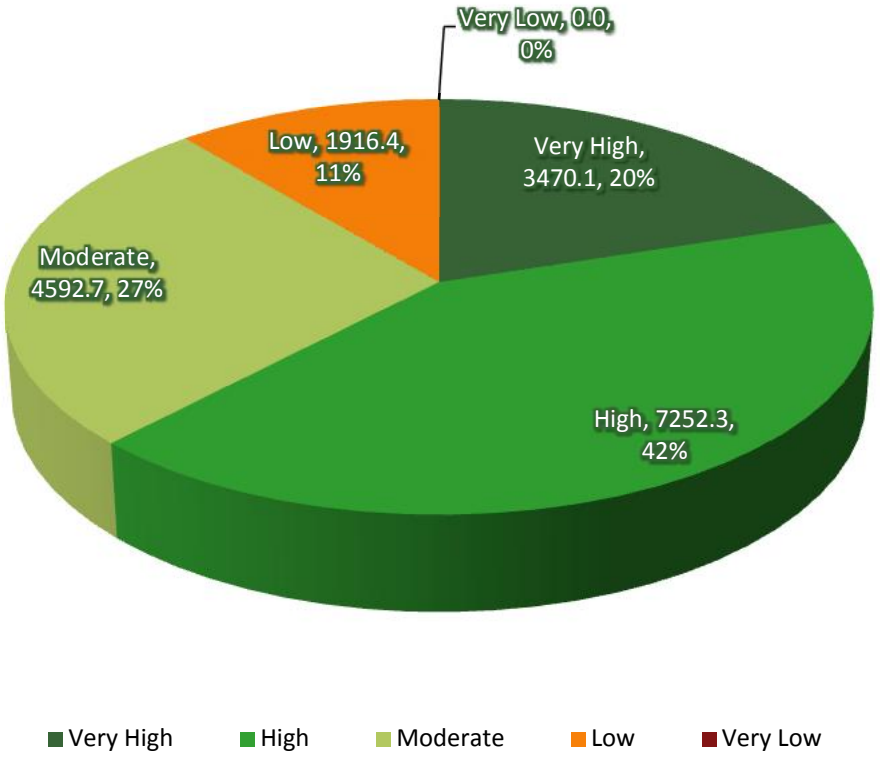
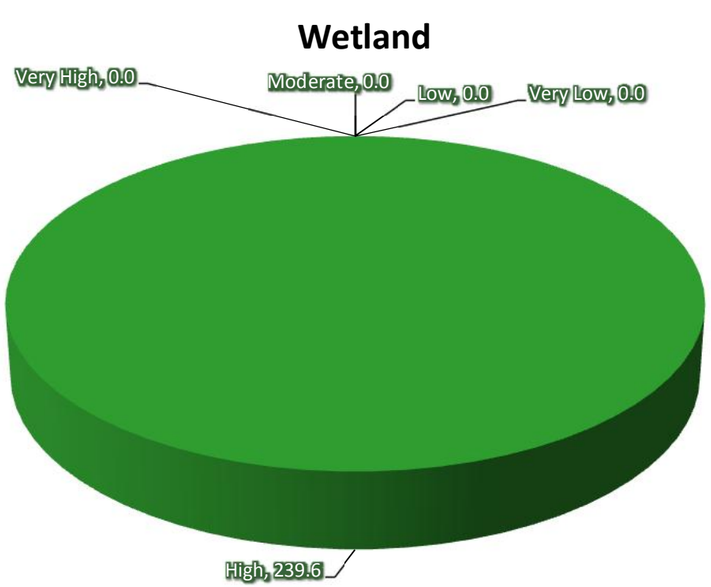
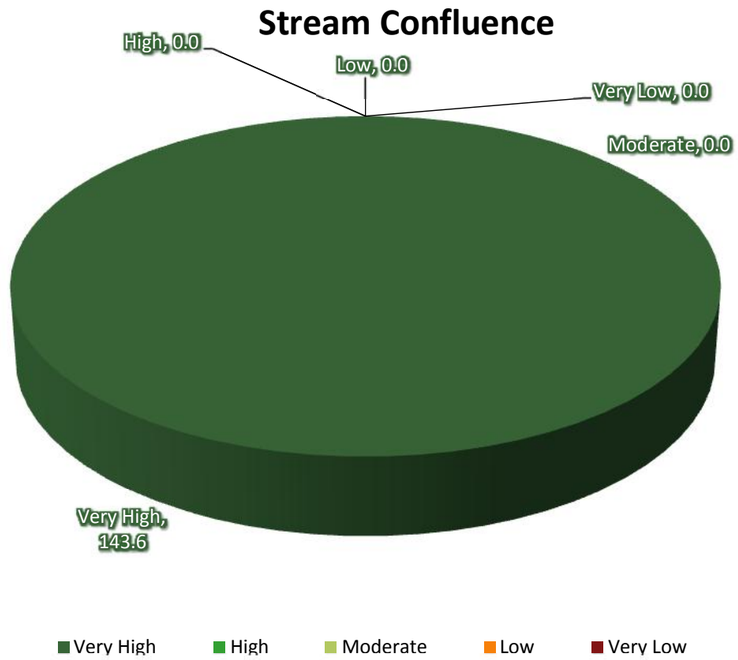


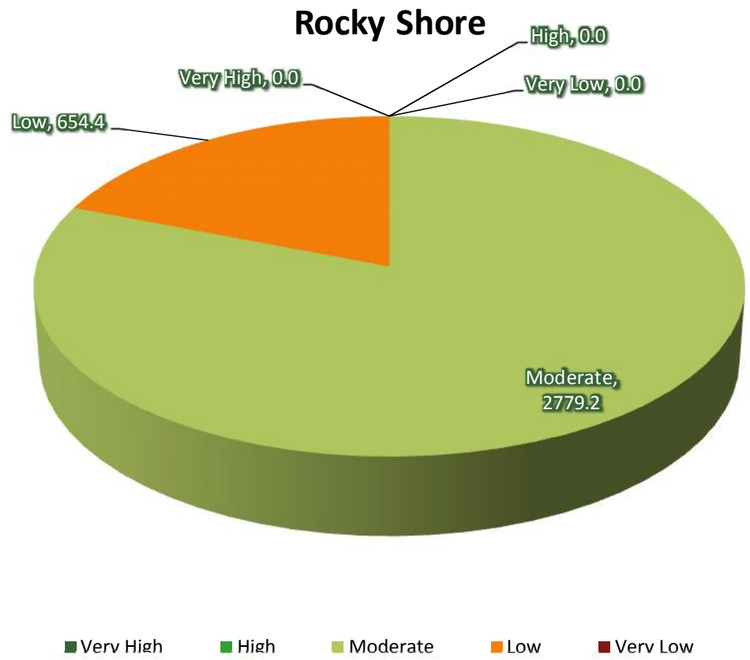
Figure 3 Shore Length and Percentage of Areas Classified as Very High to Very Low by the Potential Value Analysis for Wood Lake.

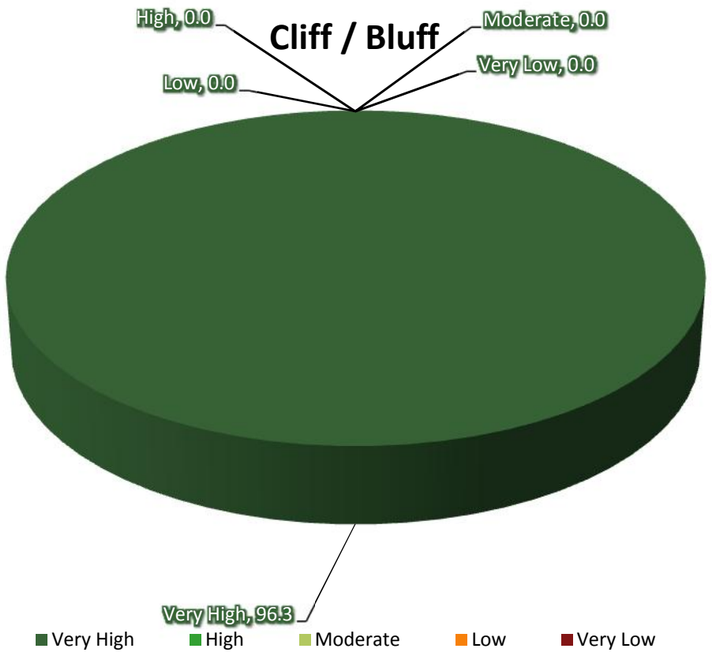
The Aquatic Habitat Index results were analyzed to determine the distribution of habitat values by shore type (Table 4). The analysis indicated that Very High Value shorelines occurred mostly adjacent to stream mouths and gravel shores with good representation

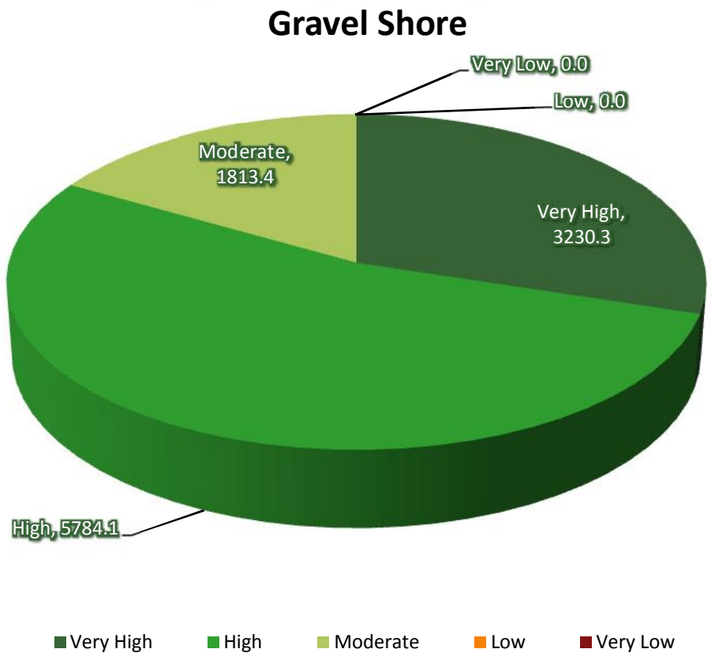
also occurring on cliff/bluff gravel shores. Most of the Very Low value habitat was found on rocky or sandy shore type areas.











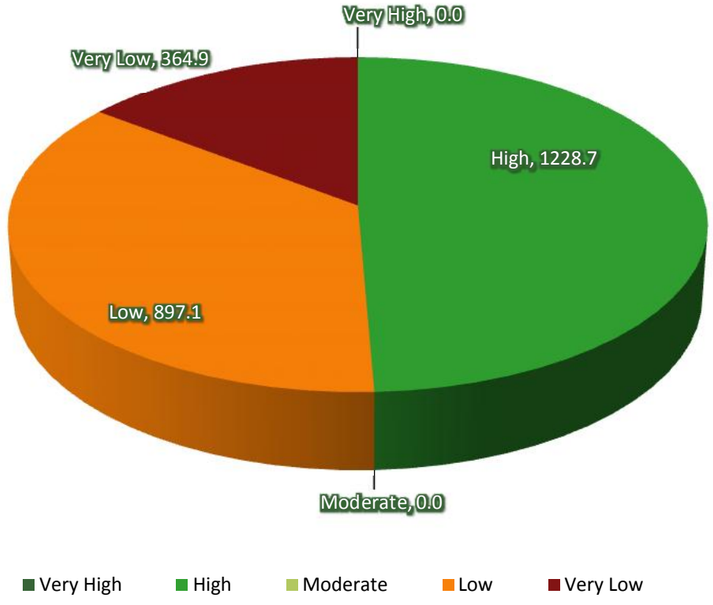


Figure 4: Shore Type vs. AHI Value for Wood Lake

The Potential Value summary presents what the habitat value would be if the modifications were removed (Table 5). This analysis highlights areas where restoration may result in a benefit. It is important to note that this analysis does not consider riparian improvements. Riparian improvements would also likely result in habitat improvements which have not been accounted for in this analysis. In general, there was a shift from very low to low. The lack of a shift in other categories is likely tied to the low overall number of segments in the analysis (24 in total). Subsequent analysis may help better interpret where restoration may be more feasible and cost effective.

Table 4: Summary of the AHI Results for the Different Shore Types for the Current Value of the Shoreline.

Categories	Current Value			CliffBluff		Rocky		Gravel		Sand2		Streammouth		Wetland		Other	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline Length
Very High	3.0	3470.1	20.1	96.3	2.8	0.0	0.0	3230.3	93.1	0.0	0.0	143.6	4.1	0.0	0.0	0.0	0.0
High	12.0	7252.3	42.1	0.0	0.0	0.0	0.0	5784.1	79.8	1228.7	16.9	0.0	0.0	239.6	3.3	0.0	0.0
Moderate	5.0	4592.7	26.7	0.0	0.0	2779.2	60.5	1813.4	39.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low	3.0	1551.5	9.0	0.0	0.0	654.4	42.2	0.0	0.0	897.1	57.8	0.0	0.0	0.0	0.0	0.0	0.0
Very Low	1.0	364.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	364.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5: Summary of the AHI Results for the Different Shore Types for the Potential Value of the Shoreline.

Categories	Potential Value			Cliff Bluff		Rocky		Gravel		Sand2		Stream mouth		Wetland		Other	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline
Very High	3.0	3470.1	20.1	96.3	2.8	0.0	0.0	3230.3	93.1	0.0	0.0	143.6	4.1	0.0	0.0	0.0	0.0
High	12.0	7252.3	42.1	0.0	0.0	0.0	0.0	5784.1	79.8	1228.7	16.9	0.0	0.0	239.6	3.3	0.0	0.0
Moderate	5.0	4592.7	26.7	0.0	0.0	2779.2	60.5	1813.4	39.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low	4.0	1551.5	9.0	0.0	0.0	654.4	42.2	0.0	0.0	1262.0	81.3	0.0	0.0	0.0	0.0	0.0	0.0
Very Low	0.0	364.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The following analysis summarizes the natural and disturbed shoreline areas that are within each of the different Aquatic Habitat Index Rankings. Within areas ranked as Very High, the shoreline was 17% natural. In High value areas, the shoreline was 31% natural and within Moderate Value areas the shoreline was 1% natural. Areas of Low and Very Low value had no areas of natural shoreline.

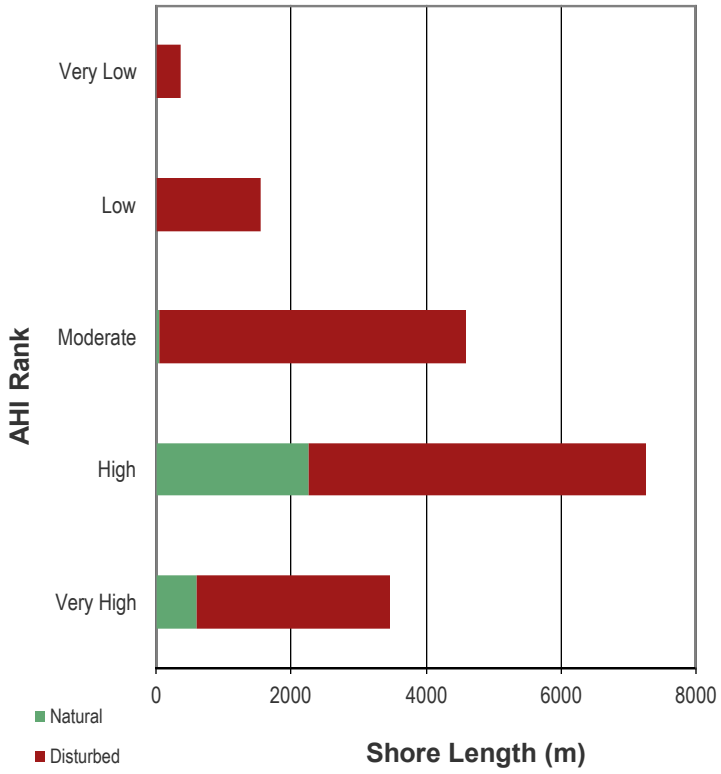


Figure 5 Natural and Disturbed Shore Length of Areas Classified as Very Low to Very High by the Wood Lake AHI

6.0 RECOMMENDATIONS

6.1 Foreshore Protection

The following provides a list of recommendations for foreshore protection. Some of the recommendations below are similar to other recent FIM and AHI reports that were completed for large lakes in the Okanagan and Shuswap. In cases of similarity, credit to the work should be given to the original authors. The following are recommendations for development of foreshore protection policies:

1. **A Shoreline Guidance Document (Step 3) should be developed by local government, the Province, First Nations bands, and DFO for Wood Lake that includes the results of this analysis.** This inventory and cumulative analysis of Wood Lake provides a basis for a risk based

approach to lake shore management and the framework for development of integrated management policies. The shoreline guidance document will facilitate inter governmental cooperation for lakeshore management. Funding should be sought to complete this next step provided that both provincial and federal environmental agencies are willing to be involved in this process. A staged approach in the development of this guidance document may be required, with a series of interim measures developed to allow sufficient effort in the development of long and short term goals (see recommendations below regarding a lakeshore management plan). In the Shuswap, guidance documents have been developed that consider the numerous different layers of data, including sensitive shore spawning sites, aquatic vegetation, and high value juvenile rearing areas. For these reasons, it should be relatively simple to incorporate both the aspects of the OLLP and results from this assessment into one shoreline guidance document. Because management of the shoreline falls under the jurisdiction of several agencies at the local, provincial and federal level, objectives need to be consistent and jointly managed among all.

2. **A clear set of objectives for the future need to be set and the objectives need to be achievable.** Clear objectives need to be set to help inform and guide future management. Examples of clear targets include identifying the amount of natural and disturbed shore line that is a desired future condition and then using this methodology to determine if this goal has been met.

3. **Historical habitat impacts should be restored during development and re-development activities, with measures in place to ensure successful completion.** This analysis addressed habitat potential where restoration activities will benefit habitat quality. For future development applications, existing modifications should be addressed through restoration or enhancement of foreshore areas affected by past modifications. Enhancement and restoration should be required if they are likely to improve habitat quality. Also, further modification to foreshore areas affected by past modifications should be minimized or mitigated. Examples include dismantling of groynes, placement of large woody debris, live staking and re-vegetating shoreline regions, riparian restoration, etc. Restoration objectives should be set higher in low-rated shoreline areas during redevelopment. There is significant opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lake. Further, it is strongly recommended that local governments develop restoration policies and objectives for disturbance areas to reverse the trends of impacts observed along the lake.

4. **The Very High and High value shoreline areas are considered the most important areas around the lake and mechanisms to protect these key habitat features need to be developed.** This analysis highlights the

importance of conserving important natural areas that remain and prioritizing habitat improvements where feasible. In review of development applications, the protection of critical and natural areas should be addressed. The results of this report should be utilized to identify shoreline areas that should be protected.

5. **Key shoreline linkages to sensitive terrestrial habitat have been identified by this assessment. These habitat linkage areas are extremely important to maintain and should be identified as early as possible in the development process.** Key linkages identified should be used in conjunction with mapping from the Okanagan Basin Biodiversity strategy (conservation ranking, biodiversity hotspots, connectivity options) and the Regional Growth Strategy to develop policy to preserve these key linkages. Core habitat areas are larger scale areas[1] that have been mapped and these areas should be considered during development. These areas typically contain or are associated with red listed ecosystems or habitats for species at risk. Detailed assessments and identification of core habitat areas for conservation should be completed as early as possible in the development process to reduce potential impacts from land use decisions (e.g., zoning a property for commercial purposes without understanding what habitat values are present may result in obligations for a minimum build-out that have significant impacts. These impacts may be difficult to mitigate later on in the development process). Numerous possibilities exist for areas identified as sensitive, including No Build / No Disturb Covenants, creation of Natural Areas Zoning bylaws (i.e., split zoning on a property), or by other mechanisms (donation to trust, etc.). Finally, these key lakeshore/upland linkages should be used in conjunction with the proposed Okanagan Biodiversity Conservation Strategy to develop policy within regional growth strategies and other local government planning documents to protect these important interface areas.

6. **Environmental information collected during FIM surveys should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information and air photos, are an extremely important part of the environmental review process because they provide extensive information regarding the current condition of an area. This information will be available in future on the Okanagan Conservation Planning website at www.okcp.ca and on the Ecological Reports Catalogue at www.env.gov.bc.ca/ecocat/.

7. **Compliance and enforcement monitoring of approved works is required, with consequences for failure to construct following standard best practices or failure to apply for necessary permits.** There were

[1] These habitat linkages are difficult to identify on a property basis through a simple setback assessment like the Riparian Areas Regulation assessment)

examples of historical and recent poor practice observed during this survey and other surveys of interior lakes have identified similar problems. An increase in compliance and enforcement monitoring at all levels of government is required because current practices do not appear to be working effectively (i.e., there were numerous, recent examples of construction inconsistent with Best Management Practices (BMPs)). There is the potential to investigate a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts. A more concerted effort is being put forward in this regard due to non-compliance but Ecoscape is not familiar with the entire extent or objectives of the project.

8. **Habitat losses and gains should be monitored to measure success.** This would include the development of indicators, actions and timelines and initiation of a detailed habitat monitoring program on Wood Lake. Results of the monitoring program should be compared to the original inventory data to determine compliance with best management practices and effectiveness of protection activities.

9. **Development and use of best practices for construction of bioengineered retaining walls is required.** Bioengineering has many different meanings. Concise guidelines and BMPs should be developed that is consistent with standard practices of bioengineering. During the assessment numerous examples of recently constructed walls that were not compliant with standard BMPs were observed.

10. **A communication and outreach strategy should be developed to inform stakeholders and the public of the findings of this study and improve stewardship and compliance.** Initially, it is recommended that notice of the availability of this report and associated products are available on the atlases for the Community Mapping Network and Okanagan Conservation Planning website. The outreach strategy is recommended 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. Funding should be sought to address outreach activities and address local government implementation.

11. **Lakeshore erosion hazard mapping should be conducted for private lands to identify areas at risk, which will streamline the review process and reverse the damaging trend of unnecessary hard armoring and construction of retaining walls along the shoreline.** This methodology would be helpful to identify areas that are sensitive to erosion by boat wake. The province has formalized a methodology for lakeshore hazard mapping and this methodology, or some adaptation of it (Guthrie and Law, 2005) should be used. This mapping should be integrated with the FIM data, and be completed for each segment. Flooding, terrain stability and alluvial fan

hazard mapping should also be considered for developing areas along the lakeshore. Until lakeshore erosion hazard mapping is completed, it is advisable to only consider shoreline protection works on sites with demonstrated shoreline erosion. To accomplish this, reports by engineers or biologists should accompany proposals for shoreline armoring to ensure that works are required to minimize impacts and to ensure that bioengineering techniques are used. It may be possible to utilize the existing FIM map base, plus other associated data (e.g., SEI or others) to identify areas more prone to shoreline erosion.

12. **Stormwater management plans need to be more adequately considered in all development applications.** There are numerous examples of local storm water concerns from adjacent land development related impacts. Even non adjacent storm water has the potential to influence water quality, fish and wildlife populations, and human health (because most storm water is associated with increased levels of fecal coliforms and potentially other contaminants). In urban areas, the focus of stormwater plans should be to correct historical systems that discharged directly to streams or lakes by improving treatment of runoff prior to discharge (e.g. detention, artificial wetlands, etc.).

13. **Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources.** Developments on Wood Lake have generally only been considered individually. This is likely one of the first assessments that has looked at development related impacts on a lake wide scale. The results indicate that cumulative impacts are measurable and that trends are pointing towards increased or further impacts if management is not revised. This is analogous to the saying "Death by a thousand cuts" and local governments should ensure that development proposals do not add to the ongoing impacts observed around the lake.

14. **Compensatory works resulting from projects or portions of projects that could result in harmful alterations, destruction, or disruption of fish habitat must follow the DFO Decision Framework for the Determination and Authorization of Harmful Alteration, Disruption or Destruction of Fish Habitat[2].** The works must be consistent with the "No Net Loss" guiding principle of the DFO Policy for the Management of Fish Habitat.

15. **Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation proposed.** The goal of mitigation is to reduce the overall impact to the environment. Mitigation measures

[2] Note that the Riparian Areas Regulation does not address habitat compensation requirements because they fall under the jurisdiction of Fisheries and Oceans Canada.

reduce the overall harm to aquatic and terrestrial systems. In those cases where mitigation does not address all impacts, habitat enhancement or other forms of compensation may be appropriate. Habitat enhancement helps to restore degraded ecosystems and improve the condition of some existing ecosystems.

16. **Habitat mitigation and compensatory efforts of biophysical resources should occur prior to, or as a condition of any approval of shoreline-altering projects.** To ensure that works are completed, estimates to complete the works and bonding amounts should be collected. These bonds will ensure performance objectives for the proposed works are met and that efforts are constructed to an acceptable standard.

17. **Development of land use alteration proposals should only be approved if the compromises or trade-offs will result in substantial, long-term net positive production benefits for biophysical resources.**

18. **Low impact recreational pursuits (biking, non motorized boating, etc.), pedestrian traffic and interpretive opportunities should be encouraged.** These activities should be directed to less sensitive areas, and risks to biophysical resources should be considered. Only activities that will not diminish theproductive capacity of biophysical resources should be considered.

19. **Helical screw anchors should be utilized as a first choice for mooring buoy anchors.** The significant numbers of mooring buoys with concrete anchors has been identified as a measurable loss of productive habitat. All current mooring buoys and any new mooring buoys should be installed using screw anchors and should follow other applicable legislation.

20. **A lakeshore management plan developed jointly by all three levels government and First Nations is required to ensure that an integrated shoreline management approach across jurisdictions is achieved.** There has been a dramatic increase in the desire to live and recreate in the Okanagan Valley. The increased development pressure is resulting in more moorage applications (either public or private) and development proposals to increase density along the shoreline. The analysis of historical data indicates that change is occurring and in some cases at a fairly fast pace. Local, provincial, and federal agencies need to identify what the maximum proposed buildout for Wood Lake will be and develop a cross jurisdictional plan to achieve this goal. The management plan should incorporate the clear set of objectives recommended above to provide guidance on whether management measures are achieving success. The development of this document should be made sooner rather than later, because it is probable that there will be a continued incremental loss over time as rural properties are proposed for increased density. Although the specific rates of change

cannot be accurately predicted at this time using data currently available, nearly all metrics for rates of change (e.g., Percent Natural Shoreline, Number of Modifications, etc.) indicated that the state of the shoreline is declining. If the build out on the lake does not occur with coordination at all levels of government, the impacts identified in this report cannot be effectively mitigated (i.e., it is better to work as part of a larger regional initiative than as solitary jurisdiction). Further, if the build out occurs without implementation of appropriate measures, it is possible that some of the rates of change documented here could occur on similar orders of magnitude. Items to consider when developing more long term management objectives include:

a. addressing substrate alteration occurring around the lake to prevent further degradation of important kokanee spawning habitats, remaining wetland areas, and important floodplains;
b. implementing sufficient measures, including ensuring adequate budget, to provide for a long term watershed management approach. The Okanagan Basin Water Board is currently an agency that has taken a leadership role in this aspect and is developing valuable tools for better water management;
c. addressing construction of moorages in Very High and High value areas by identifying areas where moorage is not appropriate. Appropriate alternatives should be developed to address moorage shortages that may arise in areas deemed unsuitable for docks or marinas. Ultimately, a moorage plan for the lake as a whole should be developed that considers habitat sensitivity, recreational carrying capacity, and other identified factors;
d. adjusting terms of occupation to ensure foreshore protection measures are incorporated (e.g., shorter moorage tenure terms with renewal based upon foreshore condition) and that public resources are appropriately protected (e.g., kokanee stocks).
e. providing sufficient moorage and boat access (e.g., boat ramps, parking, etc.) in appropriate locations to offset concerns in Very High and High value areas;
f. incorporating on land storage facilities for boats with suitable boat access facilities;
g. considering including public moorage in all private moorage facilities as a mechanism to offset demands in areas where moorage is not favoured;
h. identifying and preserving key linkages to areas identified as Core Conservation Areas, Wildlife Corridors, or Other Important terrestrial areas;
i. addressing the presence of critical kokanee spawning areas;
j. addressing the presence of important waterfowl, including identifying appropriate boating and recreational best use practices that will help avoid impacts to potential nesting areas;

k. ensuring that the lakeshore management plan considers the Biodiversity Conservation Strategy currently being developed for the Okanagan Basin;
l. identifying important drinking water intakes and incorporating appropriate buffers to avoid potential impacts with associated land development activities;
m. including allowances to address known data gaps (some have been identified in this report), including identification of other key habitat elements around the shorelines of Wood Lake that are not included in this analysis. Key linkages not considered include herptile access locations, rare plant communities, etc.;
n. identifying the most appropriate mechanisms for compliance and enforcement monitoring. Consistent and easily enforceable compliance mechanisms are required because it is apparent that substantial works have occurred that are not in compliance with standard best practices;
o. including regulations and guidelines for new development, re-development and management of existing development;
p. designating protection of critical areas;
q. exploring a memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities; and
r. considering other shoreline development guidelines and foreshore plans completed or currently being developed for Wood Lake.

6.2 Future Data Management

Future data management is extremely important to ensure that data collected during the FIM projects and subsequent AHI analyses is available, accurate, and up to date. Future data collection should be integrated into the existing concise GIS dataset. The following are recommendations for future use of the FIM dataset:

1. **One agency should take the lead role in data management and upkeep**. This agency should be responsible for holding the "master data set". Although the data may be available for download from numerous locations, one agency should be tasked with keeping the master copy for reference purposes. The Community Mapping Network is currently publishing many of the data sets that have been collected. Sufficient funding must be allocated to CMN to keep up with management of the data because as there becomes more datasets costs of management will increase. Formal data management may however, be best achieved by the Okanagan Basin Water Board, which has funded most of the GIS inventory works. Another possibly more feasible, local option is the OCCP through the Okanagan Habitat Atlas program. Again however, sufficient funding needs to be in place to appropriately manage and keep the data.

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

3. **Review and update of FIM/AHI and mapping should occur on a 5 year cycle.** Review and update of the FIM will be required to determine if shore line goals and objectives are being achieved. Previous analyses have identified that 6 years is a sufficient period of time to document change. For this reason, the timing of inventory cycles should be around 5 years. In a perfect world, changes to the FIM data set would be done as projects are approved (i.e., real time). However, at this time, it is unlikely that capacity exists to establish such a system.

6.3 Future Inventory and Data Collection

The following are recommendations for future biophysical inventory and associated indices that will help facilitate environmental considerations in land use planning decisions. These recommendations need not be completely only by local agencies but might be considered as potential topics for a graduate thesis.

1. **Data regarding shore spawning locations for resident fish species is limited.**Numerous resident fish species have been identified within the lake system. In our review, there is only limited data regarding shore or stream spawning locations for these fish species. Future inventory of important areas for these species should be conducted.

2. **The Juvenile Rearing Suitability Index should be field confirmed**. The rearing index that was developed for this project is based upon surveys in Shuswap Lake and a rearing index developed for Mabel Lake. There are differences between Mabel Lake and Wood Lake and the index utilized for this assessment should be adjusted according to results of a field program that samples different shoreline areas and types during different seasons. This type of analysis could also be replicated across different lake types to better assess the relative value of different shoreline areas to juvenile salmonids. Similar investigations into utilization and importance of the different shore types by resident fish stocks may also yield information regarding the relationships between juvenile rearing suitability, fish stocks, and shore type.

3. **A field sampling program of the different shoreline areas should be developed to confirm the results of the AHI**. The AHI has been developed based upon information that is currently available for Wood Lake, upon review of other studies, and air / GPS stamped still photo / GPS Video. However, numerous assumptions have been built into the index and a field sampling program should be developed to confirm the results of the assessment and to test assumptions of the index.

4. **In addition to the Western Ridged Mussel mentioned in this assessment, other bivalves may be present in Wood Lake and should be inventoried to identify any species of significance and their importance with the lake system.** Bivalves are good species to use as indicators. By mapping known locations, and identifying their spatial extents, it will be much easier to monitor future change in the populations. Further, monitoring of these populations may point to early warnings if the lake system is not functioning properly.

5. **The Sensitive Habitat Inventory and Mapping (SHIM) is a GIS based stream mapping protocol that provides substantial information regarding streams and watercourses and should be conducted on all watercourses around the lake**. This mapping protocol provides useful information for fisheries and wildlife managers, municipal engineering departments (e.g., engineering staff responsible for drainage), and others. This information is also extremely useful for Source Water Protection initiatives because it identifies potential contaminant sources in an inventory. Many of the streams around the lake have already been mapped. Follow up assessments should be completed on a 5 to 8 year timeframe.

6. **Future shore spawning enumerations should identify the spatial locations of spawning activity for other fish species.** Shore areas are critical habitat features necessary to the maintenance of healthy populations. Spatial data regarding the locations and numbers of individuals will provide data on species other than kokanee. This data will help managers to track changes over time and better relate changes in the watershed to changes in fish production. GIS enumeration will be a key component of any successful, long term fisheries management project.

7. **Wetlands are extremely productive and important components of our ecosystems and these features should be inventoried**. Numerous low flood and mid flood benches and shore marshes were mapped during this survey. Detailed Wetland Inventory and Mapping (WIM) of these features is recommended. Detailed mapping of terrestrial wetlands is also important to ensure that linkages between foreshore and upland areas are achieved.

8. **An inventory of high value habitat islands in urbanized areas should be conducted where settlement is concentrated.** In many cases, small sections of higher habitat quality were observed in segments ranked Moderate to Low. These areas were typically areas that had well-established native vegetation or relatively natural shorelines. Development applications proposed in these "islands" of higher habitat quality should avoid disturbance to these "islands" as much as possible. A survey of these small "islands" would clarify which segments contain "islands" and would help aid planning objectives. This could form part of a riparian mapping exercise, where all shoreline vegetation is mapped and coded appropriately (e.g., coded and lawn, landscaped, coniferous, riparian, etc.). This information could also form part of the biodiversity strategy.

9. **A carrying capacity analysis of the lake should be completed.** In this case, the carrying capacity refers to a lake's ability to accommodate recreational use (e.g., boating) and residential occupation without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors. Biological systems are extremely difficult to predict and manage. Currently, these fish and wildlife ecosystems are experiencing rapid changes due to a variety of factors including, but not limited to land development (e.g., water consumption may be exceeding the capacity of some streams, etc.) and climate change. At this point, it appears that the significant biological resources around the lake are maintaining viable populations.

Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is very difficult and therefore a conservative or precautionary approach is required. Determining carrying capacities on our large, interior lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values.

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

11. **The addition of new segment breaks in long segments should be assessed in the future.**Some segments, predominantly in more natural areas, are quite long. Future mapping updates may wish to assess some new segment breaks on longer segments as more information is collected. Features that should be considered as part of more detailed segment mapping include the locations of small tributaries, seepages, streams in natural areas, etc.

12. **Native beds of submergent and floating vegetation should be mapped in detail.** More detailed mapping, maybe as part of a Wetland Inventory and Mapping project, would help better classify and described these rare, sensitive features.

13. **Conduct a more detailed analysis of habitat restoration opportunities, including riparian restoration.** An Aquatic Restoration potential analysis (AHI_POT) which was completed by removing instream features from the AHI results. This analysis provides a summary of potential locations where habitat improvements are possible along the shoreline. This analysis *does not consider improvements to riparian vegetation*. A more detailed analysis of habitat restoration opportunities, including riparian restoration is advised in the future because riparian restoration activities will provide substantial habitat benefits to the lake.

14. **Further research on the extents and magnitude of AHI devaluation due to construction of modifications is required.** The common modifications that were observed that could be easily quantified were added to the habitat index. The devaluing effects of modifications were determined through a series of iterations and are consistent with other large lakes. Further research is needed to confirm the approach taken and the weightings applied to different factors in the analysis.

7.0 CONCLUSIONS

The following report documents the current condition of 17 km of shoreline on Wood Lake. The assessment provides background information summarizing the relative value of the upland and terrestrial zones and foreshores of Wood Lake. An Aquatic Habitat Index (AHI) was developed that used biophysical information collected during the survey to rank the relative environmental sensitivity of the shore zone areas around the lake. Recommendations are presented to help integrate this information into local land use planning initiatives.

Approximately 16% of the shoreline that remains in natural condition and represents almost 3 km of shoreline. In total, 20% of the shoreline is ranked as Very High value and these very high habitat value areas tended to occur stream confluences, or their associated floodplains, or on gravel and rocky shores with suitable kokanee spawning habitats. Approximately 2 % is ranked as very low value and these areas tended to be associated with areas that have been impacted.

The most notable shoreline modifications that were observed were road and railway construction, docks, retaining walls andboat launches. In total, approximately 47% of the shoreline has had substantial substrate modification from these activities. These impacts, along with riparian vegetation disturbance, are considered the most significant habitat degradations observed around the lake.

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GLOSSARY OF TERMS AND ACRONYMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Foreshore Inventory and Mapping
FIGURE BINDER

Mapsheet - 1

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.

Segment Number:42
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:41
Shore Type/Land Use: Gravel/Commercial
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]Yes/[2]Yes/[3]Yes/[4]No
Juvenile Rearing: High

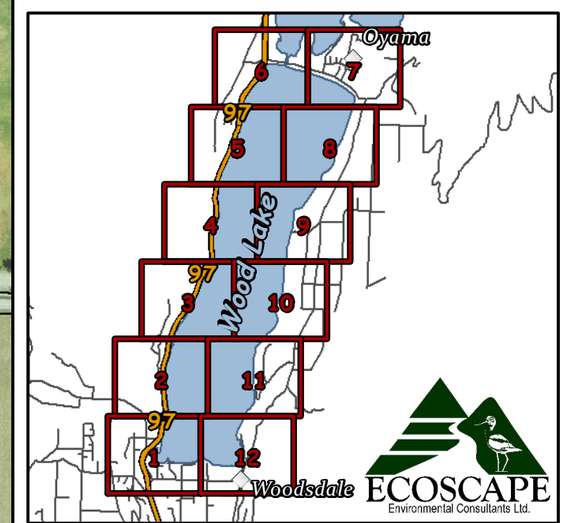
Segment Number:37
Shore Type/Land Use: Sand/Park
Level of Impact: Medium (10-40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: High

Segment Number:38
Shore Type/Land Use: Sand/Single Family
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]Yes/[2]Yes/[3]No/[4]No
Juvenile Rearing: High

Segment Number:40
Shore Type/Land Use: Sand/Single Family
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]Yes/[2]Yes/[3]No/[4]No
Juvenile Rearing: High

Segment Number:39
Shore Type/Land Use: Stream Mouth/Single Family
Level of Impact: High (>40%)
Habitat Index Rating: Very High
Rare Plant Presence:No
Fisheries Information: [1]Yes/[2]Yes/[3]Yes/[4]No
Juvenile Rearing: High

Water Intake
97 HWY
OKANAGAN CENTRE EAST ROAD
BREW ROAD
MIDDLETON ROAD
OCEOLA ROAD
PRETTY ROAD
ROBINSON ROAD
MEMAG ROAD
WOODSDALE COURT
WINFIELD CREEK
VERNON CREEK
BOTTOM WOOD LAKE ROAD
CLEMENT ROAD
WOODSDALE ROAD
REIMCHE ROAD
REDECOPP ROAD
Lake Country
Oyama
Wood Lake
Woodsdale



100 50 0 100 200 300
Meters

Mapsheet - 2

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.

Segment Number:43
Shore Type/Land Use: Gravel/Commercial
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low

Segment Number:42
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Lake Country

SHORELINE DRIVE
LAKE HILL DRIVE
CLIFFSHORE DRIVE
OLD MISSION ROAD
PONDEROSA DRIVE
LAKE VISTA COURT
LAKE BREEZE COURT
SYLVIA LANE
OCEOLA ROAD
HWY 97

Oyama
Woodsdale
Wood Lake

ECOSCAPE
Environmental Consultants Ltd.

100 50 0 100 200 300
Meters

Mapsheet - 3

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

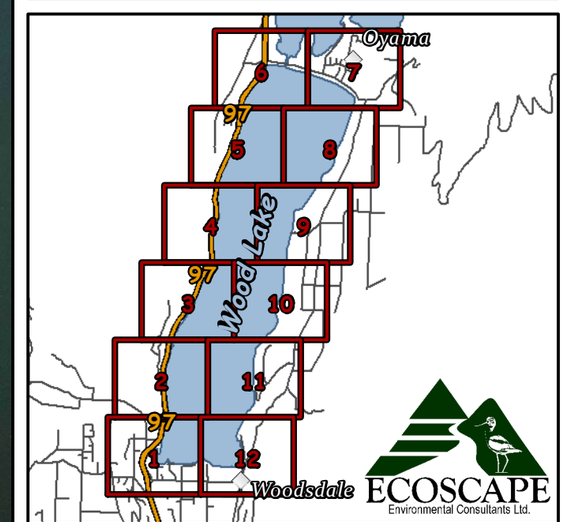
Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.



100 50 0 100 200 300
Meters

Segment Number:44
Shore Type/Land Use: Rocky Shore/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low

Lake Country
97 HWY
PARKSIDE CRES
EAST RIDGE DRIVE
CLIFFSTONE COURT
OLD MISSION ROAD
EAST RIDGE COURT
PONDEROSA DRIVE
44
43
OV
EV
SEV

327300 327400 327500 327600 327700 327800 327900 328000 328100 328200 328300 328400 328500 328600 328700 328800
5550400 5550300 5550200 5550100 5550000 5549900 5549800 5549700 5549600 5549500 5549400 5549300 5549200

Mapsheet - 4

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

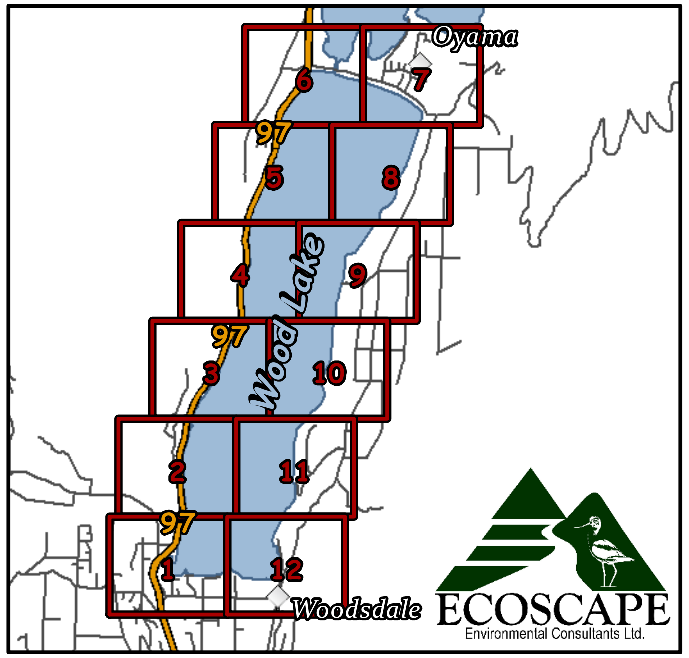
- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

N

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: 1Staging (Yes/No)/2Migration (Yes/No)/
3Salmon Spawning Stream (Yes/No)/4 Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.



ECOSCAPE
Environmental Consultants Ltd.

100 50 0 100 200 300
Meters

Mapsheet - 5

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

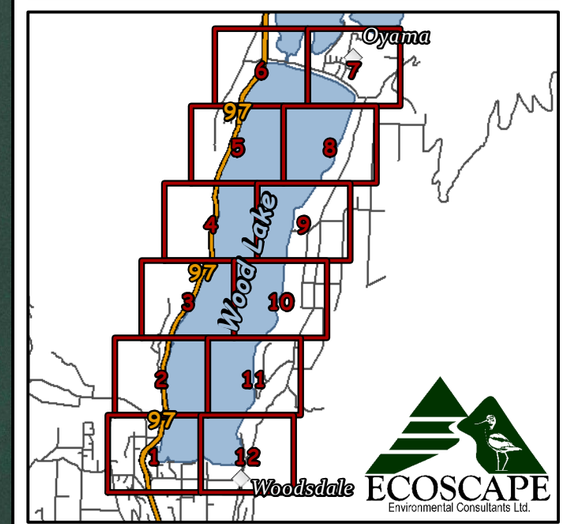
Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.

Segment Number:47
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]Yes/[3]No/[4]No
Juvenile Rearing: High

Segment Number:79
Shore Type/Land Use: Rocky Shore/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Low
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low

Segment Number:46
Shore Type/Land Use: Rocky Shore/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Low
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low



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100 50 0 100 200 300
Meters

Mapsheet - 6

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

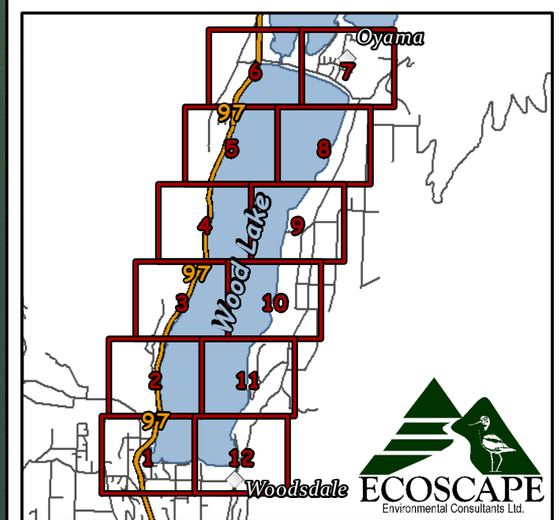
Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/ [3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.

Segment Number:48
Shore Type/Land Use: Sand/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Low
Rare Plant Presence:No
Fisheries Information: [1]No/[2]Yes/[3]No/[4]No
Juvenile Rearing: High

Segment Number:47
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]Yes/[3]No/[4]No
Juvenile Rearing: High



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Meters

Mapsheet - 7

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

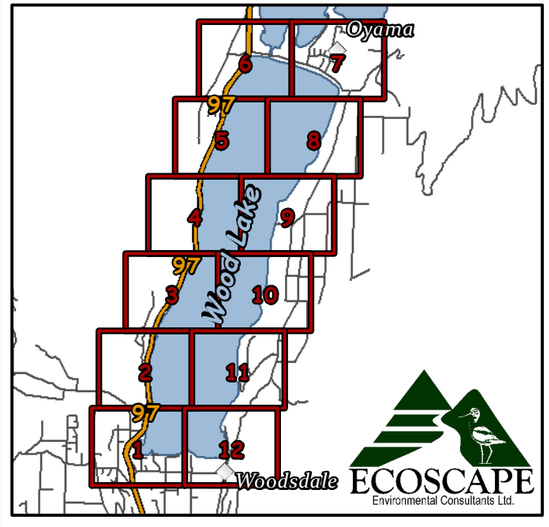
- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.

Segment Number:27
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Very High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]Yes/[3]No/[4]No
Juvenile Rearing: High



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Meters

Mapsheet - 8

Foreshore Inventory and Mapping

Wood Lake

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Segment Number:28
Shore Type/Land Use: Gravel/Transportation
Level of Impact: Medium (10-40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

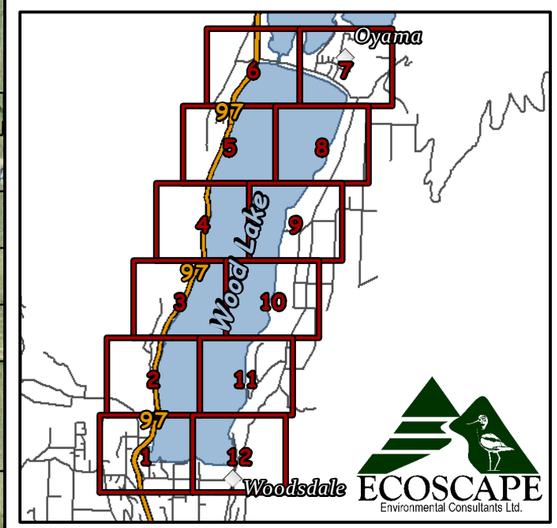
Segment Number:29
Shore Type/Land Use: Gravel/Rural
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

SEV
28
29
Abandoned Dock
Lake Country
MIDDLE BENCH ROAD
OYAMA ROAD
CRAWFORD ROAD

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/ [3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.



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5552900 5552800 5552700 5552600 5552500 5552400 5552300 5552200 5552100 5552000 5551900 5551800 5551700

Mapsheet - 9

Foreshore Inventory and Mapping

Wood Lake

Segment Number:29
Shore Type/Land Use: Gravel/Rural
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:30
Shore Type/Land Use: Wetland/Rural
Level of Impact: Low (Less than10%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:78
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low

CRAWFORD ROAD
OYAMA ROAD
ALLISON ROAD
CLIFF ROAD
BROADWATER ROAD
MIDDLE BENCH ROAD
Lake Country
29
30
78
EV

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
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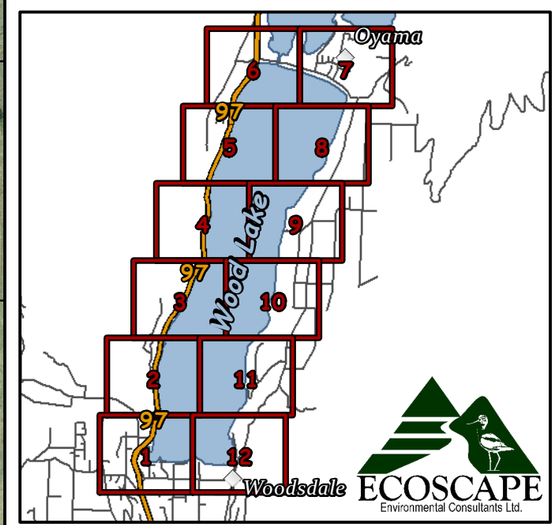

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Meters

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5551600 5551500 5551400 5551300 5551200 5551100 5551000 5550900 5550800 5550700 5550600 5550500 5550400

Mapsheet - 10

Foreshore Inventory and Mapping

Wood Lake

Segment Number:78
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Low

Segment Number:31
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

78
31
OV
OVAMA ROAD
TOWGOOD ROAD
BROADWATER ROAD
TREWHITT ROAD
RIBBLEWORTH CREEK
Lake Country

Legend

- 999 — Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
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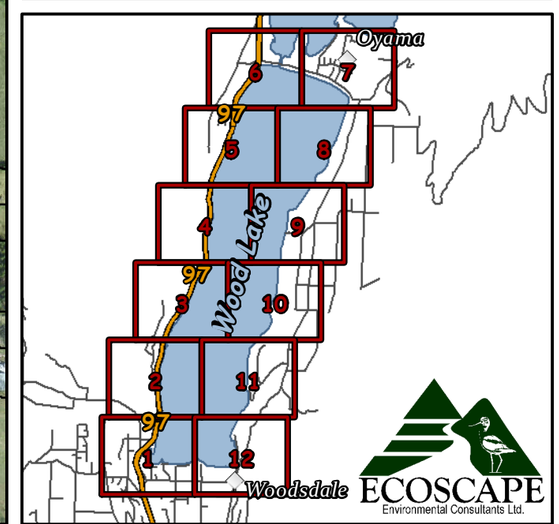

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Meters

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5550400 5550300 5550200 5550100 5550000 5549900 5549800 5549700 5549600 5549500 5549400 5549300 5549200

Mapsheet - 11

Foreshore Inventory and Mapping

Wood Lake

Segment Number:31
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:32
Shore Type/Land Use: Gravel/Single Family
Level of Impact: High (>40%)
Habitat Index Rating: Moderate
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:33
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Lake Country

EYLES ROAD
OYAMA ROAD
TREWHITT ROAD
RIBBLEWORTH ROAD
WEBBER ROAD

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
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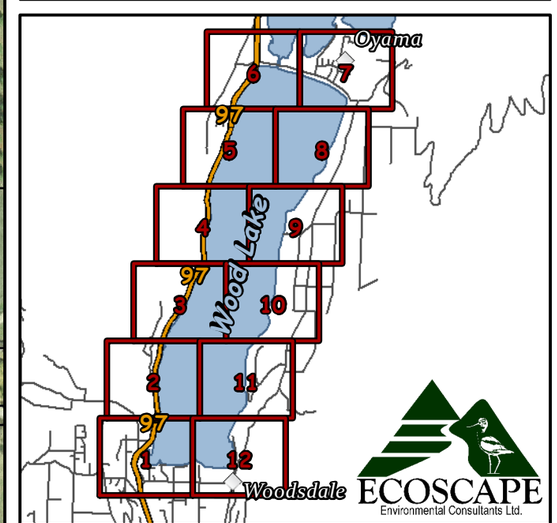

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5549100 5549000 5548900 5548800 5548700 5548600 5548500 5548400 5548300 5548200 5548100 5548000 5547900

Mapsheet - 12

Foreshore Inventory and Mapping

Wood Lake

Segment Number:33
Shore Type/Land Use: Gravel/Transportation
Level of Impact: High (>40%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:34
Shore Type/Land Use: Sand/Single Family
Level of Impact: High (>40%)
Habitat Index Rating: Low
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: Moderate

Segment Number:36
Shore Type/Land Use: Sand/Multi Family
Level of Impact: High (>40%)
Habitat Index Rating: Very Low
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: High

Segment Number:35
Shore Type/Land Use: Sand/Park
Level of Impact: Low (Less than 10%)
Habitat Index Rating: High
Rare Plant Presence:No
Fisheries Information: [1]No/[2]No/[3]No/[4]No
Juvenile Rearing: High

33 34 35 36 37

OV OV OV S

OYAMA ROAD
WILLETT ROAD
WOODSDALE ROAD
REISWIG ROAD
LODGE ROAD
DARLENE ROAD
REDECOPP ROAD

Lake Country

Legend

- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Cadastre
- Electoral Area / Municipal Boundary
- Streams
- Segment Break

Biophysical Habitat Index

- Very High
- High
- Moderate
- Low
- Very Low

Foreshore Inventory and Mapping Point Features

- Abandoned Dock
- Boat Launch
- Water Intake
- Other

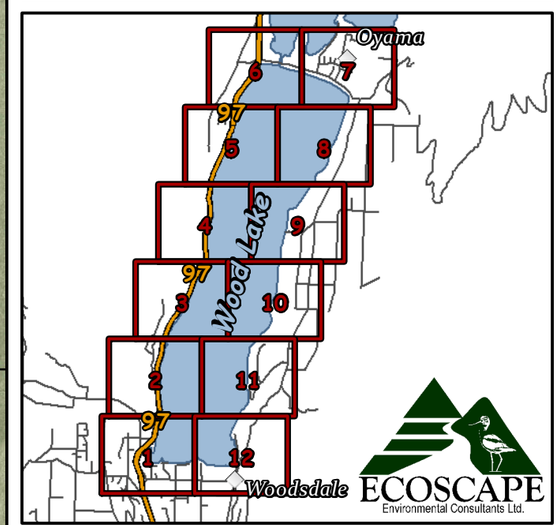
Vegetation

- Emergent Vegetation (EV)
- Emergent Vegetation and Overhanging Vegetation (EVOV)
- Floating Vegetation (FV)
- Marsh (M)
- Overhanging Vegetation (OV)
- Shallow Open Water Wetland (OW)
- Riparian (R)
- Swamp (S)
- Sparse Emergent and Overhanging Vegetation (SEOV)
- Sparse Emergent Vegetation (SEV)
- Submergent Vegetation (SV)

Label Key

Segment Number: Segment Number
Shore Type/Land Use: Shore Type/Land Use
Level of Impact: Rating (High, Moderate, Low, None)
Habitat Index Rating: Rating (Very High, High, Moderate, Low, Very Low)
Rare Plant Presence: (Yes/No)
Fisheries Information: [1]Staging (Yes/No)/[2]Migration (Yes/No)/
[3]Salmon Spawning Stream (Yes/No)/[4] Mussel Presence (Yes/No)
Juvenile Rearing: Rating (High, Moderate, Low)

Note:
Kokanee spawning, rare plant presence and mussel presence with a "No" result means that a species has not been detected or the habitat unit is not believed to be present given the data available. Since species and habitat surveys are limited, failure to detect does not imply that species or habitat units are not present. Individuals are advised to use diligence and qualified professionals to ensure adequate surveys to confirm presence and to ensure that proposed works do not result in harm to habitat units or species.



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Meters

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APPENDIX A
Detail Methodology

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.

Acknowledgements

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

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

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

Helpful comments and reviews of this document were completed by:

Brad Mason, Community Mapping Network
Interior Reforestation Ltd.

This report should be cited as:

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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. Ouput 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.

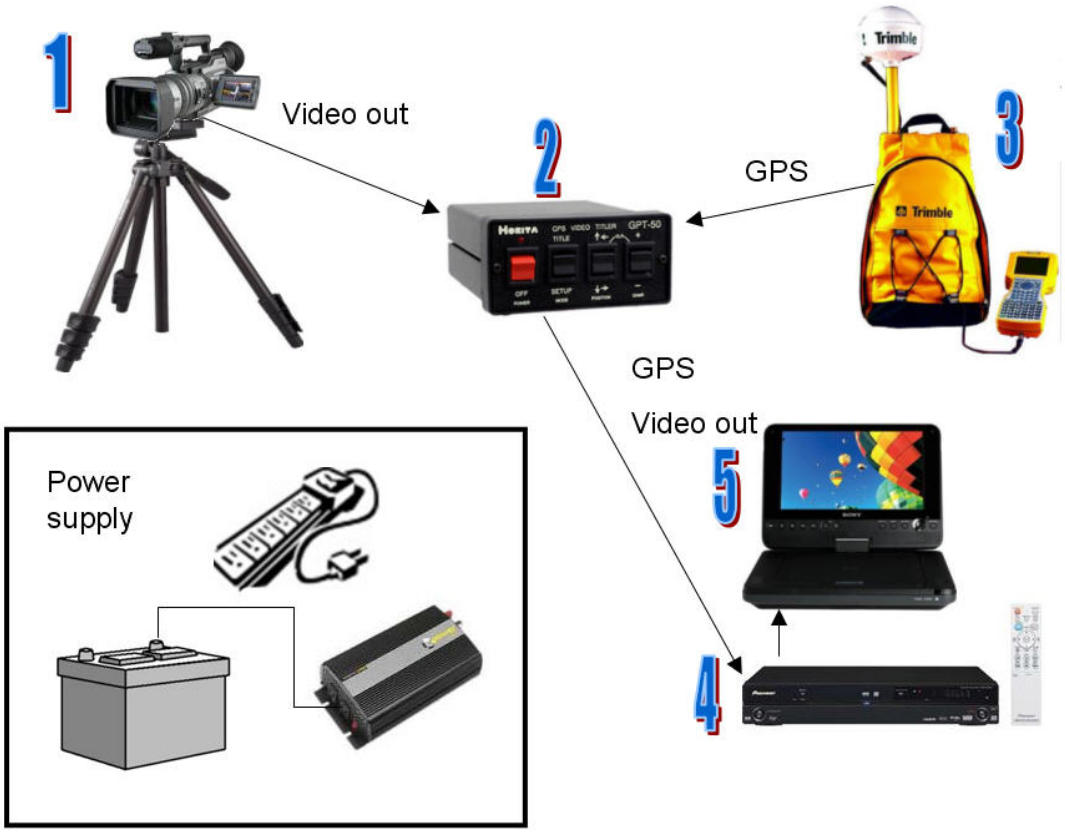


Figure 1: Shoreline video setup. 1) Digital video camera, 2) GPS stamper unit, 3) GPS data logger and receiver, 4) Digital video recorder, 5) Digital video player

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

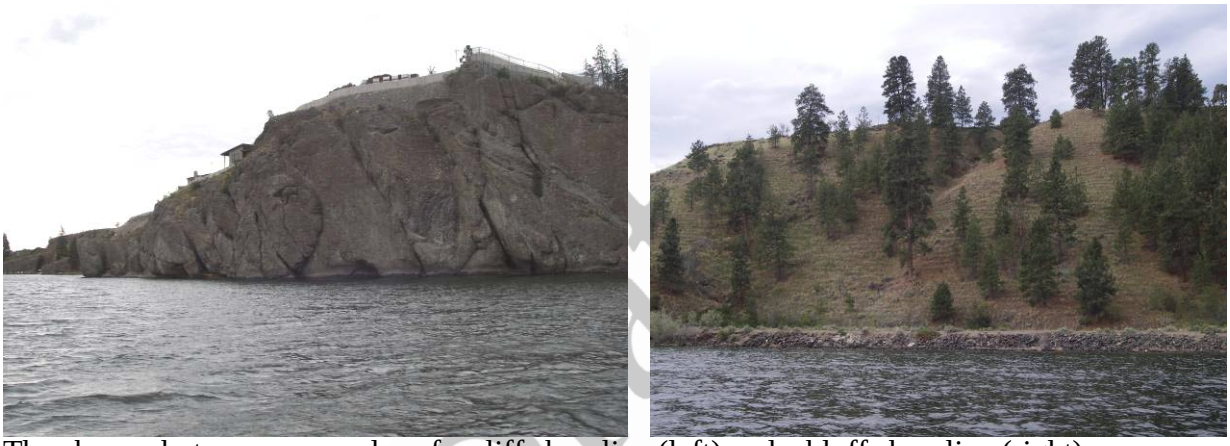
The Shore Type section is intended to provide a summary of the different shore types that may occur over the entire shore segment. In many cases, one shore type will be predominant in a segment, with other shore types occurring to a smaller extent. Examples of this include rocky shorelines, with intermittent 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

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
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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]
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```
   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
```

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

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

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

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

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

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

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

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

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

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

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

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

1_Riparian              Line Feature
```

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

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

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

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

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

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

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

Appendix D – Brief GPS Overview

Global Positioning System (GPS)

Theory

What is GPS?

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

GPS System Configuration

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

Position Computation

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

Sources of Error

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

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

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

Increasing Accuracy of Position

Dilution of Precision (DOP) Mask

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

Position Correction: Differential GPS

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

Post-Processing Reference Data

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

Real-Time GPS Surveying

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

Sound to Noise Ratio (SNR) Mask

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

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

Elevation Mask

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

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

Accuracy Requirements for SHIM

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

General Field Methods for Poor GPS Reception

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

Using the Trimble Pathfinder

Upload the Data Dictionary from Pathfinder Office
Configure GPS

Field Mapping

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

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

Entering Shoreline Information

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

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

APPENDIX B
Data Tables

Table 1: The Shore Length and Percentage of Shoreline Areas Classified as Having High, Moderate or Low Juvenile Rearing Value on Wood Lake

Juvenile Rearing Category	# of Segments	Shore Length (m or %)				
		Natural (m)	Natural (%)	Disturbed (m)	Disturbed (%)	Total
High	11	900.6	5.2	5347.8	31.0	6248.4
Moderate	9	1987.0	11.5	5440.8	31.6	7427.8
Low	4	18.3	0.1	3537.1	20.5	3555.3
Total	24	2905.9	16.9	14325.7	83.1	17231.6

Table 2: The Length of Natural and Disturbed Shorelines within the Different Okanagan Large Lakes Protocol Kokanee Shore Spawning Areas.

	Black		Red		Yellow		No Colour	
	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed	Natural	Disturbed
Percent	0%	0%	5%	95%	15%	85%	23%	77%
Length (m)	0	0	233	4383	411	2282	2261	7661

Table 3: The shoreline that is natural and disturbed (m and %) within each of the different AHI rankings.

AHI Rank	Natural		Disturbed	
	m	%	m	%
Very High	595.2477	17.2%	2874.879	82.8%
High	2263.91	31.2%	4988.433	68.8%
Moderate	46.6998	1.0%	4545.977	99.0%
Low	0	0.0%	1551.509	100.0%
Very Low	0	0.0%	364.9031	100.0%