Foreshore Inventory and Mapping and Aquatic Habitat Index

Jimsmith Lake

Prepared For:

East Kootenay Integrated Lake Management Partnership

Prepared By:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.

April, 2011

File No. 10-682

FORESHORE INVENTORY AND MAPPING AND AQUATIC HABITAT INDEX

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EAST KOOTENAY INTEGRATED
LAKE MANAGEMENT PARTNERSHIP

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EXECUTIVE SUMMARY

The east Kootenay region of BC has experienced an increase in residential development over the years, raising concerns related to pressures on local natural resource values. As the population within the Columbia watershed has grown, development pressure has spread to areas such as Jimsmith Lake near Cranbrook, BC. It has become apparent that the increased development pressure has the potential to degrade the inherent natural beauty and high recreational values within the watershed and cause negative impacts to fish, wildlife, and water quality. The spread of development to remote areas is the result of an increasing demand for lakeside vacation homes and year-round residences with better overall servicing and access. The increasing development pressures present an opportunity to assess and address foreshore conditions and lakeside development concerns to produce sustainable management plans for future proposed development.

In response to the need for better lake planning and management, the East Kootenay Integrated Lake Management Partnership (EKILMP) undertook an environmental assessment and biophysical inventory of Jimsmith Lake to document the current condition of the foreshore and to facilitate the development of an integrated approach to the watershed management. This report has been prepared based upon the belief that it is possible to manage this shoreline and the natural surrounding area in a responsible, sustainable manner.

Jimsmith Lake and the associated watershed contribute fresh water and nutrients to the Columbia basin within the Rocky Mountain Trench. According to the BC Fisheries Information Summary System (FISS), the lake and its tributaries historically supported resident populations of burbot, rainbow trout, and westslope cutthroat trout. Over time, rainbow and cutthroat trout have been replaced by non-native game fish including eastern brook trout, largemouth bass, and yellow perch. Coarse species such as redside shiner also occur, which provide forage for other fish. The shoreline and associated riparian areas also provide important habitat for a wide variety of wildlife species, including raptors (e.g., osprey, bald eagles), song birds, large game (e.g., deer and moose), and numerous other species of birds and small mammals.

Similar lake management projects within BC follow a three-step process described below.

1. Foreshore Inventory and Mapping (FIM) is a protocol that is used to collect baseline information regarding the current condition of a shoreline. The FIM uses a mapping based (GIS) approach to describe shorelines. These inventories provide information on shore types, substrates, land use, and habitat modifications. This new information has been combined where possible, with other mapping information such as previous fisheries inventories, recent orthophotos, and other information.

2. An Aquatic Habitat Index (AHI) is generated using the FIM data to determine the relative habitat value of the shoreline. This index follows similar methods that were developed for Shuswap Lake and is similar to other ongoing assessments along lakes in the Kootenay region. The AHI uses factors such as biophysical criteria (e.g., shore type, substrate information, etc.), fisheries information (e.g., juvenile rearing suitability, migration and staging areas), riparian conditions (e.g., width and type of riparian community), terrestrial conditions (e.g., veteran trees, snags), and modifications (e.g., docks, retaining walls, etc.) to estimate the relative habitat value of each discrete shoreline segment. The AHI classifies this information in a 5-category system from Very High to Very Low and describes the relative value of the shoreline segments to one another (i.e., compares shoreline segments along Jimsmith Lake to each other and not to other lakes).

3. Shoreline Management Guidelines are prepared to identify shoreline vulnerability zones or sensitivity to changes in land use or habitat modification. Shoreline vulnerability zones are based upon the AHI described above. The shoreline vulnerability zones are identified using a risk-based approach to shoreline management, assessing the potential risks of different activities (e.g., construction of docks, groynes, marinas, etc.) within the shoreline segments. The Guidelines are intended to provide background information for stakeholders, proponents, and governmental agencies when land use changes or activities are proposed that could alter the shoreline, thereby affecting fish or wildlife habitat.

The FIM results provide valuable information regarding environmental features, habitats, and other information for the shorelines of Jimsmith Lake. A summary of the results of the data analysis includes the following:

- The level of impact along the Jimsmith Lake shoreline was determined based upon categorical descriptions of the level of disturbance observed along the lake. It is estimated that 18.7% of the shoreline has a high level of impact (greater than 40% disturbance) which accounts for 511 m of shoreline. Areas of moderate impact (between 10 to 40% disturbance) account for 49.4% or 1350 m while areas of low impact (less than 10% disturbance) account for 31.9% or 871 m of the shoreline. There is 0% shoreline that is believed to have no impact. Impacts along the shoreline include lakebed substrate modification, riparian vegetation removal, retaining wall construction, docks, and beach grooming. Overall, it is estimated that approximately 25% (i.e., 684 m) of the shore length is disturbed and 75% (i.e., 2047) is natural.

- The most predominant land use around the lake is natural area (32.2%) followed by single family (24.8%) and rural (24.3%) areas. Other land uses include agricultural (12.1%) and park (6.6%).

- Wetland is the most common shore type along the lake, representing 80.7% of the entire shore length. Other shore types around the lake include Sand Beach (10.2%), Stream mouth (5.0%), and Gravel (4.0%).

- Aquatic vegetation was frequently observed and occurs along 77% of the shoreline length. Of this, emergent vegetation (e.g., cattail and bulrush) was the most commonly observed making up 75.3% of the total shoreline. Native beds of submergent vegetation were documented along 30.7% of the shoreline, and areas of floating vegetation were observed along 28.5%.

- Habitat modifications observed along the Jimsmith shoreline include the following:
    - Docks were the most common modification observed, with a total of 12. These were primarily observed within Segment 6;
    - Retaining walls were the next most predominant modification, with a total of 3;
    - A single groyne feature (i.e., concrete barrier) was observed adjacent to the sand beach within Segment 1; and
    - One (1) boat launch was observed within Segment 1.

The FIM results indicate that the Jimsmith Lake shoreline has been moderately impacted by land use practices. Reliance on provincial Best Management Practices (BMPs) and voluntary compliance with regulations and guidance documents is not providing the required protection of important fish and wildlife habitats along the shoreline. Shoreline modifications that encroach upon Crown Land (i.e., below the lake high water level) were observed. All relevant agencies and stakeholders need to work with the public to improve communication and education to ensure that everyone is aware of the habitats present, their values, and the potential influences development activities may have upon them. Recommendations for

public awareness and stewardship are presented to facilitate public involvement and compliance in the protection of foreshore. The combination of education and cooperative enforcement will help mitigate development impacts and help promote sustainable management of the foreshore.

The AHI for Jimsmith Lake 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 from Very High to Very Low. The following summarizes the results of the AHI analysis:

- Approximately 48.2% of the total shoreline is ranked as High or Very High. These areas are typically characterized by wetlands, spawning streams, aquatic vegetation, and terrestrial features such as veteran trees and snags.

- Approximately 27.0% of the total shoreline is ranked as Moderate. Moderate value areas generally occur along shoreline segments impacted by modifications and habitat alteration. These areas provide suitable fish rearing and riparian habitat but have been impacted by modifications related to residential and recreational development.

- Approximately 18.1% of the shoreline is ranked as Low. These areas occur along the segments characterized by residential development and shoreline modifications. These areas have lower terrestrial and fish habitat values.

- Approximately 6.6% of the total shoreline is ranked as Very Low. These areas are the most highly developed shorelines and provide the lowest habitat value for wildlife.

- All areas of the shoreline are considered suitable fish rearing habitat. Greater value was placed on shorelines with higher quality rearing habitat (i.e., intact wetland community, aquatic vegetation) and migration and staging habitat for spawning fish (e.g., stream mouths). Areas with relatively low juvenile habitat suitability still contribute to overall productivity within the lake.

- Greater value was placed on shorelines that provide connectivity between terrestrial and riparian habitats or between different aquatic ecosystems (e.g., East Angus Creek corridor). Stream confluences and adjacent features (e.g., wetlands, large woody debris, and riparian vegetation communities) tend to sustain the highest biodiversity and productivity.

- A restoration analysis for instream features was conducted by hypothetically removing shoreline modifications from the AHI and re-evaluating the segments. The restoration analysis did not include an assessment of how changes in riparian condition would improve relative habitat value. The analysis resulted in the relative value of one segment moving from low to moderate value. Habitat restoration opportunities include removal of docks, groynes, and retaining walls and restoration of native shoreline substrates. Habitat restoration opportunities should be considered with all proposed development or re-development applications.

Shoreline Management Guidelines are the final step in the three step shoreline management process and will ultimately be used to guide the development of shoreline policies, bylaws, and Official Community Plans (OCP). The guidelines will help make informed land use decisions across multiple agencies and will help streamline the permitting and regulatory processes at the various governmental levels by focusing resources on areas or activities with the greatest risks.

The inventories and analysis completed during this study are meant to identify important shoreline habitats, biophysical resources, and modifications along Jimsmith Lake. As a result, important shoreline

areas have been delineated into distinct segments (FIM) and the relative value of each has been categorized (AHI). Although impacts from shoreline modification were observed along the lake, there are important habitats present that require sustainable management to prevent further degradation and to protect the valuable natural resources provided by the lake ecosystem. The sensitive and modified shoreline areas that have been identified should be considered during future shoreline land use decisions and development proposals.

ACKNOWLEDGEMENTS

The following parties carried out fieldwork for this assessment:
Bruce MacDonald, Fisheries and Oceans Canada
Jon Bisset, Canadian Columbia River Inter-Tribal Fishery Commission
Peter Holmes, Ministry of Natural Resource Operations

GPS Video
Brad Mason, Fisheries and Oceans Canada

Funding and or in kind donations for this Project were provided by the following different agencies or parties:
East Kootenay Integrated Lake Management Partnership
Columbia Basin Trust Environmental Initiatives Program
Jimsmith Lake Community Association
Canadian Columbia River Inter-Tribal Fishery Commission

The following parties contributed to the development of the Aquatic Habitat Index:
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Recommended Citation:
Schleppe, J. and A. Patterson. 2011. Jimsmith Lake Foreshore Inventory and Mapping and Aquatic Habitat Index. Ecoscape Environmental Consultants Ltd. Project File: 10-682. Prepared for: East Kootenay Integrated Lake Management Partnership.

DISCLAIMER

The results described in this report are based upon data collected during surveys occurring over a one week period. Aquatic and riparian ecosystems are inherently complex and exhibit extreme variability in both space and time. For this reason, conservative estimates and assumptions have been used, based upon field results, previously published material, and aerial photo interpretation. Due to the intrinsic limitations of relatively brief field inventories (e.g., property access, GPS/GIS accuracies, aerial photo interpretation concerns, etc.), professionals are encouraged to complete their own detailed assessments to further evaluate and classify shoreline habitats and draw independent conclusions. Data in this assessment were not analyzed statistically and use of the word 'significance' does not imply statistical significance. Use of or reliance upon conclusions made in this report is the responsibility of the party using the information. Ecoscape Environmental Consultants Ltd., East Kootenay Integrated Lake Management Partnership, Jimsmith Lake Community Association, Columbia Basin Trust, project partners, and the authors of this report are not liable for data mistakes, omissions, or errors made in gathering data and in preparation of this report. Best attempts were made to verify the accuracy and completeness of the data collected.

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1.0 INTRODUCTION

The east Kootenay region of BC has faced increasing recreational and development pressures on local resource over the last several years related to population growth and a growing demand for lakefront development. Development pressures have spread throughout the Columbia watershed including Jimsmith Lake near Cranbrook, BC. It has become apparent that shoreline development has the potential to degrade the ecological and recreational values inherent within lake systems and result in negative impacts to riparian and aquatic ecosystems. The demand for shoreline development has led to a need to assess and address foreshore conditions and environmental concerns to create sustainable management plans for future proposed development.

The relationship between development pressure, the natural environment, and social, economic and cultural values is complex and fluctuating. To balance the various community and stakeholder values, a comprehensive understanding of aquatic and riparian resource values, land use interests, and concerns of local residents is required to develop appropriate long-term planning and policy objectives. Development of long term planning objectives at the local, provincial and federal agencies is also required so that our aquatic resources are effectively managed. Detailed shoreline inventories provide a broad foundation of environmental information which allows stakeholders to better understand the implications of proposed development on identified sensitive shoreline habitats. The intended result of the AHI is to facilitate informed land use planning decisions that balance the various public concerns while protecting important natural resources.

In response to the need for better lake planning and management, the East Kootenay Integrated Lake Management Partnership (EKILMP) undertook an environmental assessment and biophysical inventory of Jimsmith Lake to document the current condition of the foreshore and to facilitate the development of an integrated approach to the watershed management. This report has been prepared based upon the belief that it is possible to manage the shoreline and the natural surrounding area in a responsible, sustainable manner. Current management practices being implemented throughout British Columbia in the Shuswap, Okanagan and Kootenay regions are utilizing a three step process to help integrate environmental data with land use planning information to facilitate development review and decision making processes. The three step process involves the following steps:

1. Foreshore Inventory and Mapping (FIM) – FIM is a broad scale inventory process that attempts to define and describe the shoreline of lake systems. The inventory provides baseline information regarding the current condition and natural features of the shoreline, and characterizes the level of development (e.g., retaining walls, docks, groynes, etc.). The data collected allows managers and the public to monitor shoreline changes over time and to measure whether proposed land use decisions are meeting their intended objectives. 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, field reviews, and other data sources (e.g., Land and 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). The index provides an indication of the relative value of one shoreline area to another.
3. Shoreline Management Guidelines (Guidelines) - The Guidelines are the final step in the process and are intended to help land managers at all levels of government quickly assess applications and to provide the first step for review, planning, and prescribing shoreline alterations (i.e., land development) by applicants and review agencies. The assessments consider numerous other biological criteria (e.g., wetlands and shore marshes, aquatic vegetation, adjacency to sensitive terrestrial features, migration and staging areas, etc.) making it more inclusive of sensitive shoreline areas.

2.0 PROJECT OVERVIEW

Fish populations within Jimsmith Lake have been heavily modified and managed over the years. The current fishery is dominated by introduced, non-native sport fish species such as rainbow trout, yellow perch, eastern brook trout, and largemouth bass. Westslope cutthroat trout historically occurred within the lake but have been replaced by stocked species over time. The lake provides a recreational destination for fishing, boating, and swimming. Protection of the various environmental values is extremely important to maintain the function of the lake system and protect the integrity of the watershed.

Community members have raised concerns regarding the impacts of adjacent land uses and recreational activities on the lake. The Jimsmith Lake FIM project has provided an opportunity for the project partners to support an initiative that will inform future policy development and allow for improved future management of these resources. The information generated from this project and future steps will improve development of policy and management plans. From a local government perspective the project will provide a valuable resource that can be used to make informed decisions regarding land use applications. The mapping protocol will help stakeholders understand the current condition of the shoreline, set objectives for better shoreline management in Official Community Plans (OCP) or other policy documents, and measure and monitor changes in the shoreline over time.

2.1 Project Partners

FIM protocols have been developed over the last seven years and have formed a standard approach to shoreline inventory. Numerous local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol. The detailed methods (available as a separate document) provide a complete list of contributing parties. This project was funded by the Columbia Basin Trust Environmental Initiatives Program (CBT-EIP). Project partners include the following agencies and organizations:

1. East Kootenay Integrated Lakes Management Plan (EKILMP);
2. Columbia Basin Trust (CBT);
3. Canadian Columbia River Inter-Tribal Fishery Commission (CCRITFC);
4. Regional District East Kootenay (RDEK);
5. Fisheries and Oceans Canada (DFO);
6. Community Mapping Network (CMN); and
7. Ministry of Environment (MOE).

2.2 Objectives

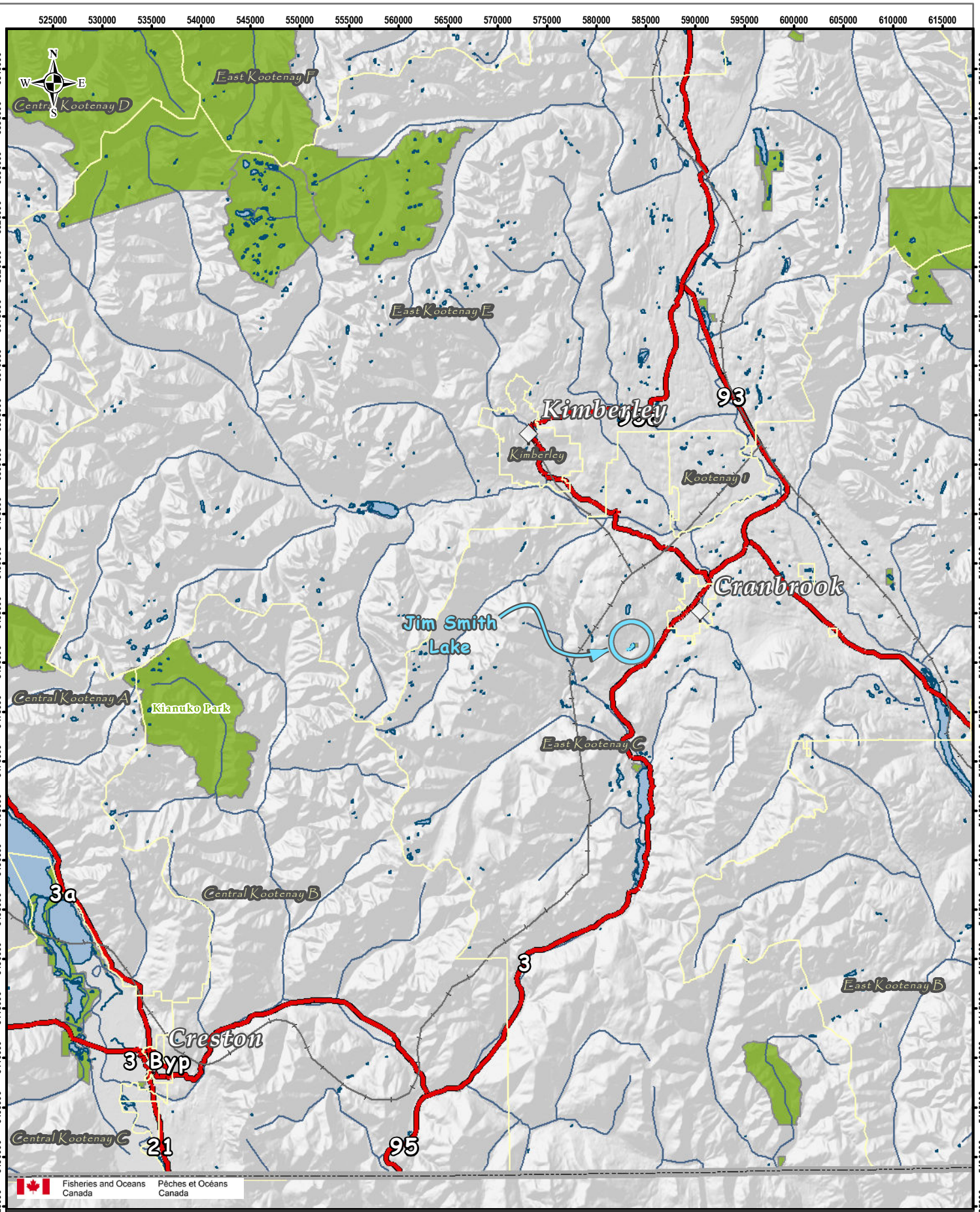
The general objectives of the Jimsmith Lake FIM project include the following:

1. Foster collaboration between EKILMP, local government (RDEK), DFO, MOE, First Nations, and local communities;
2. Compile existing map base resource information for Jimsmith Lake;
3. Provide an overview of foreshore habitat condition along Jimsmith Lake;
4. Inventory and characterize foreshore condition, current land use, riparian and aquatic ecosystem quality, fisheries values, and anthropogenic modifications;
5. Obtain spatially accurate digital video of the lake shoreline taken from a boat survey;
6. Prepare the video and GIS geo-database for loading onto the CMN at www.cmnbc.ca.
7. Collect and analyze data that will aid in prioritizing critical areas for conservation and guide sustainable shoreline development;
8. Make information available to planners, politicians, and other key referring agencies that review applications for proposed land development; and
9. Integrate information with upland development planning to ensure protection of sensitive foreshore areas that lake management planning is watershed based.

The FIM and AHI completed as part of this assessment form a basis to address these objectives. The Guidelines address more detailed planning aspects required to meet long-term objectives.

2.3 Study Location

Jimsmith Lake is located in the East Kootenay region of southeast BC, approximately 5 km southwest from the City of Cranbrook. The forest community surrounding the lake is comprised of a diverse assemblage of pine (*Pinus* sp.), spruce (*Picea* sp.), interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), and western larch (*Larix occidentalis*) mixed with black cottonwood (*Populus baslsamifera* ssp. *trichocarpa*), birch (*Betula* sp.), and trembling aspen (*Populus tremuloides*). The riparian community along the lake shoreline has a diverse structural and species composition and includes red-osier dogwood (*Cornus stolonifera*), alder (*Alnus* sp.), and willow (*Salix* sp.). Emergent vegetation along the foreshore includes cattail (*Typha latifolia*), bulrush (*Scirpus* sp.), and sedge (*Carex* sp.). The location of the study area is shown in Figure 1.



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Jim Smith Lake

Foreshore Inventory and Mapping

Figure 1 - Project Location

5 2.5 0 5 10 Kilometers

1:500,000

2.4 Important Fisheries and Wildlife Resource Information

The Jimsmith Lake fishery has been modified over the years as a result of stocking and introduction of non-native species (both legally and illegally). According to the BC FISS, fish historically present in Jimsmith Lake included burbot (*Lota lota*), eastern brook trout (*Salvelinus fontinalis*), largemouth bass (*Micropterus salmoides*), rainbow trout (*Oncorhynchus mykiss*), westslope cutthroat trout (*O. clarkii lewisi*), and yellow perch (*Perca flavescens*) (MOE 2011). The results of fish sampling in Jimsmith Lake in 2006 indicate that yellow perch were the dominant species (98% of the catch) (MOE 2006). Largemouth bass, rainbow trout, and redside shiner (*Richardsonius balteatus*) were also present and represented a combined 2% of the catch. The lake does not currently support native salmonid species and the lake tributaries are not fish-bearing (Passey, pers. comm.).

An important consideration for the future management of Jimsmith Lake is the current composition of the fishery. Years of stocking have resulted in a dominance of non-native species such as yellow perch, largemouth bass, and eastern brook trout. After habitat loss, the effect of invasive species is considered the greatest threat to freshwater fisheries (Runciman and Leaf, 2009). The non-native fish occurring within Jimsmith Lake have different ecological needs than the native fish. For example, yellow perch and largemouth bass are tolerant of warm, weedy, shallow shorelines and modification of native substrates with imported sand. These two invasive species have different and distinct effects on native fish species.

The highly fecund nature of yellow perch leads to large populations but relatively small individual sizes (MacPhail 2007). The large population leads to competition for food resources (e.g., plankton, aquatic invertebrates) with other resident fish, causing stunted growth, and a reduced overall population of the native stock (Brown et al. 2009a). Sport fish within Jimsmith Lake such as rainbow trout likely have diminished sizes and population numbers as a result. Research has shown that salmonids cannot successfully compete with yellow perch for food resources within a small lake system (Fraser 1978).

Largemouth bass are voracious predators and have significant direct effects (i.e., predation) on resident fisheries following introduction (MacPhail 2007). They are notoriously difficult to eradicate once introduced to a lake system and the effects on the native fish in Jimsmith Lake are likely significant (Brown et al. 2009b). Bass are also known to prey upon amphibians, small turtles, and ducklings, which suggests that their effects may extend beyond the impact to the salmonid fishery.

The regional approach to managing the non-native sport fisheries within Jimsmith Lake is tolerance of non-native species for sport fishing with high fishing quotas (Burrows, pers. comm.). The objectives of the managed non-native fisheries include managing fisheries that may provide non-native fish population control, provide social and economic

benefits, and discourage illegal transplants. Long-term management objectives may include eradication to help restore native fisheries. Managing the lake for species such as rainbow trout may prove difficult because of the competitive interactions with other non-native species. However, the approach of the AHI is to measure the relative value of the foreshore with respect to native fish and not introduced sport fish.

The focus of fisheries management is to restore healthy populations of rainbow trout within the lake and cutthroat trout within tributaries while controlling or eradicating non-native fish. Facilitating this general objective requires detailed understanding of the complex competitive interactions within the system, in addition to understanding the condition of the foreshore. Some of the key fisheries issues relevant to the management of Jimsmith Lake include identifying and addressing foreshore development, identifying impacts to lakeside riparian habitats, and identifying important spawning habitats.

Jimsmith Lake and the surrounding riparian and upland ecosystems (e.g., East Angus Creek corridor) also provide important habitats for a variety of terrestrial wildlife species. Waterfowl such as common loon (*Gavia immer*), common merganser (*Mergus merganser*), mallard (*Anas platyrhynchos*), and Canada goose (*Branta canadensis*) and raptors such as osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) utilize the lake and foreshore for foraging and nesting habitat. Provincially listed species such as western painted turtle (*Chrysemys picta bellii*) and great blue heron (*Ardea herodias*) also occur along the lake. Many other songbird species such as red-winged blackbird (*Agelaius phoeniceus*), sparrows, swallows, and vireos are commonly observed nesting and foraging along the lake foreshore.

2.5 Foreshore Management Overview

The importance of fisheries and wildlife resources along Jimsmith Lake and the sensitive ecosystems associated with the lake and foreshore, provide a clear rationale for completion of a detailed shoreline inventory and mapping project. A three step process is currently being used as a shoreline management template in BC. This process is described in previous sections of this document, but generally involves the following components: inventory using the FIM standards, analysis of relative habitat value using the AHI, and development of shoreline management guidelines.

3.0 FORESHORE INVENTORY & MAPPING METHODOLOGY

The FIM methodology is based upon mapping standards developed for Sensitive Habitat Inventory and Mapping (SHIM) (Mason and Knight, 2001) and Coastal Shoreline Inventory and Mapping (CSIM) (Mason and Booth, 2004). The development of these mapping initiatives is an integral part of ecologically sensitive community planning. The following sections summarize specific information related to the Jimsmith FIM project.

3.1 Field Surveys

Field surveys were conducted on August 8, 2009, July 16, 2010, and September 15, 2010. Surveys were completed by crews of various sizes. Each crew member was assigned data to collect during the surveys. Field assessors used air photos with cadastre and topographic information to assist with field data collection. Two TRIMBLE GPS units with SHIM Lake v. 2.6 (FIM Data dictionary name) were carried and a hurricane antennae was also used. Finally, digital photographs, with a GPS stamp, were collected. Other field surveys conducted included the GPS digital video, completed by DFO. The specifics of the GPS digital video are discussed in the FIM methodology. The principle objectives of the video and photographic surveys were to:

- Provide a photographic documentation of the Jimsmith Lake shoreline; and
- To record data relating to the presence or absence of shoreline modifications such as docks, retaining walls, and boat launches.

Weather is an important consideration, particularly during the photo and video documentation portions of the assessment. Good photo documentation is vital because data analysis following data collection can be hindered by poor photography. Weather during the surveys was generally clear and no significant storm events occurred.

3.2 Methodology

Standard methods for FIM projects were used for this assessment. Data collected was downloaded daily to a laptop for backup. Once downloaded, the entire database was reviewed for accuracy and corrections were made as required. Ecoscape has attempted to ensure the data is as accurate and error-free as possible. However, due to the large size of the dataset, small errors may have occurred. These errors, if found, should be identified and actions initiated to resolve the error. The following information was collected during field surveys:

1. The spatial extent of wetlands and areas of emergent, submergent and floating vegetation were mapped and photographed to delineate the approximate area where aquatic vegetation occurs. Aquatic vegetation includes any plants growing below the high water level of the lake. Areas of overhanging vegetation were also mapped.
2. Stream confluences (i.e., lake inlets and outlet), seepage areas, and other features were mapped.
3. The locations of shoreline modifications, including boat launches, docks, and groynes, were mapped.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was conducted along the shoreline. For the purposes of this assessment, aquatic vegetation includes plants occurring below the high water level of the lake (including flood benches). Although some of the plants are not truly aquatic, all are hydrophilic (i.e., water loving) and contribute to water quality and fish habitat. Vegetation mapping was completed by digitizing vegetation polygons from field observations recorded on aerial photographs. Vegetation communities were classified using the Wetlands of British Columbia – A guide to identification (Mackenzie and Moran, 2004):

Aquatic vegetation sites not described by the current nomenclature developed by Mackenzie and Moran (2004) were stratified using the following biophysical groups:

1. Emergent Vegetation (EV) generally refers to grasses, horsetail (*Equisetum* sp.), sedge, or other plants tolerant of flooding. Vegetation coverage within each polygon must be consistent and well established to be classified as EV. These areas are generally not dominated by true aquatic macrophytes and tend to occur in moderate to steep sloping areas.
2. Sparse Emergent Vegetation (SEV) refers to the same vegetation types as Emergent Vegetation, but coverage within these areas is generally sparse or patchy. The vegetation patchiness is generally related to beach grooming or other modifications.
3. Overhanging Vegetation (OV) consists of broadleaf vegetation that is growing over the lake, shading the shoreline littoral zone. Overhanging vegetation occasionally occurs with Emergent Vegetation (EVOV) and Sparse Emergent Vegetation (SVOV).
4. Submergent Vegetation (SUB) generally consists of native *Potemogeton* spp. and is considered aquatic vegetation that remains below the water surface for most of the growing season. These areas are uncommon within a few shallow areas.
5. Floating Vegetation (FLO) generally consists of species such as native *Potamogeton* spp., pond lilies, and other types of vegetation that float upon the water surface.

3.2.2 GIS and FIM Database Management

Data management for this project follows standard FIM methods and generally includes the following steps:

- Data and photos were backed up to a computer/laptop on a daily basis.
- During data analysis, numerous checks were completed to ensure that all data was analyzed and accounted for.

The following data fields were added to the FIM data dictionary:

1. An Electoral Area field was added to define the electoral area within the Regional District that shoreline segments were part of.

2. Fisheries fields were added. These fisheries fields are similar to the Zones of Sensitivity that were developed for the Lake Windermere project. The following describes fisheries fields added and the original data source for the fields:

    a. Juvenile Rearing;
    b. Migration; and
    c. Staging.

3. Terrestrial - SEI data is not available for the Jimsmith Lake shoreline. Instead, sensitive terrestrial information was determined by identifying the presence of wildlife movement corridors and other important terrestrial wildlife features such as veteran trees and snags. The terrestrial resources selected for this analysis are described in Section 4.1.4 below. The terrestrial parameters chosen include:

    a. Veteran Trees;
    b. Snags; and
    c. Wildlife Corridors.

4. An AHI results field was added (AHI_CUR). This field reflects the current conditions of the shoreline from the results of the AHI, discussed below.

5. An AHI potential analysis (AHI_POT) 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.

4.0 AQUATIC HABITAT INDEX METHODOLOGY

The AHI is a tool that is used to assess the relative habitat value of a shoreline relative to other shoreline areas within the lake. By definition, an index is a numerical or categorical scale used to compare variables with one another. A similar index has been used to assess shoreline sensitivity on Lake Windermere (McPherson and Hlushak, 2008). Indices are currently being completed for numerous lakes in the Okanagan and Kootenay regions. 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 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 parameter. Thus, features of more estimated significance are assigned higher relative values. Features that have impaired the habitat value (e.g., shoreline modifications such as groynes and docks) are assigned negative scores to reflect the impacted condition of the shoreline.

A subsequent analysis was conducted to determine the habitat *potential* of each shoreline segment. This analysis involved removing the negative scores associated with all modifications to determine if predicted shoreline restoration will achieve a measurable benefit. The Habitat Potential Index (HPI) can be used to help assess where restorative efforts should be directed. The HPI 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. To complete this, more detailed habitat restoration analyses are required.

The index generated has only utilized information that is currently available or that can be reasonably inferred based upon previous works. In many instances, data gaps have been identified and assumptions have been made. As more information is collected regarding shoreline areas of Jimsmith Lake, the AHI may be updated.

4.1 Parameters

The parameters of the AHI reflect a certain type of habitat found along the shoreline. The parameters were broken down into four general categories as follows:

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

Table 1 summarizes the parameters and logic used in the Jimsmith Lake AHI. The parameters selected for the index are similar to previous AHI analyses (e.g., Moyie and Monroe Lakes). A detailed description of each parameter category is provided in Table 1.

Table 1: The parameters and logic for the Aquatic Habitat Index of Jimsmith 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	14.3	% 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	11.4	% Substrate * Maximum Point	Yes	Organic = Mud = Marl (12) = Fines (12), Cobble (10) > Gravel (10) > Boulder = Sands (4) > Bedrock (2)
	Percentage Natural	5	10.4	4.8	% Natural * Maximum Point	No	% Natural * Maximum Point
	Aquatic Vegetation	8	16.7	7.6	% Aquatic Vegetation * Maximum Point	No	% Aquatic Vegetation * Maximum Point
	Overhanging Vegetation	4	8.3	3.8	% Overhanging Vegetation * Maximum Point	No	% Overhanging Vegetation * Maximum Point
	Large Woody Debris	4	8.3	3.8	# of Large Woody Debris/km * Relative Value * Maximum Point	No	**Relative Value** >15 LWD (1) > 10 to 15 LWD (0.8) > 5 - 10 LWD (0.6) > 0 - 5 LWD (0.4) > 0
Fisheries	Juvenile Rearing	10	55.6	9.5	High (10), Moderate (4), Low (2)	Yes	High (10), Moderate (4), Low (2)
	Migration Corridor	4	22.2	3.8	Present (4), Absent (0)	No	Present (4), Absent (0)
	Staging Area	4	22.2	3.8	Present (4), Absent (0)	No	Present (4), Absent (0)
Shoreline Vegetation[2]	Band 1	8	66.7	7.6	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)
	Band 2	4	33.3	3.8	Vegetation Bandwidth Category * Vegetation Quality * Maximum Point	Yes	**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)
Terrestrial	Veteran Trees	5	33.3	4.8	>25 (5), 5-25 (3), <5 (1)	Yes	>25 (5), 5-25 (3), <5 (1)
	Snags	5	33.3	4.8	>25 (5), 5-25 (3), <5 (1)	Yes	>25 (5), 5-25 (3), <5 (1)
	Wildlife Corridor	5	33.3	4.8	Present (5), Absent (0)	Yes	Present (5), Absent (0)
Modifications	Retaining Wall	-0.06	0.5	-0.1	% Retaining Wall * (-10)	No	% Retaining Wall * (-10)
	Docks	-10.00	82.8	-9.5	# Docks/km * (-1)	No	# Docks/km * (-1)
	Groynes	-0.01	0.1	0.0	# Groynes/km * (-2 per groyne)	No	# Groynes/km * (-2 per groyne)
	Boat Launch	-2.00	16.6	-1.9	# Launches * (-2 per launch)	No	# Launches * (-2 per launch)

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.

4.1.1 Biophysical Parameters

The following summarizes the biophysical parameters of the index:

1. Shore Type – Shore type was given a maximum value of 15. Shore types are related to many aspects of productivity. Previous habitat indices (e.g., Schleppe and Arsenault, 2006) used habitat specificity tables to determine the value of a shoreline. A 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, 2007). Wetlands are considered to be highly valuable shoreline areas for several reasons, including their contributions to biodiversity, biomass, and water quality. The general habitat specificity for Jimsmith Lake follows that of the original assessment for the Okanagan, except that wetlands have been defaulted to the highest value possible shoreline value (i.e., equivalent to a stream confluence).
2. Substrate – Substrate types were given a maximum value of 12. Substrates relate directly to lake productivity. There are generally two types of productive substrates, those utilized for spawning and those that produce more biomass. Substrates within Jimsmith Lake have value in production of biomass such as aquatic invertebrates and other organisms that occur within organic substrates. As such, greater value was placed on soft, organic substrates based on the productive forage habitat they provide for the fish species of management concern within Jimsmith Lake. Shore spawning substrates were assigned a lower relative value than substrates producing more biomass.
3. Percent Natural – Areas of natural shoreline have a relative habitat value that is greater than disturbed shoreline areas and were given a maximum value of 5. Natural shorelines tend to have better functioning ecological systems and provide better overall habitat value than disturbed shorelines.
4. Aquatic Vegetation – Aquatic vegetation was given a maximum value of 8. The percent cover of aquatic vegetation was determined along the Jimsmith Lake shoreline. The benefits of aquatic vegetation include forage, biomass production, and cover.
5. Overhanging Vegetation – Overhanging vegetation was given a maximum value of 4. Although not frequently observed along the Jimsmith Lake shoreline, it provides allochthonous inputs (i.e., nutrients), cover, and opportunities to forage.
6. Large Woody Debris – Large woody debris was given a maximum value of 4. Large woody debris provides nutrients, cover, and opportunities to forage. Along the Jimsmith Lake shoreline it also provides habitat complexity and basking habitat for turtles. Numerous studies have identified the importance of large woody debris to aquatic habitat in lake and stream systems.

4.1.2 Fisheries Parameters

The fisheries parameters used for the AHI were based upon those described above in Section 3.2.2. These parameters are considered important for fish production in the Jimsmith Lake system and were prioritized in the AHI accordingly. Parameters were considered in terms of general fish habitat and productivity. Specific habitat parameters for the management of non-native sport fish such as yellow perch and largemouth bass were not considered. The fisheries parameters added to the AHI include the following:

1. Juvenile Rearing - Juvenile rearing was given a maximum value of 10. Relative shoreline habitat value (High, Moderate, and Low) was determined for this parameter. Details of the parameters used to categorize the rearing suitability values are provided in Table 2. Since shoreline utilization data is unavailable, the juvenile rearing was based upon known rearing habitat requirements for the species known to reside within the lake (e.g., proximity to spawning streams, littoral area, substrates, etc.). For the purposes of the Jimsmith Lake analysis, habitat requirement for historical resident species (e.g., rainbow trout) were considered. Yellow perch and largemouth bass habitat needs were not considered.
2. Migration Corridor - Migration corridors were given a maximum value of 4. Juvenile fish migration areas were determined based upon known spawning areas in streams. The areas generally encompass shoreline areas where fish migrate out from or into a stream system. These areas tend to overlap with Staging Areas. Migration routes within Jimsmith Lake are essentially limited to the shoreline area between the East Angus Creek inlet and the lake outlet. The areas near the lake inlet/outlet are significant during migration of juvenile fish because they are more susceptible to predation at this time.

   Probable juvenile and adult fish migration routes (Yes or No) used by resident fish at some point in their life cycle were prepared using professional judgment and are limited to areas near the inlet and outlet of spawning streams. These routes are based upon areas where fish will likely concentrate during significant spawning, immigration, or emigration from streams. To develop these migration areas, key habitat characteristics were used and included adjacency to spawning rivers, outmigration considerations, and review of fish life history characteristics were all considered. Due to the small size of the lake, migration considerations are considered to be relatively small in relation to other aspects of fish productivity (e.g., substrates) and were assigned a lower relative score for this reason (i.e., they only accounted for 3.8% of the index).
3. Staging Area - The presence of Staging areas (Yes or No) were given a maximum value of 4. Staging areas occur where fish congregate prior to migration. In general, these areas are loosely defined and vary over space and time. The information presented is limited to the confluences of potential spawning streams, where fish congregate before migrations. It may not entirely reflect all locations

or spatial extents of staging areas. Future surveys will provide a better understanding of where mature adults stage prior to migrations. Similar to juvenile rearing areas, staging areas were assigned the lowest relative score in the index and only account for 3.8% of the total index.

Table 2: The parameters and logic for the Juvenile Rearing Habitat Suitability of Jimsmith Lake.

Category	Criteria	Maximum Point	Percent of the Category[1]	Logic	Uses Weighted FIM Data	Value Categories
Criteria	Shore Type	12	20.3	% 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	15.3	% Substrate * Maximum Point	Yes	Organic(9) = Mud (9) = Marl (9) = Fines (9) > Boulder (8) > Cobble (7) > Gravel (7) > Sands (6) > Bedrock (4)
	Aquatic Vegetation	8	13.6	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	20.3	Littoral Width Category Score	No	**Littoral Width Category Score** Wide (>50m) = 12, Moderate (10 to 50 m) = 8, Narrow (<10m) = 3
	Overhanging Vegetation	4	6.8	% Overhanging Vegetation * Maximum Point	No	% Overhanging Vegetation * Maximum Point
	Large Woody Debris	4	6.8	Large Woody Debris Category Score * Maximum Point	No	**Large Woody Debris Category Score** >15 LWD (1) > 10 to 15 LWD (0.8) > 5 - 10 LWD (0.6) > 0 - 5 LWD (0.4) > 0
	Migration Corridor	5	8.5	Present / Absent	No	Present (5), Minor (0)
	Spawning Stream Present	5	8.5	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 h

4.1.3 Shoreline Vegetation Parameters

The riparian parameters added to the index were similar to those added in the Moyie and Monroe Lakes FIM. The FIM provides a distinction between the lakeside vegetation (Band 1/Riparian) and the areas beyond (Band 2/Upland). To address this new data available, the index was modified to include a factor assessing vegetation quality (i.e., tall shrub thickets or wetland areas have a higher quality than landscaped *yards*). As with the other

indices, vegetation bandwidths were categorized and points were assigned. Vegetation bandwidth categories included 0-5 m, 5-10 m, 10-15 m, 15-20 m, and greater than 20 m. The Band 1 vegetation was assigned greater value (i.e. maximum value of 8) than Band 2 vegetation (i.e., maximum value of 4) because of direct proximity to aquatic habitats.

4.1.4 Terrestrial Parameters

The terrestrial parameters identified and used for the Jimsmith AHI analysis are described below. These parameters are considered important to maintain healthy riparian and shoreline ecosystems as well as enhancing fish productivity within the Jimsmith Lake system.

1. Veteran Trees - Veteran tree presence was categorized (i.e., 0, <5, 5-25, >25) and given a maximum value of 5. Veteran trees have survived historical disturbance (e.g., fire, flooding, logging) and are the oldest trees within a generally younger stand. Due to their age, veteran trees are often irregular in shape with deformities, split tops, and cracks, which provide unique habitat features for wildlife. These trees also provide recruitment for snags (i.e., standing dead trees) which makes them extremely valuable wildlife trees and they require conservation to protect that resource. Safety is often the cause for the removal of veteran trees as risk to the general public supersedes the ecological value the trees provide.
2. Snags - Snag presence was categorized (i.e., 0, <5, 5-25, >25) and given a maximum value of 5. A snag is a standing dead, damaged, or broken tree. These trees provide important habitat for primary and secondary cavity nesting species, perching habitat for birds of prey, and denning habitat for a variety of mammals. These trees provide recruitment for large woody debris along the forest floor or adjacent shoreline. It is important to retain snags where possible for the important contribution to habitat and overall biodiversity they provide. However, as with veteran trees, safety concerns often preclude the conservation of the trees and falling becomes necessary to protect infrastructure or the general public.
3. Wildlife Corridors - Wildlife corridors were given a maximum value of 5 because they provide connectivity between patches of habitat. Corridors prevent the isolation of habitat patches that have been fragmented within the landscape. Wildlife use the cover provided by corridors to safely migrate between habitats. These movements provide a transfer of genetic material between populations, prevent inbreeding, and maintain healthy populations of wildlife. Corridors often follow natural features such as streams and associated riparian communities. Development and disturbance should avoid these areas and comprehensive mitigation planning is required where proposed development transects or abuts wildlife corridors. A suitable wildlife corridor occurs along East Angus Creek.

4.1.5 Habitat Modifications

Habitat modification parameters are described by Schleppe and Arsenault (2006). The descriptions provided a rationale for inclusion of these parameters in the AHI. Other habitat modifications parameters, such as Percent Substrate Modification or Percent Roadway were not included in the analysis to avoid compounding their effects (i.e., groynes constructed from shoreline substrate modification gets counted twice). The following is quoted directly (shown in italics) from the EBA Engineering Consultants Ltd. report *The Kelowna Shore Zone Fisheries and Wildlife Habitat Assessment* (Schleppe and Arsenault, 2006). The City of Kelowna provided permission to utilize data from the assessment. Further information on these parameters can also be found in the Windermere Lake assessment report (McPherson and Hlushak, 2008). Text below that is not in italics has been added in regards to the application of the modifications to the Jimsmith Lake AHI.

1. *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.

   Retaining walls were not prevalent along the Jimsmith Lake shoreline. However, several were noted along Segment 5 in an area of residential development and their effects have been incorporated into the AHI.

2. *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 with 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.

   Twelve (12) docks were observed along the Jimsmith Lake shoreline. The modification value for docks was reduced from other previous AHI assessments based on the relatively lower shore spawning habitat value within Jimsmith Lake. Docks were located in areas with residential developments.

3. *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).

A single groyne feature was observed along the Jimsmith Lake shoreline within Segment 1. The groyne is actually a concrete barrier associated with the Jimsmith Lake Provincial Park boat launch and parking area. The barrier extends below the high water level of the lake. Migration and rearing habitats for juvenile fish are typically negatively impacted by groynes by diverting migrating juvenile fish to deeper water zones where they are more susceptible to predation.

4. *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).*

   One (1) boat launch was observed along the Jimsmith Lake shoreline within Segment 1. Currently, only non-motorized boats are permitted on Jimsmith Lake which reduces the demand for large or numerous boat launches. The presence of the single boat launch may provide a benefit in focusing lake access in a specific area and preventing unsanctioned or illegal access.

These modifications were selected because they are easily observed, quantified, and incorporated to the AHI. The negative effect of modifications within Jimsmith Lake was reduced from the previous AHI analyses (e.g., Moyie and Monroe Lakes) because the extent and magnitude of impacts observed were substantially lower and otherwise the criteria would have resulted in excessive devaluing of shoreline segment habitat value. Substrate modification observed along the Jimsmith Lake shoreline includes retaining wall which represents only 3 m (0.1%) of the total shoreline. Road modifications were observed along Segment 2.

4.2 Index Ranking Methodology

The AHI was used to analyze the relative habitat value of a segment to those compared around the different lakes assessed. The output of the index is a five class ranking system,

ranging from Very Low to Very High. The index was used to output two shoreline segment values described below:

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

2. Potential Value (AHI_POT) – This is the potential index value for each shore segment after the hypothetical removal of modifications. It is the total index value based upon the biophysical, riparian, fisheries, and terrestrial resource parameters only. This value is used to highlight segments where restoration would likely have the most measurable benefit. This category does not consider riparian restoration impacts.

4.2.1 Calculating the Aquatic Habitat Index

The AHI consists of a variety of parameters and each has a range in potential scores based upon the physical properties of each shoreline segment. Table 1 summarizes the logic and the maximum possible score for each parameter. To determine the AHI ranking for each segment, the score for a shoreline segment determined using the physical characteristics in the FIM database. 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 category: Biophysical, Fisheries, Shoreline vegetation, Terrestrial and, Modifications were summated for each segment. The total habitat value for each shoreline segment included all positive and all negative index parameters.

The output of the AHI is a five class ranking system, ranging from Very Low to Very High. The rank assigned to each shoreline segment reflects the relative value of the segment in its current condition. To calibrate the index, the Mabel Lake index was used as a baseline because of the many similarities between the two systems. From this baseline, numerous iterations were run (i.e., the index was run at least 50 times) and changes were made as necessary to reflect current conditions. During each run of the index, the minimum, maximum, median, and distribution of scores was reviewed. After reviewing the distribution of the data from the iterations, logical score breaks were used to determine the limits of each of the five classes. These breaks were made because of the clustering of scores based upon the output of the results.

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 AHI is to accurately represent the current relative condition of the shoreline segments and identify areas of particular sensitivity

based upon the information available. The following provides a description of each of the AHI value categories:

1. Very High - Areas classified as Very High are considered critical to the maintenance of fish and wildlife populations. Most areas identified as Very High occur in extremely sensitive floodplain areas, spawning stream mouths, wetland habitats, or provide productive rearing and spawning habitat for resident species. These areas are generally undisturbed and considered highest priority for conservation.

2. High - Areas classified as High are considered to be important to the maintenance of healthy fish and wildlife populations. These areas typically provide high quality rearing habitat, extensive aquatic vegetation communities, or sensitive stream confluence. These areas are important to maintain high quality and diversity of habitat. Goals and objectives should include maintenance of existing values and habitat restoration or enhancement where feasible.

3. Moderate - Areas classified as Moderate are typically common around the lake and have generally been affected by habitat alteration to some extent. These areas may contain important habitat areas, such as shore spawning, and these characteristics should be considered independently of the overall shoreline segment value. Development within these areas should be planned between nodes of dense development and nodes of single family. All proposed development should include some form of habitat restoration, with the goal of restoring the shoreline to a more natural state (e.g., from Landscaped to Broadleaf or Coniferous) and removal of negative modification (e.g., non-native substrates).

4. Low - Low value areas are generally highly modified. These areas have been negatively impacted through land development activities and habitat alteration. Development within these areas should be planned in a similar manner as Moderate value areas. However, restoration objectives should be set higher in these areas during redevelopment.

5. Very Low - Very Low areas are highly modified segments that are not adjacent to any known important habitat characteristics. These areas require significant remediation effort to restore habitat values.

Criteria within the Jimsmith Lake AHI are generally similar to those used for previous assessment of interior lakes. Changes that have been made are described throughout the document.

5.0 DATA ANALYSIS

General data analysis and review was completed for the FIM database. Field data collected was reviewed, refined, and corrections and additions were made as required. Analysis of the refined data focused on each shoreline segment. Analyses for this project were completed as follows:

1. The length for each discrete shoreline segment was determined using GIS (ArcView) and added to the FIM database;
2. For each category, the analysis used the percentage natural/disturbed field to determine the segment length that was either natural or disturbed. This was done on a segment by segment basis. In some cases, the percentage natural or disturbed was reported because it made comparison easier than comparing shoreline lengths.

The above summarizes the general data review and analysis approach. The following sections provide specific details for the biophysical and AHI analyses.

5.1 Biophysical Characteristics and Modifications Analysis

Biophysical characteristics of each shoreline segment were analyzed based on field data, photos, and aerial imagery. Definitions of the categories discussed below are provided in the FIM Detailed Methodology. The following summarizes the analyses that were completed:

1. Percent natural and disturbed for each shoreline segment;
2. Total shoreline length of natural or disturbed for each slope category that occurs along each shoreline segment;
3. Total shoreline length that remained natural or disturbed for each land use identified along each shoreline segment;
4. Total shoreline length of natural or disturbed for each shore type that occurs along each shoreline segment;
5. Total shoreline length that contained aquatic vegetation (i.e., emergent, floating, or submergent) along each shoreline segment;
6. Total number of modification features recorded along each shoreline segment. This data represents point counts taken during the survey for groynes, docks, retaining walls, marinas, marine rails, and boat launches; and
7. Total shoreline length of other shoreline modifications (i.e., roadways, substrate modification, retaining walls) along each shoreline segment.

5.2 Aquatic Habitat Index Analysis

A summary of the shoreline lengths and shore types is presented in the Results Section 6.0. 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.

6.0 RESULTS

The following section provides an overview of the AHI analysis of Jimsmith Lake. Data is presented graphically and summarized in the text for ease of interpretation. Data tables for each analysis are presented in Appendix A.

6.1 Biophysical Characteristics of Jimsmith Lake

The FIM survey was completed on 2731 m of shoreline along Jimsmith Lake. The total length of disturbed shoreline is 684 m, which represents approximately 25% of the total shoreline (Figure 2). The total length of natural shoreline is 2047 m, which represents approximately 75% of the total shoreline.

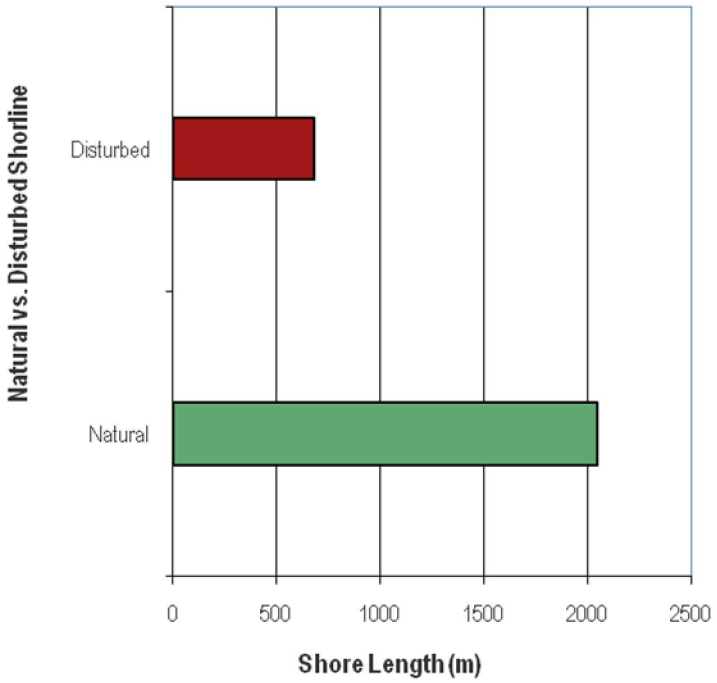


Figure 2. Natural and disturbed shore lengths along Jimsmith Lake.

The slope analysis is a summary of slope categories (% slope) that occur in upland areas above the high water level of the lake. Areas of lower gradient tend to have the highest level of disturbance due to the suitability for development. Jimsmith Lake is generally characterized by low to moderate sloping shorelines, with a short section of steep slope. There are 1185 m of low gradient slopes (0-5%), which are approximately 26% disturbed. There are 1546 m of moderate gradient slopes (5-20%), and these slopes are approximately 24% disturbed. Benches and Very Steep slopes do not occur along the shoreline of Jimsmith Lake.

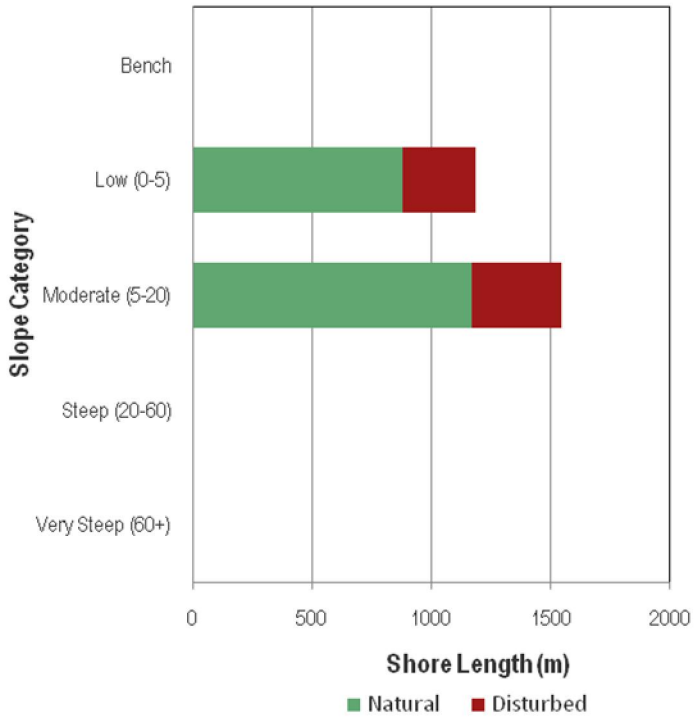


Figure 3. Natural and disturbed shore lengths within slope categories along Jimsmith Lake.

Land use around Jimsmith Lake is dominated by Natural Area which accounted for 879 m (32.2%) of the total shoreline. Within the Natural Area shoreline, approximately 98.3% is undisturbed. Single Family and Rural land use represent the next greatest land use at 677 m (24.8%) and 664 m (24.3%), respectively. Agricultural and Park represent relatively minor land use at 330 m (12.1%) and 181 m (6.6%), respectively.

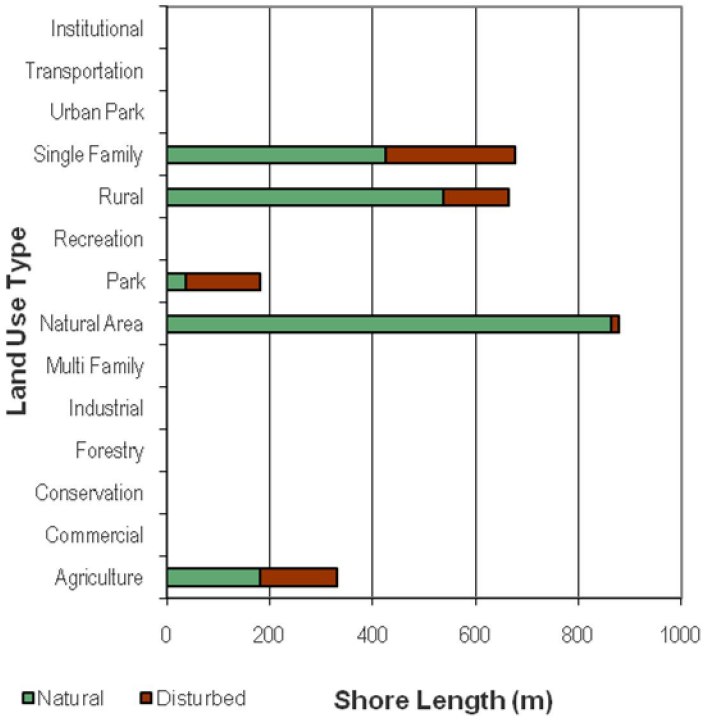


Figure 4. Natural and disturbed shore lengths within land use categories along Jimsmith Lake.

The dominant shore type observed along Jimsmith Lake is Wetland, which represents 2204 m (80.7%) of the total shoreline. Overall, the wetland shore type is approximately 80.5% natural. Sand Beach is the next greatest shore type, representing 280 m (10.2%) of the total shoreline. The Sand Beach shore type is only 32.4% natural. Approximately 137 m (5.0%) of the shoreline is Stream Mouth which represents tributary inlets such as Upper Jimsmith Creek and East Angus Creek, as well as the lake outlet. The stream mouth shore type is approximately 85.4% natural. The remainder of the shoreline is represented by Gravel (4.0%) shore type, which is 58.1% natural.

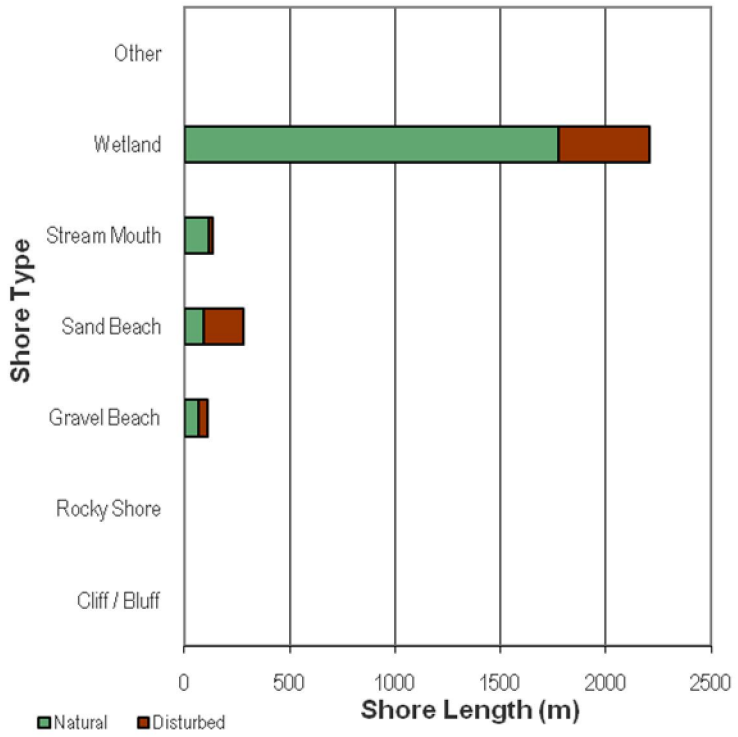


Figure 5. Natural and disturbed shore lengths within shore types along Jimsmith Lake.

Aquatic vegetation is generally defined as any type of emergent, submergent, or floating vegetation that occurs below the high water level of an aquatic ecosystem. The aquatic vegetation category includes true aquatic macrophytes as well as plants that are hydrophilic or tolerant of periods of inundation during periods of high water. Research indicates that terrestrial vegetation during periods of inundation provides allochthonous input for juvenile fish and other aquatic organisms so it has been included (Adams and Haycock, 1989).

Approximately 2102 m (77.0%) of the total shoreline is characterized by some form of aquatic vegetation. The majority of the aquatic vegetation is represented by emergent vegetation which comprises 2057 m (75.3%) of the shoreline. Emergent vegetation includes cattail (*Typha latifolia*) and bulrush (*Scirpus* sp.) communities which are associated with the extensive wetland communities along the shoreline. Submergent and floating vegetation is less common along the lake, representing 839 m (30.7%) and 779 m (28.5%), respectively.

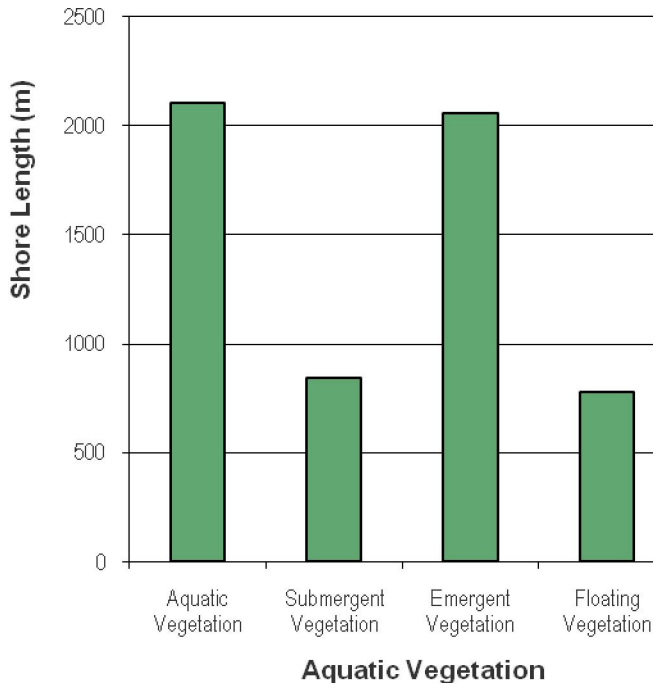


Figure 6. Shore lengths of aquatic vegetation types along Jimsmith Lake.

Docks are the most common form of shoreline modification with a total of 12. Retaining walls are the next most common modification with 3 structures. A single groyne and a single boat launch also occur along the lake shoreline.

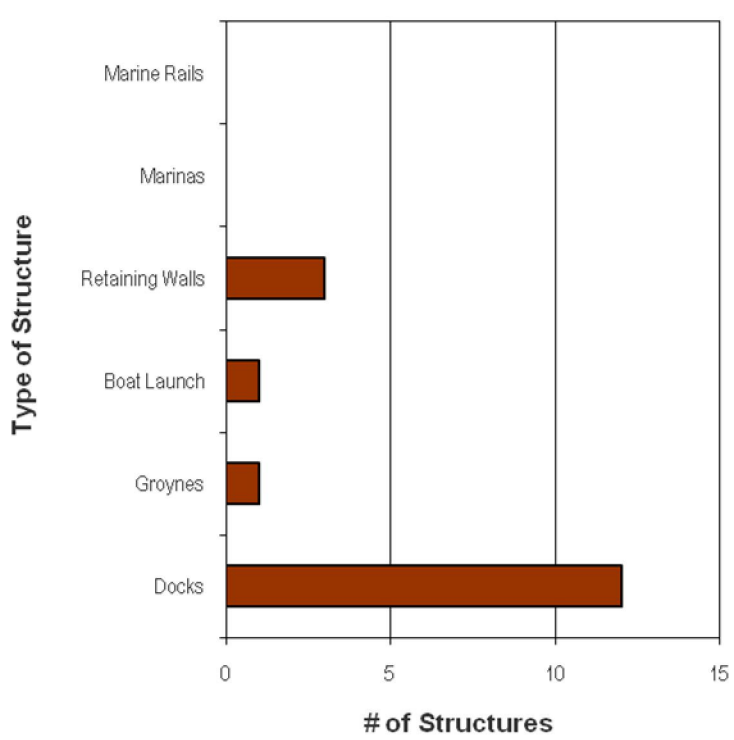


Figure 7. Number and type of modification structures observed along Jimsmith Lake.

Shoreline substrate modification includes impacts from roads, railways, retaining walls, and other substrate modification. Substrate modification observed along the Jimsmith Lake shoreline includes road modification which represents approximately 4.0% of the total shoreline and retaining wall which represents approximately 3 m (0.1%) of the total shoreline.

The relative level of impact along the Jimsmith Lake shoreline is shown in Figure 8. It is estimated that 511 m (18.7%) of the shoreline is characterized by a High level of impact (i.e., >40% disturbed). Approximately 1350 m (49.4%) of the shoreline is characterized by Moderate impact (i.e., 10-40% disturbed). Approximately 871 m (31.9%) of the shoreline is characterized by Low impact (i.e., <10% disturbed). There are no shoreline areas with no disturbance.

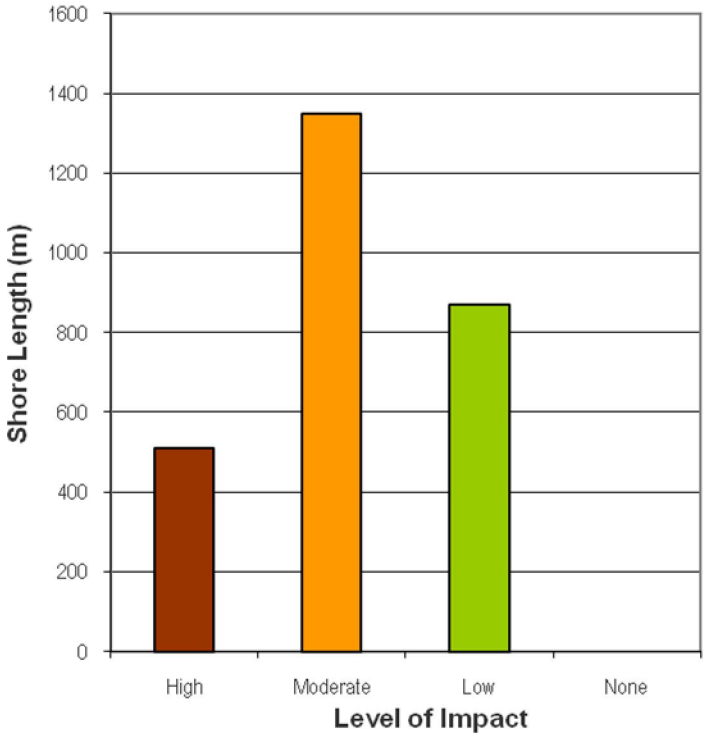


Figure 8. Shore length levels of impact along Jimsmith Lake.

The juvenile fish rearing categories for the Jimsmith Lake shoreline are shown in Figure 9. Areas classified as having High juvenile rearing values represent 1320 m of the total shoreline, 1010 m of which are undisturbed (76.5% natural). Areas of moderate rearing value occur along 1232 m of shoreline and are 81.3% disturbed. Areas of low rearing value occur along 181 m of shoreline and are 20% natural.

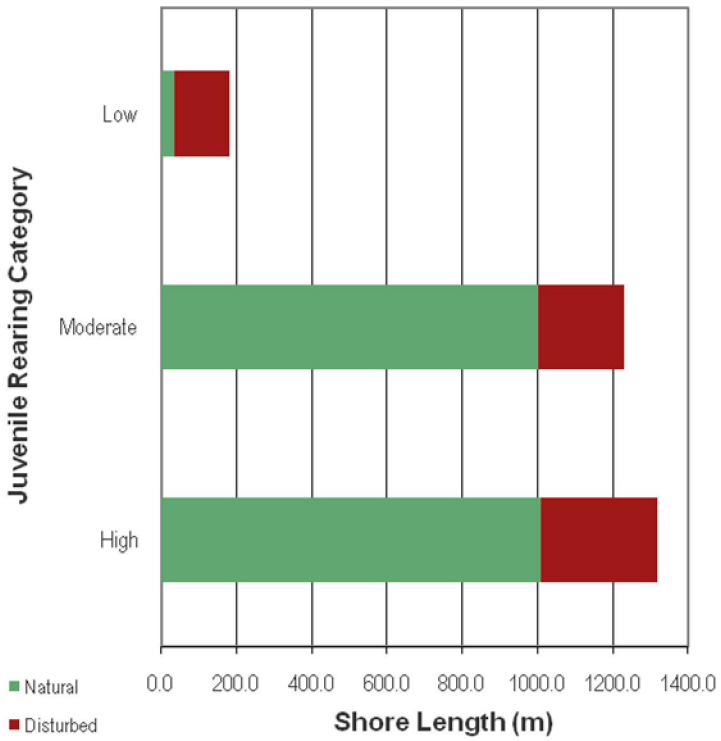


Figure 9. Natural and disturbed shore lengths within juvenile rearing areas along Jimsmith Lake.

6.2 Summary of Foreshore Modifications

Jimsmith Lake provides important wildlife habitat for fish, birds (e.g., great blue heron), and a variety of other species (e.g., western painted turtle). The extensive shoreline wetlands represent sensitive ecosystems with important values for water quality, fish rearing, and biomass productivity. The corridor formed by the lake outlet and the East Angus Creek channel provides connectivity between Jimsmith Lake and upstream habitats.

The lake provides unique local recreational opportunities for boating, swimming, and fishing. The proximity of the lake to a larger city centre (i.e., Cranbrook) makes the area a desirable destination for visitors. Jimsmith Lake Provincial Park occurs along the northeastern shoreline of the lake. The park contains a 35 site campground with facilities for recreational vehicles. The existence of the park ensures that future development will not occur in that area, but also attracts numerous visitors and adds recreational pressure along that portion of the shoreline (Segment 1). The shoreline area along the park is heavily modified with riparian vegetation removed and replaced with lawn, native substrates replaced with sand, and the construction of a groyne feature and boat launch.

The natural beauty of the lake draws residents who want to build homes along the natural shoreline with views of the lake. This combination of important fish and wildlife habitat and development pressure present a vital need to identify and characterize shoreline features and manage the resource in a sustainable way. The data collected during this assessment provides the baseline information necessary to guide the development of a long-term plan to manage the resource effectively for both environmental and socio-economic concerns.

Currently, the shoreline of the lake is approximately 75% natural, based upon the results of the FIM survey. Most of the undisturbed shoreline occurs within natural areas of the shoreline (i.e., Crown Land) and park (i.e., Jimsmith Lake Provincial Park). Areas of particular significance (e.g., corridor formed by the lake outlet and East Angus Creek inlet) occur within areas that have been disturbed by beach grooming, riparian vegetation removal, and house construction. The FIM analysis indicates there is a need to develop long-term sustainable development objectives to protect the existing natural features and restore areas that have been disturbed by development.

In general, impacts to the foreshore from development along the lake are relatively minor and localized. Contiguous areas of undisturbed habitat are prevalent. During the FIM field surveys, observations regarding the state of the foreshore were made and are summarized below:

- A significant impact observed below the high water level along the shoreline was substrate modification. Within Jimsmith Lake Park, a section of shoreline has been

modified to create a sand beach. This is desirable from a recreational perspective as it allows easy access for swimmers, boaters, and other lakeshore users. However, the removal of riparian and aquatic vegetation and replacement of native substrates with sand has distinct negative effects on fish habitat and productivity of the lake foreshore. Potential effects of substrate modification include:

- loss of aquatic vegetation (actual loss has not been determined);
- loss of vegetation cover along the shoreline which normally provides shade and allochthonous inputs;
- loss of available habitat through alteration of shorelines from a natural shoreline to a sand beach;
- loss of structural complexity which provides cover and forage for fish and other aquatic organisms; and
- increased risk of erosion and sediment inputs to the lake.

- Aquatic vegetation has been removed along the shoreline due to foreshore and substrate modifications. In these areas, emergent riparian vegetation (e.g., willows and cottonwoods), grasses and sedges, and other types of vegetation have been cleared. Most of the vegetation removal is the result of beach grooming (e.g., within Jimsmith Lake Provincial Park) or residential development (e.g., removal of vegetation for shoreline access or views). The continued removal of riparian and aquatic vegetation will further negative effects on fish habitat and lake productivity.

- Shoreline impacts such as roadways are not always visible from the lake. However, because the roads are located a short distance from the shoreline, they have negative effects on the calculated value of the foreshore area (e.g., Segment 2).

- Twelve (12) docks were observed along the shoreline. Many of the docks observed were not constructed following best management practices which require elevated walkways on piles to deeper water zones at low water level. It was reported that a large area of cattails was removed for dock construction along the western shoreline of the lake (i.e., Segment 4).

- One (1) boat launch and one (1) boat house were observed along the shoreline. The boat launch occurs within the Jimsmith Lake Provincial Park and provides lake access to park users. It is important to note that motorized boat use is not permitted on Jimsmith Lake. It is unknown whether the boat launch was constructed using provincial Best Management Practices (BMP) or with *Water Act* or *Fisheries Act* approval.

- One (1) groyne feature (i.e., concrete barrier) has been constructed along the shoreline adjacent to the Jimsmith Lake Provincial Park (Segment 1).

- Retaining walls comprised 3 m of the shoreline which represents 0.1% of the total shoreline length. Retaining walls were constructed out of mixed materials. It is probable that the retaining walls observed have been constructed without using provincial BMPs or with *Water Act* or *Fisheries Act* approval.

- The presence of large woody debris was less than expected overall. Large woody debris is considered a critical aspect of habitat for juvenile fish. This highlights the need to conserve veteran trees and snags, as they provide the source of large woody debris to the riparian and shoreline areas.

6.3 Aquatic Habitat Index Results

The results of the AHI are most easily reviewed graphically. The attached Figure Binder presents the spatial results of the FIM assessment. The Figure Binder has been prepared to summarize the information contained within this report. Because of the small size of the lake, the AHI results are depicted on a single figure. The results of the AHI are also provided in tabular format within Appendix B.

The AHI incorporates biophysical information to categorize the relative value of each discrete shoreline segment. The overall results of the AHI indicate that approximately 48.2% of the entire shoreline is ranked as Very High and High. Approximately 27% of the shoreline length is ranked as Moderate, and the remaining 24.7% is ranked as Low and Very Low. Areas of high and very high habitat value were typically represented by stream confluences (lake inlets and outlet), wetlands areas, and high value fish staging, rearing or migrating areas. The majority of the low value segments are characterized by shoreline modifications such as substrate modification, docks, and landuse such as single-family development and agricultural.

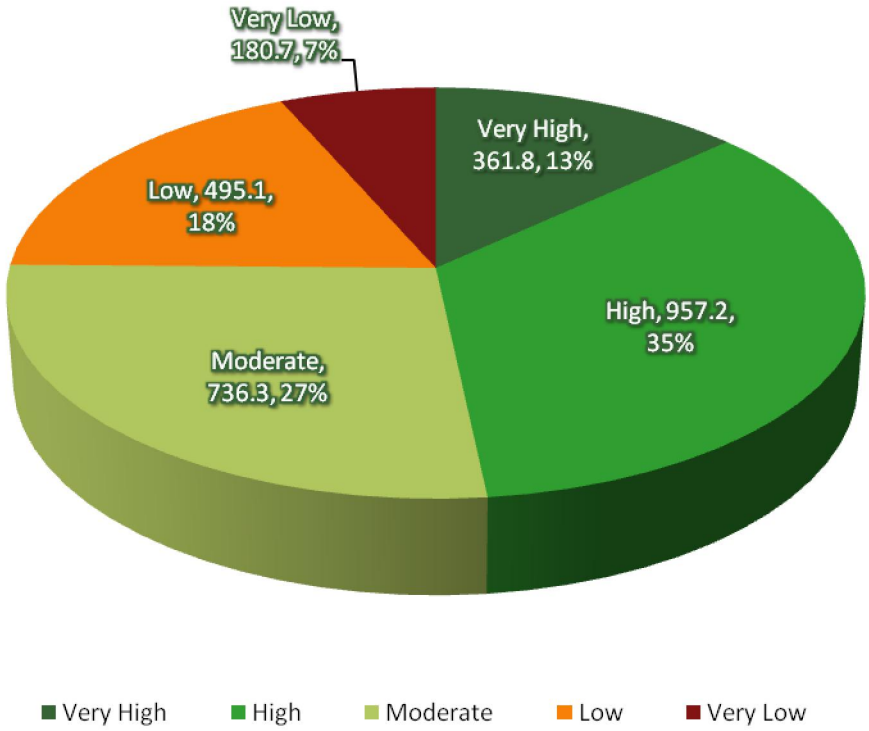


Figure 10. Proportional Aquatic Habitat Index rankings for shore lengths along Jimsmith Lake.

Table 3 provides further detail on the current and potential value of the shoreline segments along Jimsmith Lake.

Table 3: Current and Potential AHI Value for each shore length along Jimsmith Lake.

Categories	Current Value			Potential Value		
	# of Segments	Shoreline Length (m)	% of Shoreline	# of Segments	Shoreline Length (m)	% of Shoreline
Very High	2	361.8	13.2	2	361.8	13.2
High	2	957.2	35.0	2	957.2	35.0
Moderate	1	736.3	27.0	2	1231.4	45.1
Low	1	495.1	18.1	0	0.0	0.0
Very Low	1	180.7	6.6	1	180.7	6.6
Total	7	2731.2	100.0	7	2731.2	100

The AHI results were analyzed to determine the distribution of habitat values by shore type (Figure 11). The analysis indicated that Very High Value shorelines occurred mostly adjacent to Stream Mouth and Wetland areas. Most of the Very Low value habitat was found on Sand or Gravel areas.

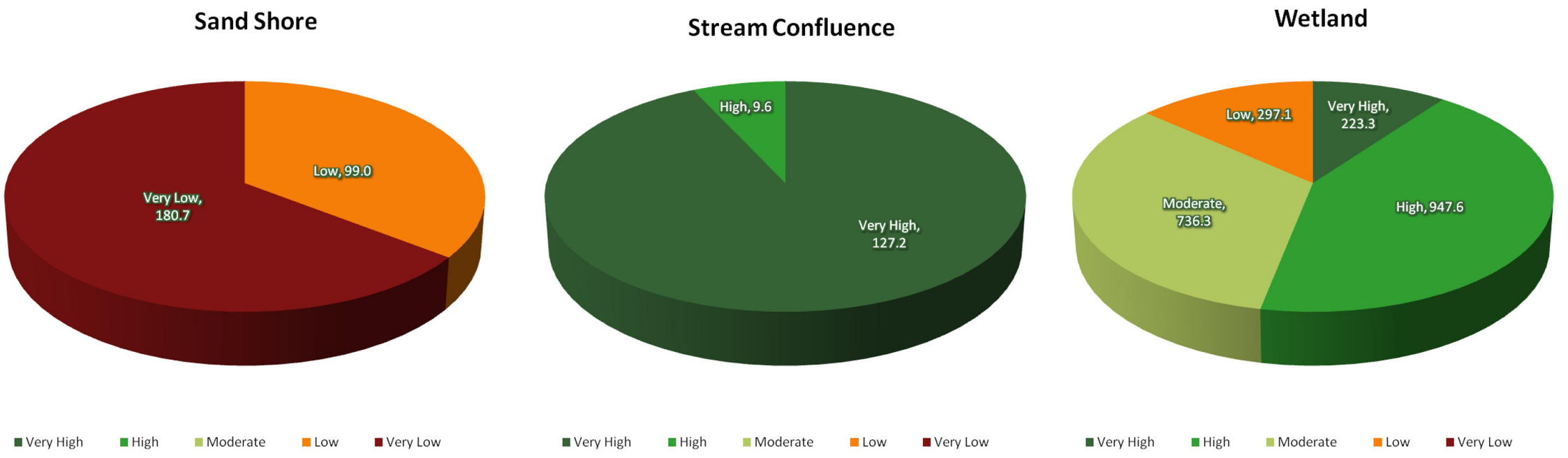


Figure 11. Proportional Aquatic Habitat Index rankings for each shore type along Jimsmith Lake.

The AHI Potential Value summary indicates what the habitat value would be if the existing modifications were removed (Table 5). This analysis highlights areas where restoration will most likely result in a measurable improvement to shoreline habitat. It is important to note that this analysis does not consider riparian improvements which would likely result in additional habitat improvements. A shift occurred from low to moderate in areas characterized by gravel and sand shorelines. There was no change observed in the other categories. More detailed analysis will help to better interpret where restoration efforts may be more realistic, feasible, and cost effective.

Table 4: Current value AHI results for shore types along Jimsmith Lake.

Categories	Current Value			Gravel		Sand		Stream Mouth		Wetland	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline Length	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline
Very High	2	361.8	13.2	11.4	3.1	0.0	0.0	127.2	35.2	223.3	61.7
High	2	957.2	35.0	0.0	0.0	0.0	0.0	9.6	1.0	947.6	99.0
Moderate	1	736.3	27.0	0.0	0.0	0.0	0.0	0.0	0.0	736.3	100.0
Low	1	495.1	18.1	99.0	20.0	99.0	20.0	0.0	0.0	297.1	60.0
Very Low	1	180.7	6.6	0.0	0.0	180.7	100.0	0.0	0.0	0.0	0.0

Table 5: Potential value AHI results for shore types along Jimsmith Lake.

Categories	Potential Value			Gravel		Sand		Stream Mouth		Wetland	
	# of Segments	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline	Shoreline Length	% of Shoreline
Very High	2	361.8	13.2	11.4	3.1	0.0	0.0	127.2	35.2	223.3	61.7
High	2	957.2	35.0	0.0	0.0	0.0	0.0	9.6	1.0	947.6	99.0
Moderate	2	1231.4	45.1	99.0	8.0	99.0	8.0	0.0	0.0	1033.4	83.9
Low	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Very Low	1	180.7	6.6	0.0	0.0	180.7	100.0	0.0	0.0	0.0	0.0

Figure 12 summarizes the relative amount of natural and disturbed shoreline areas within each of the AHI Ranking categories. Within areas ranked as Very High, the shoreline is 90.2% natural. In High value areas, the shoreline is 71.4% natural and within Moderate value areas the shoreline was 99.0% natural. Areas of Low and Very Low value are characterized by 55% and 20% natural shoreline, respectively.

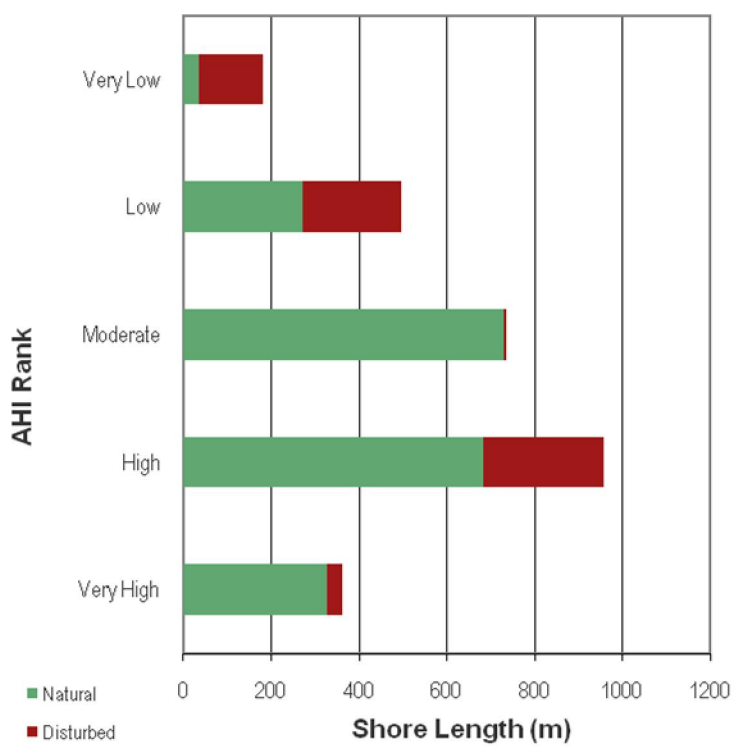


Figure 12. Natural and disturbed shore lengths in each AHI Rank category observed along Jimsmith Lake.

7.0 RECOMMENDATIONS

The following sections provide general recommendations for protection of the existing shoreline values, and future data management and inventory considerations.

7.1 Foreshore Protection

The following section provides a summary of recommendations for foreshore protection along Jimsmith Lake. Some of the recommendations below are similar to previous FIM reports that were completed within the Okanagan and Kootenay regions. 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. **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.**
   Maintaining connectivity between riparian and terrestrial habitats or along corridors connecting aquatic ecosystems should be a major consideration during future management. The riparian corridor along Angus Creek that connects Jimsmith Lake to New Lake and the spring-fed East Angus Creek are examples. Maintaining intact corridors between habitats mitigates the effects of fragmentation and isolation and helps maintain healthy wildlife populations. Riparian communities make obvious corridors as they are associated with the streams that connect lakes and other aquatic habitats. These areas are also typically associated with sensitive ecosystems and provide habitat for species at risk. Detailed assessments have been conducted along East Angus Creek which further demonstrate the importance of this sensitive area. Similar assessments should be conducted between Jimsmith Lake and New Lake to identify and inventory the important habitat features along that corridor.

   This information should be incorporated into future policy to reduce potential impacts from land use decisions (e.g., zoning a property for commercial purposes may result in impacts that are difficult to mitigate). Numerous options exist to protect sensitive, habitats including No Build/No Disturb Covenants, creation of Natural Area Zoning bylaws (i.e., split zoning on a property), or other mechanisms (donation to trust, etc.). The Very High and High shoreline areas are considered the most important areas around the lake and protection of these key habitats is necessary.

2. **Restoration of shoreline ecosystem communities, including riparian and aquatic vegetation, should be conducted during future re-development activities with measures in place to ensure successful completion.**
   Conservation of ecological communities provides important and measurable effects on water quality and fish habitat. Increased density and diversity and structural complexity of emergent and submergent vegetation will benefit juvenile trout as it provides increased productivity and food resources and cover from predators (i.e., largemouth bass) (Brown et al. 2009b).

   As development or re-development occurs within single-family land use areas or other residential zones, restoration activities should be conducted. These may include removal of docks, placement of large woody debris, live-staking and re-vegetating the shoreline with native riparian plants, and removal of non-native substrates. There is significant opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to help encourage and facilitate habitat restoration around the lakes.

3. **Environmental and information collected during this survey should be available to all stakeholders, relevant agencies, and the general public.**
   Environmental information, including GIS information and air photos, are an important part of the environmental review process because they provide detailed technical information regarding the current ecological condition of the shoreline and associated habitats. This information should be readily available to the public to provide a transparent review process and include public input during land development decision making. A single agency should take the lead role in data management and any significant studies that add to this data set should be incorporated and updated accordingly.

4. **Compliance monitoring and policy enforcement during approved works is required, with negative consequences for failure to follow standard best management practices or to apply for relevant permits.**
   Unsanctioned and illegal modifications of shorelines are common along many interior lakes. Retaining walls, docks, boat launches, and other shoreline access points are created without an appropriate permit or following provincial standards or best management practices. Improved compliance monitoring and policy enforcement at all levels of government will help ensure best practices are maintained.

5. **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**.

6. **Local, provincial, and federal governments should only approve proposed developments with net neutral or net positive effects for biophysical resources.**

7. **Developments that have "significant" adverse effects to biophysical resources (e.g., wetlands, spawning areas) should not be approved on the basis that compensatory habitat works may offset such effects unless suitable rationale and arguments are presented (e.g., it benefits the general public versus an individual).**

8. **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 (HADD) of Fish Habitat[1]. The works must be consistent with the "No Net Loss" guiding principle of The DFO Policy for the Management of Fish Habitat.**

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

9. **Habitat mitigation and compensation plans for 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 construction meets an acceptable standard.

10. **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.**

11. **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 the productive capacity of biophysical resources should be considered.

7.2 Future Data Management

Ongoing appropriate management of the data is important to ensure that data collected during this survey is kept available, accurate, and up to date. Future data collection should be integrated into the current AHI and additions and edits made as required. The following are recommendations for future management of the dataset:

1. **A single agency should take the lead role in data management and maintenance**.
The responsible agency should manage and maintain 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.

2. **The shoreline segment numbers used in this report are the unique identifiers. Any new shoreline information that is collected should reference and become linked to the existing shoreline segment number.**
This will help maintain consistency and connectivity between current and future data collection and integration. The responsibility of maintaining this consistency will be that of the single agency described above.

3. **A summary column(s) should be added to the FIM dataset that flags new GIS datasets as they become available.**
Examples of this include new location maps for rare species occurrences and fish distributions. Other examples include the addition of appropriate wildlife habitat use data. Where feasible, these new data sets should reference the shoreline segment numbers identified in this report.

4. **Review and update of the FIM/AHI data and mapping should occur on a regular (i.e., 5 to 10 ten year) cycle.**
   Review and update of the FIM/AHI will be required to determine if shoreline goals and objectives are being achieved. Ideally, updates to the dataset will be done as projects are approved and completed (i.e., real time). However, at this time, it is unlikely that the multiple government agencies responsible have the capability to establish such a system.

7.3 Future Inventory and Data Collection

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

1. **Data regarding stream and shore spawning locations for resident fish species is limited.**
   Fish species including burbot, cutthroat trout, and rainbow trout have been identified as historically occurring within the lake system. During the FIM review, it was noted that there is limited data regarding shore or stream spawning locations for these fish species. Future inventory of important areas for these species should be conducted to allow improved management of the requisite habitats.

2. **The Juvenile Rearing Suitability Index should be field confirmed**.
   The index should be adjusted according to the results of a field program that samples the lake shoreline 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 and other fish. Similar investigations into utilization and importance of the different shore types by resident fish stocks may yield valuable information regarding the relationships between juvenile rearing suitability, fish stocks, alien species influence, 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 Jimsmith Lake, upon review of other studies, camera photos, air photos, and 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. **Complete Sensitive Habitat Inventory and Mapping (SHIM) for watercourses around the lake**.
   SHIM is a GIS-based stream mapping protocol that provides substantial information regarding streams and watercourses. 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.

5. **Complete Wetland Inventory and Mapping (WIM) for wetlands along the shoreline of the lake and associated tributaries.**
   WIM is another GIS-based mapping protocol that provides information regarding wetland communities. WIM mapping along the Jimsmith Lake shoreline and associated tributaries (i.e., Angus Creek) is recommended to ensure that corridors between aquatic and terrestrial habitats are identified. Mapping details are currently available for wetlands along East Angus Creek and similar inventories should be conducted along Angus Creek between Jimsmith Lake and New Lake. Wetlands are sensitive and productive components of natural ecosystems and these features should be inventoried and mapped.

6. **A carrying capacity analysis of the lake should be completed.**
   The carrying capacity of a lake is defined as a lakes capacity to accommodate recreational use (e.g., boating) and shoreline residential development without compromising adjacent aquatic and terrestrial habitats, biological resources, aesthetic values, safety, and water quality. Biological systems are extremely complex and difficult to predict and manage. Shoreline ecosystems throughout the province are experiencing rapid changes due to a variety of factors including land development and climate change. Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is difficult and controversial; therefore a conservative approach is required. Accurately determining sustainable carrying capacities on lake systems is currently one of the most challenging obstacles to lakeshore management because it affects cultural, social, and environmental resources and values.

7. **A survey of individual properties should be conducted and the results provided to home owners to provide educational and stewardship opportunities.**
   A property 'report card' could be prepared that would provide shoreline home owners with a review of the current condition of their properties. The assessment should provide them with sufficient information to help home owners work towards restoring and enhancing shoreline habitats on their property. An assessment like this is not intended to single out individual property owners, but rather to provide educational opportunities regarding the importance of shoreline habitats present along the lake.

8. **Native beds of submergent and floating vegetation should be mapped in detail.**
   Native beds of aquatic (i.e., submergent and floating) vegetation require more detailed mapping. Conducting a Wetland Inventory and Mapping project would help better identify, classify, and describe these important, sensitive features.

8.0 CONCLUSION

This report documents the current condition of approximately 2.7 km of shoreline along Jimsmith Lake in the east Kootenay region of BC. The Foreshore Inventory and Mapping (FIM) assessment provides a summary of current and background information characterizing the condition of the shoreline and riparian communities that comprise the foreshore of Jimsmith Lake. An Aquatic Habitat Index (AHI) was developed that incorporates the biophysical information collected during the surveys to rank the relative environmental sensitivity and level of disturbance of each of the discrete shoreline segments around the lake. Recommendations are provided to help integrate this information into local land use planning initiatives and the development of Shoreline Management Guidelines for Jimsmith Lake.

Approximately 75% of the Jimsmith Lake shoreline is in a natural condition, representing approximately 2,047 m of shoreline. Overall, approximately 48.2% of the shoreline is ranked as High or Very High value. The High value habitats tend to occur within undisturbed wetland and stream mouth communities that provide suitable fish and wildlife habitat. Approximately 6.6% of the shoreline is ranked Very Low value and these areas tend to occur within areas that have been impacted by shoreline development and substrate modification.

Docks represented the most common form of shoreline modification. Of the approximately 25% of disturbed shoreline, approximately 68% is characterized by Moderate to High levels of impact resulting from docks, groynes, retaining walls, boat launches, and substrate modification. These impacts, along with riparian vegetation removal, are considered the most significant form of shoreline degradation observed around Jimsmith Lake.

REFERENCES

Adams, M.A., and R. Haycock. 1989. Shuswap Lake Mointoring Program. Completed by ECL Envirowest Consultants Ltd. Prepared for: Fisheries and Oceans Canada. Draft Report.

Brown, T.G., Runciman, B., Bradford, M.J., and Pollard, S. 2009a. A biological synopsis of yellow perch (Perca flavescens). Can. Manuscr. Rep. Fish. Aquat. Sci. 2883: v+28p.

Brown, T.G., Runciman, B., Pollard, S., and Grant, A.D.A. 2009b. Biological synopsis of largemouth bass (Micropterus salmoides). Can. Manuscr. Rep. Fish. Aquat. Sci. 2884: v + 27 p.

Carrasquero, J. 2001. Overwater Structures: Freshwater Issues. Prepared by: Herrera Environmental Consultants. Prepared for: Washington Department of Fish and Wildlife. April 12, 2001.

Fraser, J.M. 1978. The effect of competition with yellow perch on the survival and growth of planted brook trout, splake, and rainbow trout in a small Ontario lake. Trans. Am. Fish. Soc. 107(4):505-517.

Guthrie, R.H., and P.D. Law. 2005. Lakeshore Erosion Hazard Mapping. B.C. Ministry of Environment, Nanaimo, BC. Technical Handbook No. TH1. 30 pp.

Kahler, T, M. Grassley, D. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shore zone development on ESA-listed salmonids in Lakes. Prepared for: City of Bellevue, WA. Prepared by: Tom Kahler, The Watershed Company Kirkland, WA.

Lange, M. 1999. Abundance and diversity of fish in relation to littoral and shoreline features. a Thesis presented to the faculty of graduate studies of the University of Guelph. September, 1999.

MacPhail, J.D. The Freshwater Fishes of British Columbia. The University of Alberta Press. 2007.

Mason, B. and J. Booth. 2004. Coastal Shoreline Inventory and Mapping. Community Mapping Network. Vancouver, BC.

Mason, B., and R. Knight. 2001. Sensitive Habitat Inventory and Mapping. Community Mapping Network, Vancouver, British Columbia. 315pp + viii. M. Johannes, Editor.

Mackenzie, W.H., and Jennifer Moran. 2004. Wetlands of British Columbia - A guide to identification. British Columbia Ministry of Forests, Forests Science Program. 287pp.

McPherson S. and D. Hlushak. 2008. Windermere Lake Fisheries and Wildlife Habitat Assessment. Consultant report prepared for the East Kootenay Integrated Lake Management Partnership. Prepared by Interior Reforestation Co. Ltd., Cranbrook, BC.

Ministry of Environment (MOE). 1998. Field Manual for Describing Terrestrial Ecosystems. BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests. Land Management Handbook 25.

Ministry of Environment (MOE). 2006. Kootenay Fisheries Field Report (Jimsmith Lake). BC Ministry of Environment. Source: The Ecological Reports Catalogue.

Ministry of Environment (MOE). 2011. Fisheries Information Summary System (FISS). Fisheries Inventory Data Queries. Accessed: March 3, 2011. Available: http://a100.gov.bc.ca/pub/fidq/main.do

Murphy, S.M. 2001. Development and Assessment of the Effectiveness of Fish Habitat Compensation Plans for infilling projects on Georgian Bay and Lake Simcoe, Ontario. Research and Development Monograph Series, 2001. Prepared by: Azimuth Environmental Consulting Inc.

Passey, B. 2010. Jimsmith Lake Watershed Baseline Assessment. Prepared for: Jimsmith Lake Community Association. Prepared by: Brian Passey, Environment Director Jimsmith Lake Community Association.

Piaskoski, R.M., and R.A. Tabor. 2001. Nocturnal habitat use by juvenile Chinook salmon in nearshore areas of southern Lake Washington. U.S. Fish and Wildlife Service. Lacey, Washington.

Runciman, J.B. and Leaf, B.R. 2009. A review of yellow perch (Perca flavascens), smallmouth bass (Micropterus dolomieu), largemouth bass (Micropterus salmoides), pumpkinseed (Lepomis gibbosus), walleye (Sander vitreus) and northern pike (Esox lucius) distributions in British Columbia. Can. Manuscr. Rep. Fish. Aquat Sci 2882: xvi + 123 p.

Schleppe, J. and D. Arsenault. 2006. The Kelowna Shore Zone Fisheries and Wildlife Habitat Assessment. EBA Consulting Engineers and Scientists. Project File: 0808-8840209. March 2006. Prepared for the City of Kelowna.

GLOSSARY OF TERMS AND ACRONYMS

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

Allochthonous Inputs - Organic material (e.g., leaf litter) that is contributed to an aquatic community from a terrestrial community.

Aquatic Habitat Index (AHI) -The index is a ranking system based upon the biophysical attributes and shoreline modifications 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 has developed documents containing standards and 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.

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.

SEGMENT PHOTO PLATES

Jim Smith Lake **Segment No.** 1

Shore Type: Sand

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	0%	100%	0%	0%	0%
Comments	natural sand beach					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
Very Low	Very Low	Low	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%
Comments	Jim Smith Lake Provincial Park												

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
0%	0%	20%	0%	80%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Herbs/grasses	Grass/Herb	Sparse (<10%)	Sparse (<10%)	Patchy	30
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
30%	30%	5%	5%	

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	0	0.00	0	1	0.01	1	0	0	0	0	0	0
Comments													

*N/A = Not Available

Jim Smith Lake **Segment No.** 2

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	0%	0%	0%	100%	0%
Comments						

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
Moderate	Moderate	Moderate	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	95%	0%	0%	5%	0%	0%	0%
Comments	road incusion . 5 m wide												

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
95%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Mixed forest	mature forest	Abundant (>50%)	Abundant (>50%)	Continuous	30
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
95%	30%	95%	95%	

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	0	0.00	0	0	0.00	0	0	15	0	0	0	0
Comments													

*N/A = Not Available

Jim Smith Lake **Segment No.** 3

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	0%	0%	1%	99%	0%
Comments	intact wetland/disturbed upland					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
High	High	High	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Comments													

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
95%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Natural wetland	Grass/Herb	Sparse (<10%)	Sparse (<10%)	Patchy	30
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
95%	20%	95%	95%	

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	1	0.00	0	0	0.00	0	0	0	0	0	0	0
Comments													

*N/A = Not Available

Jim Smith Lake **Segment No.** 4

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	0%	0%	1%	99%	0%
Comments	intact wetland/disturbed upland					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
High	High	High	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Comments													

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
95%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Natural wetland	mature forest	Moderate (10-50%)	Moderate (10-50%)	Patchy	50
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
95%	60%	95%	95%	chara/lilly pads

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	1	0.00	0	0	0.00	0	0	0	0	0	0	0
Comments													

*N/A = Not Available

Jim Smith Lake **Segment No.** 5

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	0%	0%	10%	90%	0%
Comments	Upper Jim Smith Creek					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
Very High	Very High	High	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
Comments													

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
95%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Mixed forest	mature forest	Abundant (>50%)	Abundant (>50%)	Continuous	50
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
95%	20%	95%	95%	chara/lilly pads

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	0	0.00	0	0	0.00	0	0	0	0	0	0	0
Comments													

*N/A = Not Available

Jim Smith Lake **Segment No.** 6

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	20%	20%	0%	60%	0%
Comments	10 percent lawn					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
Low	Moderate	Moderate	No	No	No

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Comments													

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
90%	0%	5%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Mixed forest	mature forest	Abundant (>50%)	Moderate (10-50%)	Patchy	20
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
40%	10%	40%	40%	

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
3	1	10	0.02	0	0	0.00	0	0	0	0	0	0	0
Comments	fence. 2 swim platform .sand pile												

*N/A = Not Available

Jim Smith Lake **Segment No.** 7

Shore Type: Wetland

Cliff / Bluff	Rocky	Gravel	Sand	Stream Confluence	Wetland	Other
0%	0%	5%	0%	50%	45%	0%
Comments	Angus Creek, lake outlet					

AHI and Fisheries Information

AHI Rating	AHI Potential	Juvenile Rearing	Migration	Staging	Spawn Stream
Very High	Very High	High	Yes	Yes	Yes

Land Use

Agriulture	Commercial	Conservation	Forestry	Industrial	Institutional	Multi Family	Natural Area	Park	Recreation	Rural	Single Family	Urban Park	Transportation
0%	0%	0%	0%	0%	0%	0%	20%	0%	0%	0%	80%	0%	0%
Comments													

Substrates

Marl	Mud	Organic	Fines	Sand	Gravel 2	Gravel Fin	Gravel Coa	Cobble	Cobble Fin	Cobble Coa	Boulder	Bedrock
85%	0%	5%	0%	5%	0%	5%	0%	0%	0%	0%	0%	0%
Comments												

Vegetation Band 1

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith
Mixed forest	young forest	Abundant (>50%)	Moderate (10-50%)	Continuous	50
Comments					

Vegetation Band 2

Class	Stage	Shrub Cover	Tree Cover	Distribution	Bandwith (m)
0	0	0.00	0	0	0
Comments					

Aquatic Vegetation

Aquatic Veg	Submergent	Emergent	Floating	Comment
50%	20%	50%	50%	

Modifications

Retaining Walls	% Ret. Wall	Docks	Docks per km	Boat Houses	Groynes	Groynes per km	Boat Launches	% Rail Modifier	% Road Modifier	Marine Railways	Marinas	Substrate Mod.	% Substrate Mod
0	0	0	0.00	0	0	0.00	1	0	0	0	0	0	0
Comments	private beach												

*N/A = Not Available

Foreshore Inventory and Mapping
FIGURE BINDER

Jim Smith Lake

Foreshore Inventory and Mapping

Legend

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

Aquatic Habitat Index Ranking

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

Segment Number: 7
Habitat Index Rating: Very High
Juvenile Rearing: High

Segment Number: 6
Habitat Index Rating: Low
Juvenile Rearing: Moderate

Segment Number: 1
Habitat Index Rating: Very Low
Juvenile Rearing: Low

Segment Number: 5
Habitat Index Rating: Very High
Juvenile Rearing: High

Segment Number: 2
Habitat Index Rating: Moderate
Juvenile Rearing: Moderate

Segment Number: 4
Habitat Index Rating: High
Juvenile Rearing: High

Segment Number: 3
Habitat Index Rating: High
Juvenile Rearing: High

Jim Smith Lake

Upper Jimsmith Creek (349-411700-09100-39400)

East Jimsmith Creek (349-411700-09100-39600-8470)

Jimsmith Creek (349-411700-09100-39400)

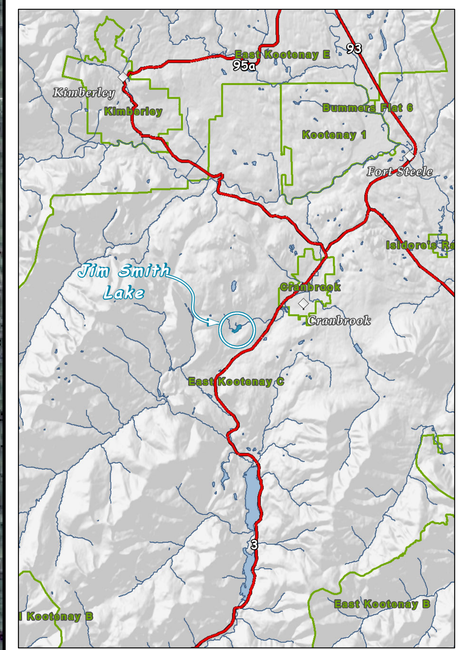
Hillsop Creek

Lakeview Dr

Jim Smith Lake Rd

Unnamed Tributary

Unnamed Tributary



ECOSCAPE
Environmental Consultants Ltd.

50 25 0 50 100 150
Meters

1 : 1,500

East Angus Creek

East Angus Creek Survey Provided by the Jimsmith Lake Community Association with data prepared by the Selkirk Geospatial Research Centre and Interior Reforestation Co. Ltd. (July 9, 2010)

Legend

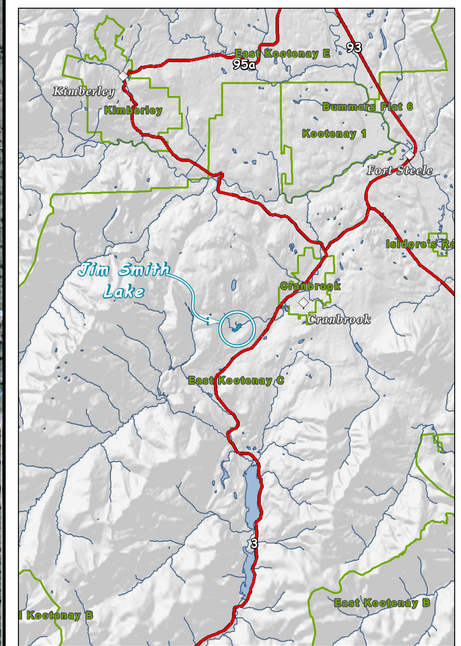
- 999 Foreshore Inventory and Mapping (FIM) Segment Number
- Segment Break
- Culvert
- Seep
- Streams
- Electoral Area / Municipal Boundary
- Cadastre

Angus Creek Stream Survey

- Stream
- Subsurface
- Surveyed Pond
- Surveyed Riparian
- Surveyed Wetlands

Jim Smith Lake Aquatic Habitat Index Ranking

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



ECOSCAPE
Environmental Consultants Ltd.

50 25 0 50 100 150 200
Meters
1 : 2,500

Connection to New Lake Approximately 2 Kilometers Upstream

East Angus Creek

Seep
Seep
Seep

Culvert
Culvert
Culvert
Culvert

Michel Rd
Hilltop Cres
Lakeview Dr
Jim Smith Lake Rd
Orrin Rd
Jim Smith Creek
Campground

Segment Number: 1
Habitat Index Rating: High
Juvenile Rearing: High

582800 582850 582900 582950 583000 583050 583100 583150 583200 583250 583300 583350 583400 583450 583500 583550 583600 583650 583700 583750 583800 583850 583900 583950 584000 584050 584100 584150 584200 584250 584300 584350 584400 584450 584500 584550

5452250 5452200 5452150 5452100 5452050 5452000 5451950 5451900

APPENDIX A
Data Tables

Table 1: The percentage of natural and disturbed shoreline along Jim Smith Lake

	% of Shoreline	Shore Length (m)
Natural	74.95%	2047
Disturbed	25.05%	684

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

Slope	% of Total Shore Length	Total Shore Length (m)	Shore Length Natural (m)	Shore Length Disturbed (m)	% Natural	% Disturbed
Very Steep (60+)	0.0	0	0	0	0.0	0.0
Steep (20-60)	0.0	0	0	0	0.0	0.0
Moderate (5-20)	56.6	1546	1170	376	75.7	24.3
Low (0-5)	43.4	1185	877	308	74.0	26.0
Bench	0.0	0	0	0	0.0	0.0

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

Land Use	% of Shoreline Length	Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Agriculture	12.1%	330	182	149	55.0%	45.0%
Commercial	0.0%	0	0	0	0.0%	0.0%
Conservation	0.0%	0	0	0	0.0%	0.0%
Forestry	0.0%	0	0	0	0.0%	0.0%
Industrial	0.0%	0	0	0	0.0%	0.0%
Multi Family	0.0%	0	0	0	0.0%	0.0%
Natural Area	32.2%	879	864	15	98.3%	1.7%
Park	6.6%	181	36	145	20.0%	80.0%
Recreation	0.0%	0	0	0	0.0%	0.0%
Rural	24.3%	664	538	126	81.1%	18.9%
Single Family	24.8%	677	427	250	63.1%	36.9%
Urban Park	0.0%	0	0	0	0.0%	0.0%
Transportation	0.0%	0	0	0	0.0%	0.0%
Institutional	0.0%	0	0	0	0.0%	0.0%

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

Shore Type	% of Total	Total Shoreline Length (m)	Natural Shore Length (m)	Disturbed Shore Length (m)	% Natural	% Disturbed
Cliff / Bluff	0.0%	0	0	0.0	0.0%	0.0%
Rocky Shore	0.0%	0	0	0.0	0.0%	0.0%
Gravel Beach	4.0%	110	64	46.3	58.1%	41.9%
Sand Beach	10.2%	280	91	189.1	32.4%	67.6%
Stream Mouth	5.0%	137	117	19.9	85.4%	14.6%
Wetland	80.7%	2204	1775	428.8	80.5%	19.5%
Other	0.0%	0	0	0.0	0.0%	0.0%

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

Type	% of Total Shoreline Length	Shoreline Length (m)
Aquatic Vegetation	77.0%	2102
Submergent Vegetation	30.7%	839
Emergent Vegetation	75.3%	2057
Floating Vegetation	28.5%	779

Table 6: The total number and density (# per km) of shoreline modifications occurring around Jim Smith Lake

Type	Total #	# Per km
Docks	12	4.39
Groynes	1	0.37
Boat Launch	1	0.37
Retaining Walls	3	1.10
Marinas	0	0.00
Marine Rails	0	0.00

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

Category	% of Shoreline	Shore Length (m)
Roadway	4%	110.4
Retaining Wall	0%	3.0
Railway	0%	0.0
Substrate Modification	0%	0.0

Table 8: The Level of Impact around Jim Smith Lake (High > 40%, Moderate (10-40%), Low (<10%), None (0%))

Level of Impact	% of Shoreline	Shore Length
High	18.70%	511
Moderate	49.42%	1350
Low	31.88%	871
None	0.00%	0

Table 9: The shore length and percentage of shoreline areas classified as having High, Moderate, or Low Juvenile Rearing Value on Jim Smith Lake.

Juvenile Rearing Category	# of Segments	Shore Length (m or %)				
		Natural (m)	Natural (%)	Disturbed (m)	Disturbed (%)	Total
High	4	1009.6	76.5%	309.4	23.5%	1319.8
Moderate	2	1001.3	81.3%	230.2	18.7%	1232.2
Low	1	36.1	20.0%	144.6	80.0%	180.9

APPENDIX B

AQUATIC HABITAT INDEX RESULTS

Denotes the Lowest Score Possible in the Category					
Very High	58	Moderate	41	Very Low	0.0
High	50	Low	25		

	Biophysical						Fisheries				Riparian		Terrestrial						Modifications				
Segment	Shore Type	Substrate	% Natural	Aquatic Vegetation	Overhanging Vegetation	Large Woody Debris	Spawning	Juvenile Rearing	Migration Corridor	Staging Area	Band 1 (Riparian)	Band 2 (Upland)	Buffer	Core	Veteran Trees	Snags	Wildlife Corridor	Rare Plants	Retaining Wall	Docks	Groynes	Boat Launch	Marina
1	8	4.8	1	2.4	0	0	0	2	0	0	4.8	0	0	0	1	0	0	0	0	0.00	-0.01	-2	0
2	15	8	4.95	7.6	0.08	0	0	4	0	0	6.4	0	0	0	1	0	0	0	0	0.00	0.00	0	0
3	15	8	2.75	7.6	0	0	0	10	0	0	8	0	0	0	1	0	0	0	0	-1.00	0.00	0	0
4	15	8	4	7.6	0	0	0	10	0	0	8	0	0	0	1	3	0	0	0	-1.00	0.00	0	0
5	15	8	4.95	7.6	0	4	0	10	0	0	6.4	0	0	0	1	3	0	0	0	0.00	0.00	0	0
6	13	7.8	2.75	3.2	0.04	4	0	4	0	0	5.12	0	0	0	3	1	0	0	-0.060595	-10.00	0.00	0	0
7	14.85	7.9	4.25	4	0	0	0	10	4	4	6.4	0	0	0	1	0	5	0	0	0.00	0.00	0	0

Score Possible	Total Score Possible			
	48	18	12	12.1

Segment	Biophysical	Fisheries	Riparian	Terrestrial	Modification (All)	Seg final
1	16.2	2	4.8	1	-2.0	1
2	35.63	4	6.4	1	0.0	2
3	33.35	10	8	1	-1.0	3
4	34.6	10	8	4	-1.0	4
5	39.55	10	6.4	4	0.0	1000
6	30.79	4	5.12	4	-10.1	5
7	31	18	6.4	6	0.0	6

Summary							
	Max	61.4	68.2	Max	61.4	68.2	Max
	Min	22.0	24.4	Min	24.0	26.6	Min

Segment	Shore Length	Current Value	Current Value Total Percent	AHI Ranking	Potential Value	Potential Value Percentage	Potential Value AHI Ranking
1	180.7	22.0	24.4	Very Low	24.0	26.6	Very Low
2	736.3	47.0	52.2	Moderate	47.0	52.2	Moderate
3	330.1	51.4	57.0	High	52.4	58.1	High
4	627.1	55.6	61.7	High	56.6	62.8	High
5	134.3	60.0	66.6	Very High	60.0	66.6	Very High
6	495.1	33.8	37.6	Low	43.9	48.8	Moderate
7	227.5	61.4	68.2	Very High	61.4	68.2	Very High

APPENDIX C

Additional Legal Requirements

This Appendix was reproduced entirely from the Windermere Lake Shoreline Management Guidelines. All credit should be given to the original authors of that document.

Laws and regulations provide the regulatory 'teeth' to uphold environmental protection and management. Applicable legislative requirements must be met for a project to be in compliance with the law. Legal requirements have been presented here in the following categories: Federal, Provincial, Regional District and District of Invermere. For each of these jurisdictions, a list of pertinent legislation bylaws and/or plans; and contact information (web site links) has been provided. The reader is cautioned that other legislation (not listed) may apply to their development, and they are encouraged to consult with the appropriate agency prior to proceeding with any proposed works.

1. Federal Legislation

All federal legislation is administered by the parliament of Canada (federal government).

Canada Migratory Birds Convention Act

This Act implements an internationally recognized Convention between Canada and the United States to protect various species of migratory game birds, migratory insectivorous birds and migratory non-game birds including herons. The taking of nests or eggs of these birds is prohibited, except for permitted scientific or propagating purposes.

Fisheries Act

The *Fisheries Act* is administered by the federal DFO and is one of the most important pieces of legislation for managing aquatic resources in Canada. The fish habitat provisions of this Act enable the federal government to protect marine and freshwater habitats supporting those species that sustain fisheries, namely fish, shellfish, crustaceans and marine mammals.

Navigable Waters Protection Act

This act is administered by Transport Canada and is primarily applicable to protecting, maintaining, and developing opportunities for the public to access and use waterbodies for navigation and recreation. Any activities that may affect movement of people or goods, near or on water are affected (i.e. dock/marina construction, dredging, shoreline development).

Pesticides Act

The *Pesticides Act* is intended to 1) prevent and mitigate harmful effects to the environment and human health, and 2) rationalize and reduce the use of pesticides. The Act promotes the analysis, assessment and control of the effects of the use of pesticides through specific activities intended to widen knowledge about these products (environmental monitoring, for example).

Species at Risk Act

This act prevents Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, provides for the recovery of endangered or threatened species and encourages the management of other species to prevent them from becoming at risk.

Canadian Environmental Assessment Act (CEAA)

The CEAA requires federal departments to conduct environmental assessments (EA) for prescribed projects and activities before providing federal approval or financial support. The EA is a planning tool used to identify potential effects of projects or activities on the environment. This includes the air, water, land and living organisms, including humans.

Indian Act

The *Indian Act* provides legislation relating to Indians and Lands Reserved for Indians. The Indian Act is administered by the Minister of Indian Affairs and Northern Development.

2. Provincial Legislation

All provincial government legislation within BC is administered by the legislative assembly of British Columbia (provincial government).

Land Act

The *Land Act* is the main legislation governing the disposition of provincial Crown (i.e. public) land in British Columbia. Crown land is any land owned by the Province, including land that is covered by water, such as the foreshore and the beds of lakes, rivers and streams. The *Land Act* is administered by the Ministry of Sustainable Resource Management.

Wildlife Act

The provincial Ministry of Environment administers the *Wildlife Act*, which includes legislation relating to the conservation and management of wildlife populations and habitat, issuing licenses and permits for fishing, game hunting, and trapping. A provision of the *Wildlife Act*, which may be pertinent to shoreline development is the prohibition, to take, injure, molest, or destroy a) a bird or its egg; b) the nest of an eagle, peregrine falcon, gyrafalcon, osprey, heron, or burrowing owl; c) or the nest of any other bird species when the nest is occupied by a bird or its egg.

Water Act

The *Water Act* is the primary provincial statute regulating water resources. Under the *Water Act*, a stream is defined as "*a natural watercourse or source of water supply, whether usually containing water or not, and a lake, river, creek, spring, ravine, swamp and gulch*." Section 9 of the *Water Act* requires that a person may only make "changes in and about a stream" under an Approval or Notification where required; or under a Water License or Order.

Weed Control Act

The B.C. *Weed Control Act* imposes a duty on all land occupiers to control designated noxious plants. The purpose of the Act is to protect our natural resources and industry from the negative impacts of foreign weeds.

3. Regional District of East Kootenay

The Regional District of East Kootenay (RDEK) provides local government services to rural areas outside municipal boundaries. The RDEK functions as a partnership of the municipalities and electoral areas (unincorporated areas) within its boundaries. These local governments work together through the RDEK to provide and coordinate services in both urban and rural areas. Regional districts are governed by the *Local Government Act* and other provincial legislation.

APPENDIX D

Best Management Practices and Regional Operating Statements

This Appendix was reproduced entirely from the Windermere Lake Shoreline Management Guidelines. All credit should be given to the original authors of that document.

Many provincial and federal agencies have developed Best Management Practices (BMP) in order to provide consistent direction to the public on acceptable development methods. The BMPs provide information to help ensure that proposed development activities are planned and carried out in compliance with the various applicable legislation, regulations, and policies. The range of activities that associate BMPs is broad.

The province of BC has, over a period of many years, developed a series of BMPs. These have evolved into "Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia." The Develop with Care Guidelines have links to several provincial BMPs related to shoreline development activities. Examples are as follows:

- Standards and Best Management Practices for Instream Works;
- Best Management Practices for Small Boat moorage on Lakes
- Timing and Terms and Conditions for Changes In and About a Stream Specified by MOE Habitat Officers, Kootenay Region
- Small Boat Moorage
- Boat Launch Construction and Maintenance on Lakes
- Lakeshore Stabilization
- Installation and Maintenance of Water Line Intakes
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia
- Best Management Practices for Amphibians and Reptiles in Urban and rural Environments in BC
- Best Management Practices for Recreational Activities on Grasslands in the Thompson and Okanagan Basins

The Regional Operating Statements (ROS) developed by DFO, provide information regarding several low risk activities associated with shoreline development, including but not limited to:

- Aquatic Vegetation Removal in Lakes
- Bridge & Culvert Maintenance
- Dock and Boathouse Construction in Freshwater Systems
- Routine Maintenance Dredging for Navigation
- Public Beach Maintenance
- Clear Span Bridges
- Culvert Maintenance
- Directional Drilling
- Small Moorings
- Underwater Cables in Freshwater Systems
- Overhead Line Construction
- Maintenance of Riparian Vegetation in Existing Rights of Ways
- Dry Open Cut Stream Crossing
- Isolated Ponds