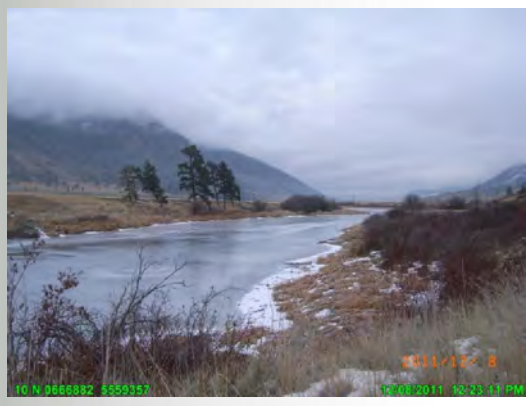
Foreshore Inventory and Mapping

NICOLA LAKE



Prepared For:

Thompson-Nicola Regional District

and

Fisheries and Oceans Canada

Prepared By:

Ecoscape Environmental Consultants Ltd.

March, 2012

File No.: 11-849

ECOSCAPE
Environmental Consultants Ltd.

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EXECUTIVE SUMMARY

The Nicola watershed encompasses a large area of rolling hills, open pine and fir woodland, grassland, and a number of streams and lakes. Within the watershed, Nicola Lake (Watershed Code: 120-246600) represents a significant natural resource to local First Nations, residents, visitors, and wildlife that depend on a reliable source of clean water and healthy aquatic and riparian ecosystems. Nicola Lake provides an important source of water for human consumption, irrigation, and recreation, as well as supporting stocks of sea-run coho, chinook, pink salmon, and steelhead trout. For these reasons, the Thompson-Nicola Regional District and Fisheries and Oceans Canada have collaborated to complete Foreshore Inventory and Mapping (FIM) to determine the effects of cumulative shoreline modifications and identify important fisheries and wildlife values.

To provide comprehensive and collaborative shoreline planning, the project partners, agencies, and stakeholders have documented and described the current condition of the Nicola Lake shoreline to develop an integrated approach to shoreline and watershed management. The project partners have identified the need to address watershed concerns such as shoreline development, water quality, regulation of flows, and demands on water quantity from residential and agricultural expansion. The FIM process and report were completed based upon the belief that it is possible to manage the shoreline resource in a sustainable manner. The results of the FIM report will allow stakeholders access to the data which is intended to facilitate the management of these watershed resources.

Currently, lake management projects in the province of BC follow a three-step process described below. For this project, step 1 has been completed.

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 (i.e., GIS) approach to describe shorelines. The inventories provide information on shore types, substrates, land use, and habitat modifications. This information has been combined with other mapping information such as fisheries inventories, recent orthophotos, and other natural resource data.

2. An Aquatic Habitat Index (AHI) is generated using the FIM data to determine the relative habitat value of discrete segments along the shoreline. The AHI uses many different factors such as biophysical criteria (e.g., shore type, substrate information), fisheries information (e.g., juvenile rearing suitability, migration, and staging areas), shoreline vegetation (e.g., width and type of shoreline vegetation), terrestrial information (e.g., conservation areas), and modifications (e.g., docks, retaining walls) to provide a qualitative estimate of the relative habitat value of each shoreline segment using a 5-Class system (i.e., Very High to Very Low). The value of each shoreline segment is considered relative to the other segments along the lake shoreline (i.e., describes shoreline segments within the lake relative to

each other and not to other lakes). The AHI also includes a restoration analysis and indicates where restoration efforts will result in the greatest ecological benefit.

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

The results of the FIM data (Step 1) for Nicola Lake are summarized below:

- The level of impact along the Nicola Lake shoreline is based upon categorical descriptions of disturbance observed along the lake. It is estimated that 42.8% of the shoreline has a high level of impact (i.e., greater than 40% disturbance) which accounts for 22,834 m of shoreline. Areas of moderate (i.e., 10 to 40% disturbance) and low impact (less than 10% disturbance) account for 25.5% (13,599 m) and 22.6% (12,081 m) of shoreline, respectively. The remaining 9.1% (4,879 m) of shoreline has no impact.
- Observed impacts include lakebed substrate modification, riparian vegetation removal, and construction of retaining walls, docks, and groynes. In total, it is estimated that 55.5% or 29,818 m of the shoreline is disturbed and 44.5% or 23,944 m remains natural.
- The most predominant land use around the lake is agricultural (33.7%), followed by transportation (25.9%). Other noted land uses include rural, single family residential, natural area, recreation, park, and urban park.
- Gravel beach (30.8%), rocky shore (28.7%), and wetland (26.5%) represent the most common shore types observed along the shoreline. Stream mouth (5.5%), sand beach (4.3%), and cliff/bluff (4.1%) account for the remaining shore types.
- Aquatic vegetation was observed along 36.8% of the shoreline. Of this, emergent vegetation was the most commonly observed (e.g., emergent grasses, willows, or other areas with vegetation inundated during high water). Native beds of submergent vegetation were rarely observed. Floating vegetation was not documented.

Habitat modifications observed along the Nicola Lake shoreline are described below:

- Groynes are the most common modification, with a total of 154. Lakebed cobbles and boulders are commonly used to construct groynes and it is probable that construction required the use of heavy equipment. The use of lakebed substrates

to construct groynes may have impacts on aquatic vegetation, which provides important habitat for rearing juvenile salmon.

- Docks are the next most common modification, with a total of 106. Both pile supported and floating docks were observed.
- Retaining walls are the next most predominant modification, with a total of 83, and which cover approximately 4% of the shoreline. Some retaining walls extend beyond the high water level of lake which is not compliant with provincial Best Management Practices.
- Boat launches are the least common modification with a total of 15.
- Substrate modification occurs on 31% of the shoreline, with roadways accounting for a substantial portion. It is estimated that roadways occupy approximately 20% of the near shore area.

In general, the FIM results indicate that the foreshore areas of Nicola Lake have been moderately impacted by land use practices. The FIM also identified important natural and wetland habitats along the shoreline that are currently in good condition. It appears that the current reliance on Best Management Practices and voluntary compliance with the regulations and guidance documents does not provide reasonable protection of important fish and wildlife habitats along the shoreline. It is apparent that property owners tend to mimic neighbouring activities and this tendency has been observed along many other developed lake shorelines throughout BC.

Some shoreline modifications have encroached onto Crown Land (i.e., below the lake high water level). As such, it is imperative that relevant agencies and stakeholders work with the public on improved communication and education to ensure that everyone is aware of the sensitive habitats present along the foreshore, their ecological and economical values, and the potential negative influences development activities may have upon them. Recommendations for public awareness and education have been developed to facilitate public involvement and compliance in the protection of foreshore areas. The combination of education and cooperative enforcement will help reduce the continued losses of habitat along the shoreline and promote environmental stewardship along the foreshore.

Other recommendations were developed to promote foreshore protection, guide future data management, and for future biophysical inventory works. One of the key recommendations is:

- An AHI and Shoreline Management Guidelines (i.e., Steps 2 and 3) should be completed to finalize the three-step shoreline management process. The FIM provides a foundation to complete the AHI which will in turn facilitate the guidelines. The results of the AHI and guidelines will contribute to the development and update of shoreline policies, bylaws, and Official Community Plans. The guidelines will also allow regulators to make informed land use decisions across multiple agencies and streamline the permitting and approval processes by focusing on areas or activities that present the greatest environmental risks.

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DISCLAIMER

The results contained in this report are based upon data collected during surveys occurring over a limited period of time. Biological systems respond differently both in space and time and exhibit extreme variability. For this reason, conservative assumptions have been used and these assumptions are based upon field results, previously published material on the subject, and air photo interpretation. Due to the inherent problems of brief inventories (e.g., property access, GPS/GIS accuracies, air-photo interpretation concerns, etc.), professionals should complete their own detailed assessments of shore zone areas to understand, evaluate, classify, and reach their own conclusions regarding them. Data in this assessment was not analyzed statistically and no inferences about statistical significance should be made if the word significant is used. Use of or reliance upon conclusions made in this report is the responsibility of the party using the information. Ecoscape Environmental Consultants Ltd., Thompson-Nicola Regional District, Fisheries and Oceans Canada, and the authors of this report are not liable for accidental mistakes, omissions, or errors made in preparation of this report because best attempts were made to verify the accuracy and completeness of the data collected and presented.

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1.0 INTRODUCTION

The Thompson-Nicola region, in the southern interior of BC, is a popular recreational and tourism destination experiencing increasing pressures on natural resources related to agricultural development, water use, and a growing demand for lakefront properties. Development pressures are affecting lakes throughout the region, including Nicola Lake, northeast of Merritt, BC. Shoreline development has the potential to degrade aesthetic and recreational values associated with lake systems and may result in negative impacts to terrestrial, riparian, and aquatic ecosystems. Local development pressure has led to a need for project partners to assess and address foreshore conditions along Nicola Lake to facilitate improved information sharing amongst stakeholders and to guide land use policies for future proposed development. The purpose of this Foreshore Information and Mapping (FIM) report is to identify and describe the characteristics and impacts observed along the foreshore of Nicola Lake.

The relationship between development pressure, the natural environment, and social, economic, and cultural values is complex and dynamic. To address the various community and stakeholder values, a comprehensive understanding of aquatic and riparian resource values, land use interests, and concerns of First Nations and local residents is required to develop appropriate long-term planning and policy objectives. Detailed shoreline inventories provide a 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 FIM process is to facilitate informed land use planning decisions that balance stakeholder interests with natural resource values.

In response to the need for improved understanding of foreshore conditions, an assessment and inventory was conducted along the shoreline of Nicola Lake. This report has been prepared to characterize discrete segments of the shoreline, identify historical modifications and impacts, and evaluate the overall environmental condition of the foreshore. Current management practices being implemented throughout BC 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. For this project, step 1 has been completed. The entire process typically involves the following steps:

1. Foreshore Inventory and Mapping (FIM) – FIM is a broad scale inventory process that defines and describes the shoreline of lake systems. The inventory provides baseline information regarding the current condition, natural features, and levels of development (e.g., docks, groynes, marinas). Sufficient data is collected to allow the general public, stakeholders, policy makers, and government regulators 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 environmentally sensitive shoreline segments as part of step 2 below.

2. Aquatic Habitat Index (AHI) – The AHI utilizes data collected during the FIM, field reviews, and other data sources to develop and rank the environmental 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 environmental sensitivity of different shoreline areas within the lake system rather than to other lakes). The index provides an indication of the relative ecological value of different shoreline segments.

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 development applications and to facilitate review, planning, and prescription of shoreline alterations (i.e., land development) for regulatory agencies. The guidelines consider a broad range of biological criteria (e.g., wetlands, aquatic vegetation, adjacency to sensitive terrestrial features, migration and staging areas, etc.) making it more inclusive of sensitive habitats.

2.0 PROJECT OVERVIEW

Nicola Lake (Watershed Code: 120-246600) has a surface area of approximately 2,500 ha with a maximum depth of 55 m and an average depth of 23.5 m (FISS 2012). The lake supports a variety of non-anadromous resident sport fish species, including kokanee, rainbow trout, bull trout, lake trout, dolly varden, and cutthroat trout. Anadromous (i.e., sea-run) salmonids such as coho, chinook, pink salmon, and steelhead trout also occur within the lake. Other sport fish known to occur within the lake include burbot and mountain whitefish. Kokanee spawning is reported to occur primarily within two major tributaries to the lake: the Nicola River and Moore Creek (Lorz and Northcote 1965; Kosakoski and Hamilton 1982).

These fish species contribute to significant First Nations and recreational sport fishery values and support a considerable local ecotourism industry. Nicola Lake is an extremely important natural resource for ecological, social, aesthetic, and economic reasons. The need for responsible and sustainable management of the watershed resources is recognized by local, provincial, and federal governments, First Nations, and residents as critical to the future of this region (TNRD 2009). Community members have raised a number of concerns with regard to the impacts adjacent land use and recreational demands are having on the lake.

Development pressures, including regulation of flows at the lake outlet, water extraction, and fish passage constraints, have raised concerns with community members and stakeholders, especially as they pertain to sea-run salmon and steelhead populations (Rosenau and Angelo 2003). Agricultural activities including crop production and cattle ranching have had significant impacts along the fluvial and lacustrine terraces, floodplains, and riparian communities associated with the lake and tributary streams (Walthers and Nener 1997). The importance of maintaining minimum flows for fish and the effects of increased water extraction and diversion has been examined and highlighted by others (Kosakoski and Hamilton 1982; Hatfield 2006; Summit 2007). A Multi-Stakeholder Committee completed a Water Use Management Plan (WUMP) for the Nicola Watershed in response to growing concerns over water demands related to agricultural use and human consumption, shoreline development, insufficient flows, and general water quality (Nicola WUMP 2010).

The Thompson-Nicola Regional District (TNRD) has produced lakeshore development guidelines (2004) that provide land use and site development policies and approval processes. The TNRD has also developed an Official Community Plan (OCP 2011) for the Nicola Valley that provides environmental policies and constraints, including the implementation of the provincial Riparian Areas Regulation (RAR). The RAR is used to determine Streamside Protection and Enhancement Area (SPEA) setbacks associated with watercourses and lakes to protect and restore these sensitive ecological communities. Other policies include retention of riparian vegetation, erosion and sediment control, and site specific development guidelines.

The Nicola Lake FIM project provides an opportunity for project partners to provide information for policy updates and development and allow for improved adaptive management of the resource. The FIM information and subsequent steps (i.e., AHI and shoreline management guidelines) will improve and enhance existing policies and management plans. The results of the FIM provide an important planning tool that can be used to make informed decisions regarding development permit applications and area structure plans. The FIM protocol will help stakeholders understand the current condition of the shoreline, set objectives for improved shoreline management in OCP or other guidance documents, and be used to measure and monitor foreshore changes over time.

2.1 Project Partners

The current FIM protocol has been developed over the last seven years and has been used as a standard method for shoreline inventory. Various local governments, non-profit organizations, biological professionals, and provincial and federal agencies have contributed to the development of the FIM protocol and detailed methods are provided in Appendix A. The Nicola Lake FIM project was funded by the following organizations:

- Thompson-Nicola Regional District (TNRD); and

- Fisheries and Oceans Canada (DFO)

2.2 Objectives

The Nicola Lake FIM project objectives are to:

1. Compile existing mapped resource information for Nicola Lake;
2. Foster collaboration between TNRD, DFO, Ministry of Forests, Lands, and Natural Resource Operations, First Nations, and local residents;
3. Provide an overview of foreshore habitat conditions along the lake;
4. Inventory foreshore morphology, land use, riparian condition, and anthropogenic modifications;
5. Obtain spatially accurate digital video of the Nicola Lake shoreline;
6. Prepare the video and GIS geo-database for loading onto the Community Mapping Network (www.cmnbc.ca);
7. Collect information that will aid in prioritizing critical areas for conservation and/or protection and lake shore development;
8. Make the information available to planners, politicians, and other referring agencies that review applications for land development approval; and
9. Integrate information with upland development planning to ensure protection of sensitive foreshore areas to ensure lake management planning is watershed-based.

The Nicola Lake FIM addresses many of these objectives. Completion of an AHI (Step 2) and development of Shoreline Management Guidelines (Step 3) will be required to address the more detailed planning aspects and to meet identified long-term objectives.

2.3 Study Location

Nicola Lake is located in the Thompson region of BC, approximately 10 km northeast of the City of Merritt. The majority of the lake shoreline occurs within the Very Dry Warm Bunchgrass Biogeoclimatic zone (BGxw2). The shoreline transitions to the Very Dry Hot Interior Douglas-fir zone (IDFxh2) towards the higher elevation upland areas. The forest community surrounding the lake is comprised of shrub and grassland with sparse, open stands of ponderosa pine and interior Douglas-fir. Saskatoon, sagebrush, and rabbit-brush comprise the understory. Black cottonwood occur along floodplains and other wetted habitats with a narrow fringe of riparian shrubs. Pockets of emergent and submergent vegetation occur along the foreshore. The location of the Nicola Lake study area is shown in Figure 1.

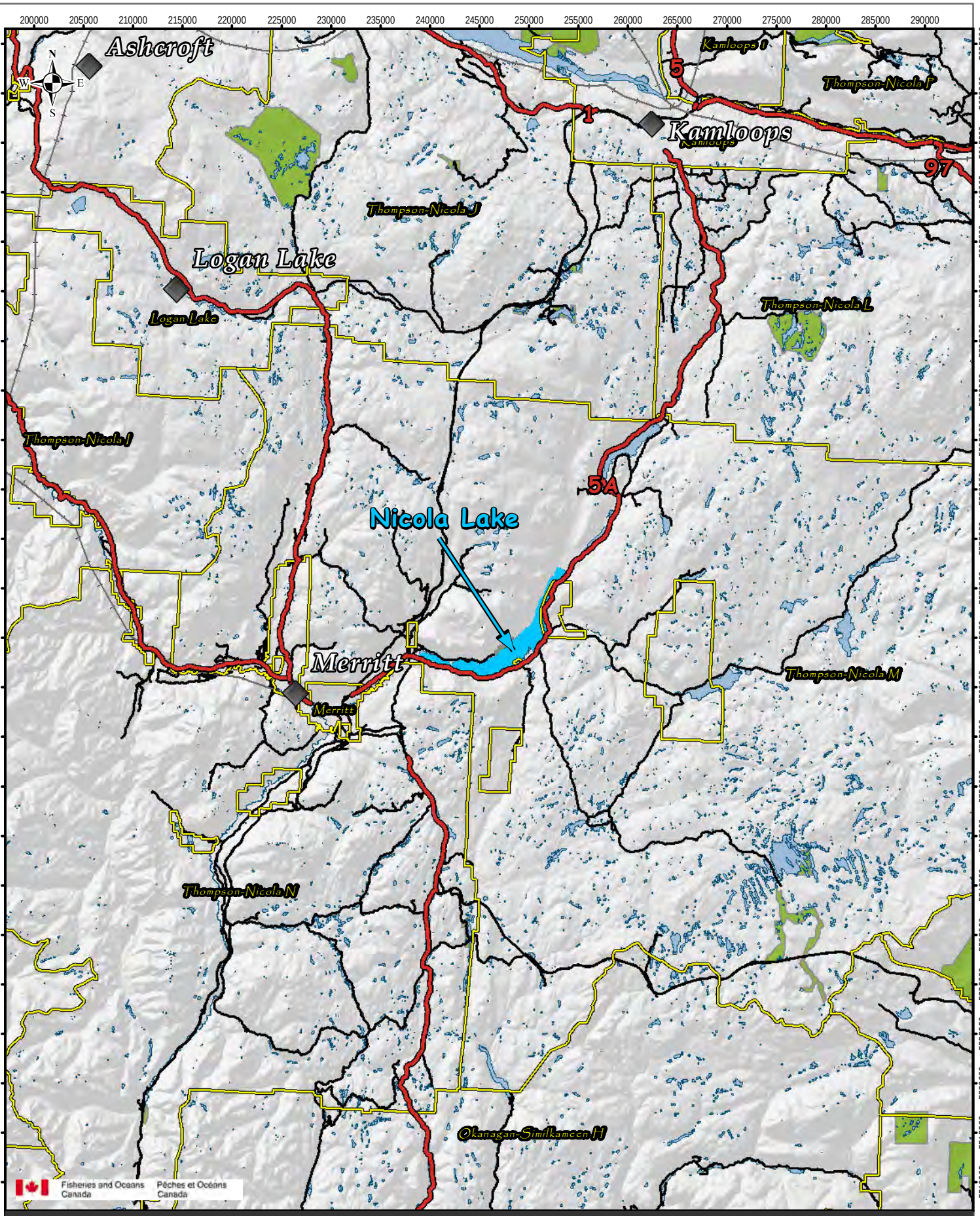
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Figure 1 - Project Location
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2.4 Important Fisheries and Wildlife Resource Information

According to the BC Fisheries Information Summary System (FISS), fish present in Nicola Lake include rainbow trout, kokanee, bull trout, lake trout, dolly varden, cutthroat trout and anadromous species including coho, chinook, pink salmon, and steelhead trout (FISS 2011). Other sport fish reported to occur within the lake include burbot and mountain whitefish. The fish assemblage also includes coarse species such as sculpin, dace, lake chub, longnose sucker, peamouth chub, and redside shiner. The non-native carp is also reported to occur within Nicola Lake (FISS 2011).

Many of the species occurring within Nicola Lake have importance as sport fish and cultural value to First Nations and local residents. Chinook and other anadromous salmon are considered extremely important ecologically due to the complex relationships they have with other species and with aquatic, riparian, and terrestrial ecosystems (Watkinson 2000). Spawning salmon provide an important food source for bears, eagles, osprey, and other scavenging wildlife and the carcass remains provide valuable marine-derived nutrients to riparian and terrestrial plant communities (Mathewson et al. 2003). Salmon spawning and rearing behaviour is highly sensitive to environmental conditions such as water quality, sedimentation, and riparian condition, and the status of salmon stocks provides an indication of overall watershed health and integrity (Knapp et al. 1982).

Issues and concerns related to water use within the Nicola watershed have been identified and described within the Nicola WUMP (2010). The key aquatic environmental issues identified for Nicola Lake include:

- Low summer reservoir levels may restrict tributary access for spawning salmonid fish species (e.g., kokanee, chinook, coho, pink salmon, and trout);
- Condition of burbot rearing habitat along the rocky shoreline in the summer;
- Effect of potential changes to littoral productivity;
- Effect on burbot spawning habitat associated with decreasing water levels (i.e., from February to March);
- Influence of reservoir levels on forage fish species populations (e.g., chub, shiner, pikeminnow), which may affect food availability for predator species (i.e., burbot, bull trout, rainbow trout); and
- Low reservoir levels may restrict fish passage at the dam.

The following additional issues were identified in association with wildlife and terrestrial environments:

- Low reservoir levels in spring have the potential to affect staging habitat for waterfowl (e.g., pelicans, Canada geese, swans);

- Fluctuating reservoir levels may affect nesting habitat for waterfowl;

- Impacts to riparian vegetation from erosion caused by waves from wakeboard boats; and

- Public concerns regarding increasing populations of mule deer.

The riparian and upland ecosystems associated with Nicola Lake also provide important habitats for a variety of terrestrial wildlife species. Waterfowl such as loons, mergansers, and ducks, and raptors such as osprey and bald eagle utilize the lake and foreshore for important life history stages such as, perching, foraging, and nesting habitat. Unique habitats such as rock outcrops, talus, caves, and snags are scattered along the lakeshore. The high quality terrestrial habitat surrounding Nicola Lake suggests high potential for rare and sensitive species including bats, snakes, and invertebrates. The conservation of these features is important to maintaining the overall integrity of the Nicola Lake ecosystem.

The BC Conservation Data Centre (CDC) lists element occurrences of several species at risk along Nicola Lake and associated tributaries (CDC 2012). Species that rely on natural foreshores, access to freshwater, and healthy riparian ecosystems that are reported to occur near the lake include American avocet, Lewis's woodpecker, and Great Basin spadefoot. While less reliant on aquatic ecosystems, the endangered burrowing owl is also reported to occur within the grasslands adjacent to Nicola Lake. These species are all listed as threatened or endangered according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or are red or blue-listed by the province of BC.

A number of economic and social issues have been described by the Water Use Management Plan, including the effects of agricultural activity, recreation, tourism, and visual aesthetics. The TNRD has also identified concerns regarding the establishment and proliferation of Eurasian milfoil within Nicola Lake. Downstream of the Nicola Lake dam, identified issues are generally related to flow management (i.e., low flows, fish passage, flooding). These issues highlight the concerns held by local residents and stakeholders and the value of the aquatic, riparian, and wildlife resources associated with Nicola Lake. The identified issues and concerns were considered during the completion of the shoreline inventory and FIM analysis.

3.0 FORESHORE INVENTORY & MAPPING METHODOLOGY

The FIM detailed methodology is provided in Appendix A. The inventory methodology is based on standards developed for Sensitive Habitat Inventory and Mapping (SHIM) (Mason and Knight, 2001) and Coastal Shoreline Inventory and Mapping (CSIM) (Mason and Booth, 2004). The development of mapping initiatives such as SHIM, CSIM, and FIM is a key component of environmentally sound community planning. The following sections summarize the process undertaken for the Nicola Lake FIM.

3.1 Field Surveys

The field component of the Nicola Lake FIM project was completed on December 7 and 8, 2011. Each member of the field crew was assigned a category of data to collect. The field crew used 11" x 17", scaled, colour aerial photos, with an overlay of cadastre and topographic information, to assist with orientation and field data collection. Two Trimble GPS units with SHIM Lake v. 2.6 (FIM data dictionary) and hurricane antennae were used for recording data. Photographic documentation of the shoreline was conducted using a digital camera with a time/date and location coordinate stamp.

Other field surveys conducted include recording of GPS digital video, completed by DFO staff and project partners. The specifics of the GPS digital video are discussed in the FIM methodology. The principle objectives of the video and photographic recordings are to:

- Provide photographic documentation of the shoreline for the main areas of development; and

- Record data relating to the presence and abundance of shoreline modifications, such as retaining walls and boat launches.

Weather is considered an important factor during the field survey, particularly during the photo and video data collection. High quality photo documentation is critical since the photos are instrumental during subsequent data analysis. The weather conditions that occurred during the field surveys were considered appropriate to collect accurate data. Data that was estimated is clearly delineated as such in the GIS datasets.

3.2 Methodology

Detailed methodology used for the Nicola Lake FIM project is provided in Appendix A. Data collected was downloaded to a laptop daily as a backup. Following completion of the field survey component, the entire database was reviewed and corrections were made as necessary. Ecoscape has attempted to ensure the data is as accurate as possible. However, due to the large size of the dataset, small errors may be encountered. These

errors, if found, should be identified and actions initiated to resolve the error. The following additional information was collected during field surveys:

1. The spatial extent of emergent grasses on flood benches, and areas of submergent and floating vegetation were mapped and photographed to determine the approximate area where aquatic vegetation occurs. Aquatic vegetation includes any plants growing below the high water level of the lake. Areas of extensive overhanging vegetation were also mapped. Due to the timing of the surveys (i.e., mid-December), unmapped areas of vegetation may occur. The accuracy of mapping is largely dependent upon the resolution of air-photos. It should be noted that on large littoral areas, vegetation mapping may not have captured all occurrences.

2. Small stream confluences, seepage areas, and other drainage features were recorded.

3. Attempts were made to map locations of boat launches, boat mooring zones/haul outs, riparian areas, and other features of interest along the foreshore.

3.2.1 Aquatic Vegetation Mapping and Classification

Aquatic vegetation mapping was carried out for the entire shoreline, with focus on foreshore areas. For the purpose of this assessment, aquatic vegetation includes any plant life 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 fish habitat. Vegetation mapping was completed by digitizing vegetation polygons from field observations recorded on air photos. Vegetation communities were classified using nomenclature from the Wetlands of British Columbia (Mackenzie and Moran 2004) and were generally categorized as:

Marsh (Wm)

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

Low Bench Flood Ecosystems (Fl)

Low bench flood ecosystems occur on sites that are flooded for moderate periods (i.e., <40 days) of the growing season. These conditions limit the canopy to tall shrubs, such as

willow and alder. Annual erosion and deposition of sediment generally limit understory and humus layer development.

Mid Bench Flood Ecosystems (Fm)

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

Swamp (Ws)

A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs occurring on sites with a flowing or fluctuating, semi-permanent, near-surface water table. Swamps tend to occur on slope breaks, peatland margins, inactive floodplain back-channels, back-levee depressions, lake margins, and gullies. Tall-shrub swamps typically form dense thickets, while forested swamps have large trees occurring on elevated microsites with an understory cover of tall deciduous shrubs.

Aquatic Vegetation

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

1. Emergent Vegetation (EV) generally refers to grasses, *Equisetum* spp. (i.e., horsetails), sedges, or other plants tolerant of flooding. Coverage within polygons 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 steeper sloping areas.

2. Sparse Emergent Vegetation (SEV) refers to the same vegetation types as emergent vegetation, but in these areas coverage is typically not very dense or is very patchy. The patchiness is typically due to association with rocky beaches or intensive beach grooming.

3. Overhanging Vegetation (OV) consists of broadleaf vegetation that grows over the surface of the lake, providing shade and allochthonous inputs to the nearshore littoral zone. Overhanging vegetation sometimes occurs with Emergent Vegetation (EVOV) and with Sparse Emergent Vegetation (SEVOV).

4. Submergent Vegetation (SUB) areas generally consist of aquatic vegetation that does not break the water surface for most of the growing season, such as *Potemogeton* spp.

5. Floating Vegetation (FLO) generally consists of species such as native *Potamogeton* spp., pond lilies, and other types of vegetation that have floating parts.

3.2.2 GIS and FIM Database Management

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

1. Data and photos were backed up on a laptop computer on a daily basis.

2. A GPS camera that time/date stamps photos and creates GIS shapefiles, and GPS-enabled video were used to record data for review and interpretation.

3. Air photo interpretation was completed using high-resolution air photos.

4. During data analysis, numerous quality assurance/quality control measures were completed to ensure that all data was reviewed, corrected, analyzed, and accounted for.

5. Air photo interpretation and TRIM shoreline files were used to accurately determine the high water level of the lake. It is believed that for the length of the shoreline, the high water level used is within 5 m of the mean annual high water level for at least 50% of the lake. A site specific survey must be conducted to accurately determine the high water level for any site specific considerations and the line presented in this assessment should not be considered a surveyed HWL.

4.0 DATA ANALAYSIS

The following section provides an overview of data analysis procedures for the Nicola Lake FIM.

4.1 General

General data analysis and review was completed using the Nicola Lake FIM database. Data collected was reviewed and analysis focused on discrete segments of shoreline. Analyses for this project were completed as follows:

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

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

4.2 Biophysical Characteristics and Modifications Analysis

Biophysical characteristics of the shoreline segments were analyzed using the FIM database. For definitions of the categories discussed below, please refer to Appendix A. The following summarizes the analyses that were completed:

1. Percent distribution of natural and disturbed shoreline;

2. Total shoreline length that remained natural or disturbed for each slope category that occurs along the shoreline;

3. Total shoreline length that remains natural or has been disturbed for each land use identified along the shoreline;

4. Total shoreline length that remained natural or has been disturbed for each shore type that occurs along the shoreline;

5. Total length of shoreline that contained aquatic vegetation, emergent vegetation, floating vegetation, or submergent vegetation;

6. Total number of modification features recorded along the shoreline. This data represents point counts taken during the survey and is reported for groynes, docks, retaining walls, marinas, marine rails, and boat launches; and

7. Total shoreline length of different shoreline modifiers (roadways, substrate modification, and retaining walls) was determined.

5.0 RESULTS

The following section provides an overview of the results of the Nicola Lake FIM. Data is presented graphically and summarized in the text for ease of interpretation. Data tables for each analysis are provided in Appendix B.

5.1 Natural vs. Disturbed Shoreline

The Nicola Lake FIM was completed along 53,762 m (54 km) of shoreline. The total length of disturbed shoreline is 23,944 m (24 km), which represents 44.5% of the total shoreline (Figure 2). The total length of natural shoreline is 29,818 m (30 km), which represents 55.5% of the shoreline (Figure 2).

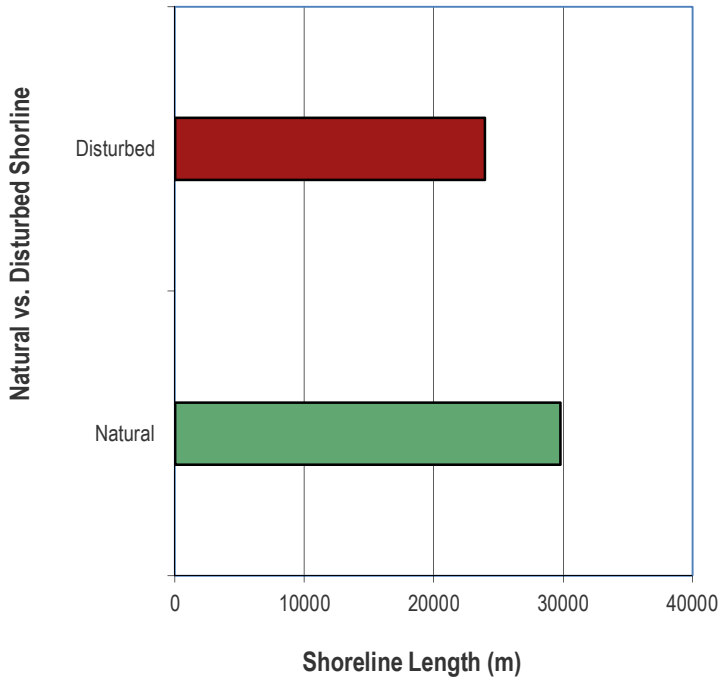

Figure 2. The total shoreline lengths described as natural or disturbed.

5.2 Slope Category

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 a lower gradient tend to have the highest level of disturbance, typically because they are most suitable for development.

There are approximately 26,337 m of low gradient slopes, and these areas are 39.4% disturbed (Figure 3). Benches and Moderate gradient areas are disturbed along 65.0% (542 m) and 39.8% (10,925 m) of their respective shore

Photo 1. View of low gradient slope with residential land use along Segment 1

lengths within these slope categories. Disturbance occurs along 76.9% (11,496 m) of steep shorelines. Disturbance was observed along only 0.5% (23 m) of the 4,461 m of very steep shoreline.

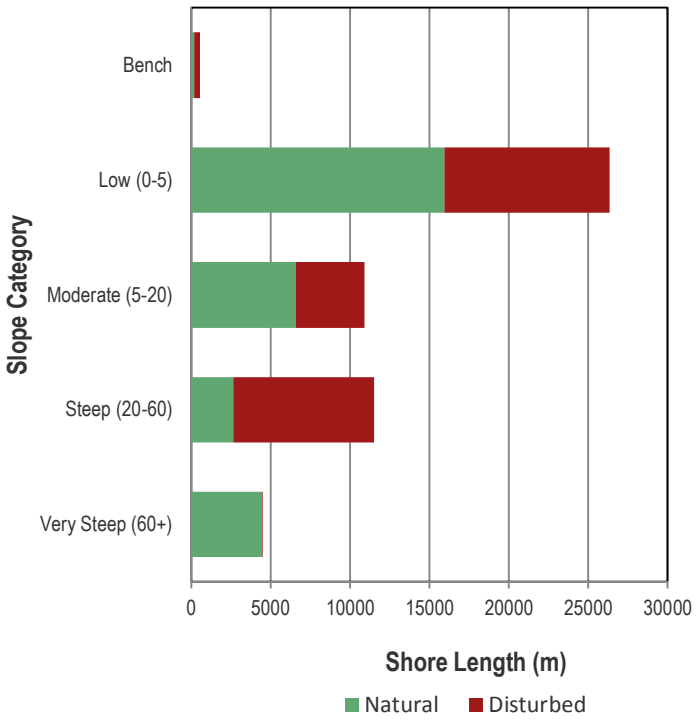

Figure 3. The natural and disturbed shoreline lengths along different slope gradients.

5.3 Land Use

Agricultural land use accounts for 33.7% (18,098 m) of the shoreline (Figure 4). The agricultural areas are described as 71.6% (12,964 m) Natural and 28.4% (5,135 m) Disturbed shoreline. Transportation is the next most dominant land use and accounts for 25.9% (13,907 m) of the shoreline. Transportation areas are 14.0% (1,940 m) Natural and 86.0% (11,967 m) Disturbed.

Photo 2. View of agricultural land use along Segment 42

Rural and Single Family Residential represent the other major land uses around the lake. Rural represents 13.7% (7,349 m) and Single Family represents 13.6% (7,297 m) of shoreline. The Rural areas are 3.7% Disturbed while the Single Family areas are 47.1% disturbed. Natural Area (5.2%), Recreation (5.1%), Park (2.6%), and Urban Park (0.3%) represent the remaining land uses around the lake. Natural Areas are relatively undisturbed (3.2%), while Recreation is considered heavily disturbed (90.4%). Park and Urban Park areas are 34.7% and 40.0% disturbed, respectively.

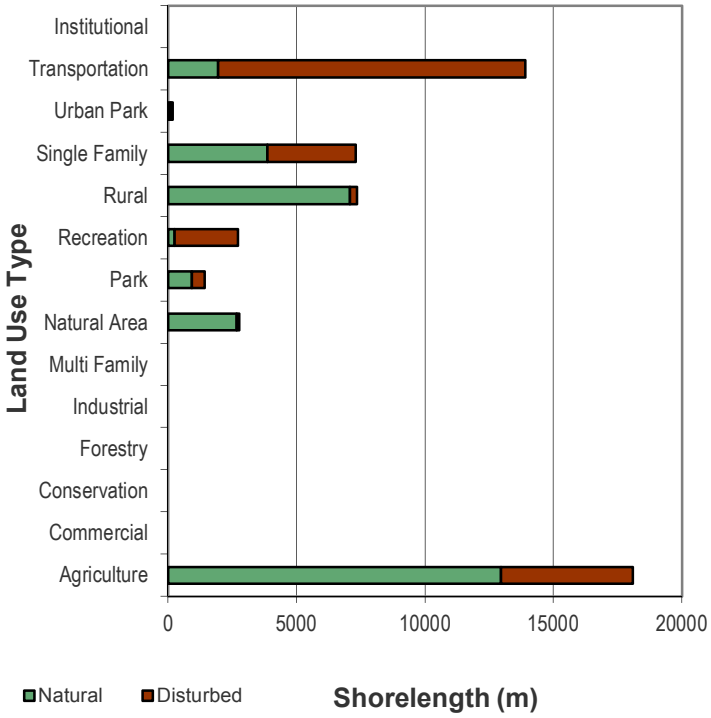

Figure 4. The natural and disturbed shoreline lengths within different land use categories.

5.4 Shore Type

Gravel Beach is the most common shore type, which accounts for 30.8% (16,572 m) (Figure 5). The Gravel Beach shore type is considered 47.5% Disturbed. Rocky shore (15,436 m) and wetland (14,253 m) represent the next most predominant shore types, accounting for 28.7% and 26.5% of the shoreline, respectively. Along Nicola Lake, the wetland shore type is 72.3% Natural, which is a positive sign for the general condition of the foreshore.

Stream Mouth (5.5%), Sand Beach (4.3%), and Cliff/Bluff (4.1%) represent the remaining shore types. Stream Mouth is 54.5% Disturbed and Sand Beach is 32.5% Disturbed. The Cliff/Bluff shore type was only 6.8% Disturbed, due to the undevelopable nature of the shoreline.

Photo 3. View of typcial gravel shore with adjacent natural area land use along Segment 16

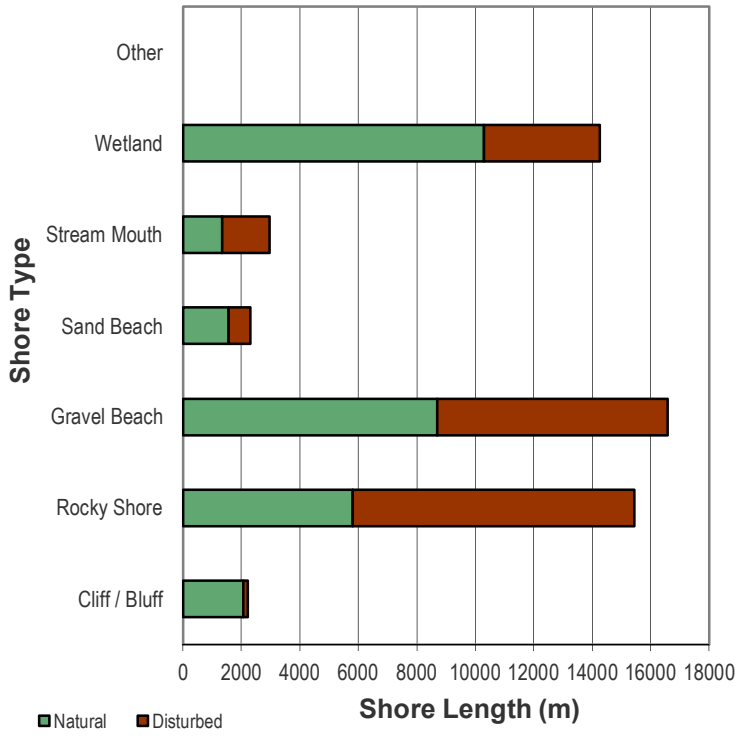

Figure 5. The length of natural and disturbed shorelines within each identified shore type.

5.5 Aquatic Vegetation

Aquatic vegetation is generally defined as any type of emergent, submergent, or floating vegetation that occurs below the normal high water level of a waterbody. Thus, aquatic

vegetation includes true aquatic macrophytes as well as plants that are hydrophilic or tolerant of periods of inundation (e.g., sedges, willows, etc.). Studies have shown that even terrestrial vegetation, during periods of inundation, provide important habitat for juvenile salmonids and other aquatic life (Adams and Haycock, 1989). As such, these vegetation types were included in the aquatic vegetation category.

Aquatic vegetation occurs along approximately 36.8% (19,769 m) of the shoreline (Figure 6). Emergent and grass-like vegetation represents 36.8% (19,787 m) of the Aquatic Vegetation shoreline. Submergent Vegetation only occurs along 0.1% (57 m) of the Aquatic Vegetation shoreline. Floating Vegetation was not observed during the survey. More detailed mapping of aquatic vegetation is recommended to accurately determine total areas of each vegetation type.

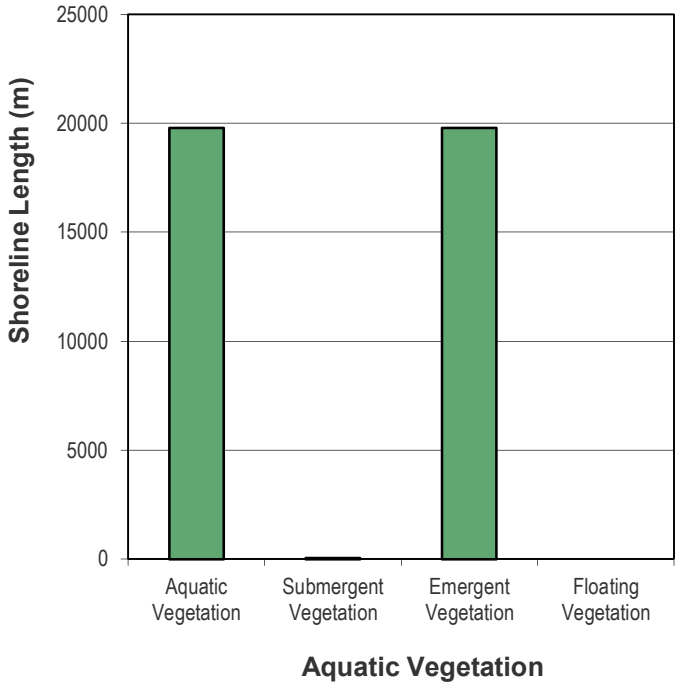

Figure 6. The total shoreline length with aquatic vegetation.

5.6 Shoreline Modification

Groynes are the most common type of shoreline modification (Figure 7). A total of 154 groynes were observed during the assessment, which amounts to an occurrence rate of 2.86 groynes per km of shoreline. Docks are the next common type of modification observed with a total of 106 (1.97 per km). A total of 83 retaining walls (1.54 per km) and 15 boat launches (0.28 per km) were also observed along the shoreline. There are no marinas or marine rails.

Photo 4. View of groyne and other shoreline modifications along Segment 1

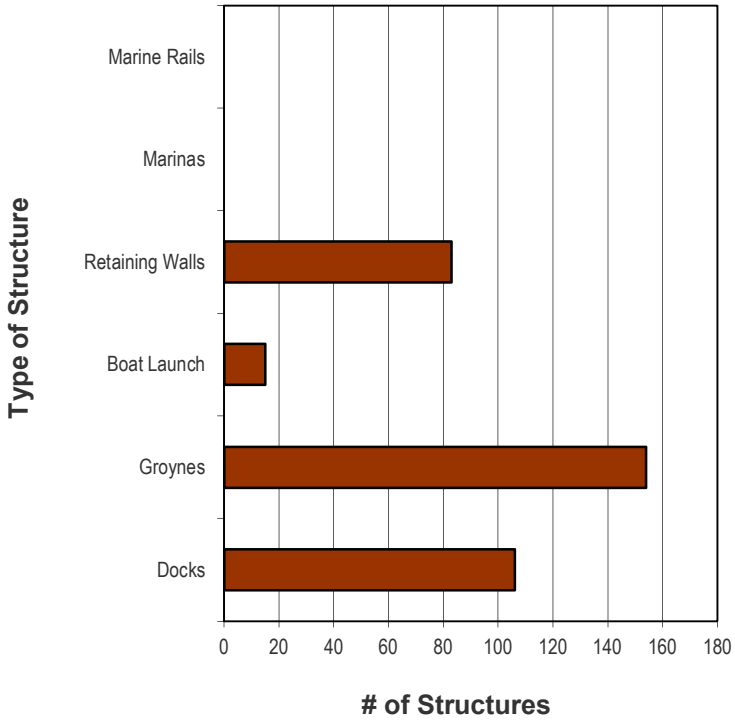

Figure 7. The total number and types of different shoreline modification structures.

5.7 Modification Type

The percentage of shoreline impacted by roads, railways, retaining walls, and where substrate modification has occurred was recorded (Figure 8). Substrate modification is the most prevalent impact that was observed along the shoreline, representing approximately 31% (16,522 m) of the total shoreline.

Photo 5. View of cutbank and roadway along the shoreline within Segment 21

The nature of substrate modification is variable but is commonly associated with beach grooming, historic fills (e.g., retaining walls below HWL), and structural fill for transportation. Roadway represents the next most prevalent form of modification, representing 20% (10,753 m) of the shoreline. Retaining walls have resulted in the modification of 4.0% (2,271 m) of the shoreline. Railways were not observed along the Nicola Lake shoreline.

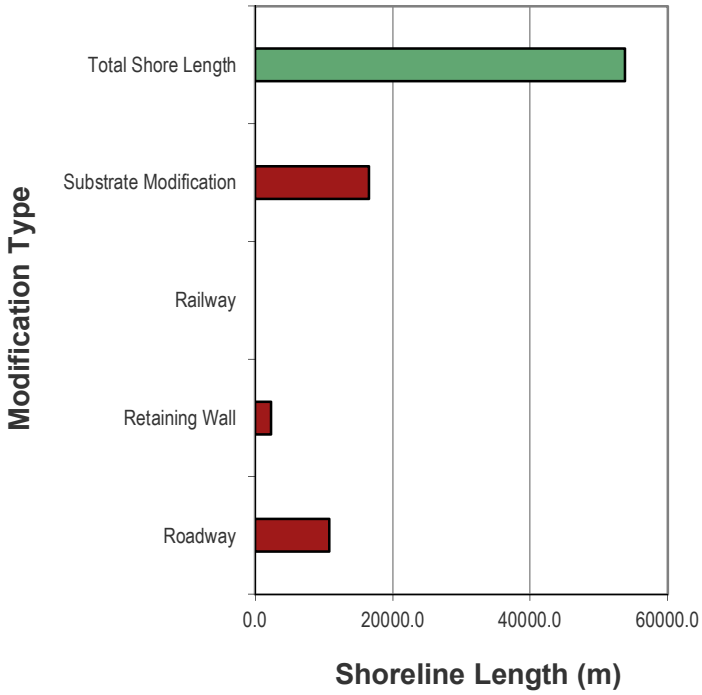

Figure 8. The total shoreline length impacted by different modification types.

5.8 Level of Impact

The Level of Impact is a categorical description of disturbance along the shoreline. The following definitions were taken from the FIM methods (Appendix A) and are included for ease of reference.

1. *Level of Impact* - Level of Impact is a categorical field that is used to describe the general level of disturbance observed along the shoreline. Disturbances are considered any anthropogenic influence that has altered the shoreline, including foreshore substrates, vegetation, or the shoreline itself (e.g., retaining walls). The Level of Impact is considered both looking at the length of the shoreline (i.e., along the segment) and the extent beyond the shoreline to between 15 to 50 m back. In more rural settings, the assessment area is typically greater (i.e., 50 m) and in more developed shorelines, the assessment area is less (i.e., 15 to 30 m). In cases of roadways or railways, one should generally consider the location of the rail or roadway along the segment (i.e., how far back is it set, is the lake in-filled). To facilitate interpretation of this category, air photo interpretation is recommended to better estimate disturbance.

   Disturbance categories include High (>40%), Medium (10-40%), Low (<10%), and None (0%). Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The FIM report for Okanagan Lake defines *Level of Impact* as follows (Magnan and Cashin 2004):

   a. *Low* - Segments that show little or limited signs of foreshore disturbance and impacts. These segments exhibit healthy, functioning riparian vegetation. They have substrates that are largely undisturbed, limited beach grooming activities, and no to few modifications.

   b. *Moderate* - Segments that show moderate signs of foreshore disturbance and impacts. These segments exhibit isolated, intact, functioning riparian areas (often between residences). Substrates (where disturbed) exhibit signs of isolated beach grooming activities. Retaining walls (where present) are generally discontinuous. General modifications are well spaced and do not impact the majority of the foreshore segment.

   c. *High* - Segments that show extensive signs of disturbance and impacts. These segments exhibit heavily disturbed riparian vegetation, often completely removed or replaced with non-native species. Modifications to the foreshore are extensive and likely continuous or include a large number of docks. Generally, residential development is high intensity. Modifications often impact a majority of the foreshore.

It is estimated that 42.8% (22,834 m) of the Nicola Lake shoreline has a high level of impact (Figure 9). Areas of moderate and low impact occur along 25.5% (13,599 m) and 22.6% (12,081 m) of the shoreline, respectively. Approximately 9.1% (4,879 m) of the shoreline has not been impacted.

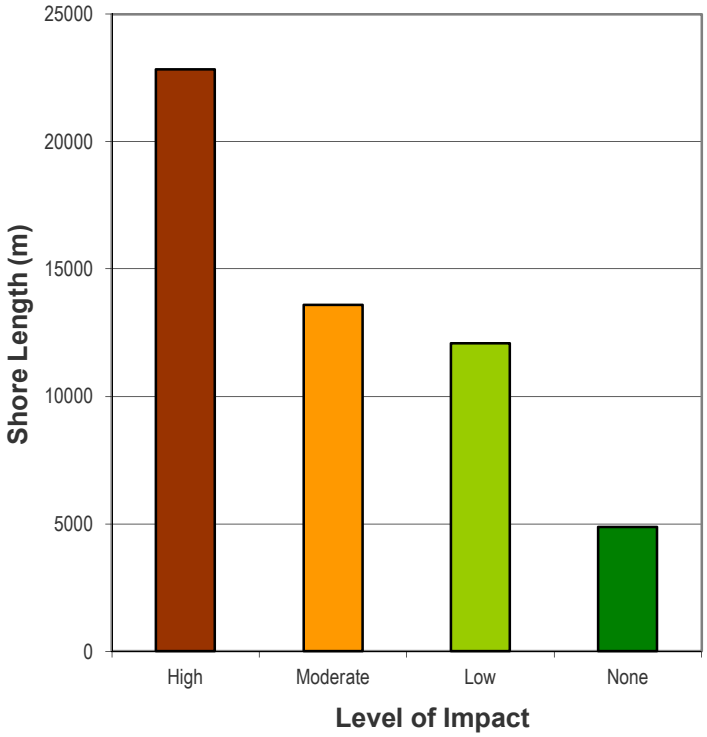

Figure 9. The relative Level of Impact observed along the shoreline.

5.9 Summary of Shoreline Modifications

Nicola Lake provides critical habitat for wildlife and fish populations, including sensitive species such as kokanee and sea-run salmon. Nicola Lake and the Nicola River provide water for human consumption and agricultural practices, placing additional demands on a resource that is already subject to periods of drawdown and drought. The combination of important fish, wildlife, and water quality values make protection of the shoreline area a vital consideration. The data collected during this assessment provides baseline information necessary to begin to manage these resources effectively. It also provides a foundation upon which clear goals and objectives can be created and monitored. Nicola Lake was assessed based upon its current condition and water management practices. It is acknowledged that historical water extraction and flow regulation (i.e., drawdown) have previously altered shoreline processes.

The Nicola Lake shoreline is estimated to be 55.5% natural based upon the results of this inventory. Some of the natural shorelines occur in rural and agricultural land use areas that may be subject to future development. The extents of disturbance observed were of a similar nature to impacts observed within other interior lake systems, including substrate modification, riparian vegetation removal, and construction of docks, groynes, and retaining walls. The results of the FIM analysis highlight the importance of implementing long term objectives in an effort to conserve the important natural areas that remain and prioritize habitat improvements where appropriate.

As with previous shoreline studies (e.g., Okanagan, Shuswap, Mable, and Moyie Lakes), lower gradient shoreline slopes tend to have higher levels of disturbance (e.g., terraces and floodplains). The most notable disturbances occur in the form of substrate modification and riparian vegetation disturbance. However, wetland and aquatic vegetation communities persist and many “pockets” of natural shoreline remain. Varying degrees of foreshore development are present along the shoreline. Observations made during the field survey are summarized below:

1. The most significant impact observed below the high water level along the shorelines is substrate modification. Beach grooming, construction of groynes and retaining walls, and development upon historical floodplains have resulted in foreshore impacts including:
    - loss of aquatic, riparian, and wetland vegetation;
    - loss of shoreline communities and overhanging vegetation;
    - loss of habitat through alteration or modification of shorelines;
    - loss of structural complexity and habitat diversity;
    - increased risk of sedimentation and erosion;
    - reduced suitability for shore spawning fish species; and
    - reduced accessibility to tributaries for stream spawning fish species.

The extent of habitat loss associated with substrate modification has not been determined as part of this assessment. Many of the habitat modifications observed were constructed on Crown Land (i.e., below the high water level) and it is likely that many were not permitted under the BC *Water Act* or Federal *Fisheries Act*.

2. Aquatic vegetation, such as emergent grasses and sedges, has been removed due to foreshore disturbance such as substrate modification, agricultural activity, and shoreline construction. The loss of soil material that supports aquatic vegetation, particularly along rocky shorelines, will likely take decades to naturally regenerate. The continued loss of aquatic vegetation will further impact juvenile salmonids during periods of high water in the spring when they are known to feed upon organisms within the vegetation (Adams and Haycock, 1989).

3. Within rural and residential areas, landscaping with turf and removal of native riparian vegetation was observed. Mature trees and snags have been retained along the lakeshore; however the native riparian understory had been often modified or completely removed within the SPEA. Opportunities for riparian restoration and enhancement exist along many private properties.

4. The 15 boat launches observed were generally constructed out of concrete. These boat launches were almost all associated with vehicular access, which has impacted lake substrates and riparian vegetation. It is possible that some of these were constructed without regulatory approval or permitting.

5. Retaining wall construction around the lake was apparent along rural and residential areas. Retaining walls were constructed out of varying materials, but rock substrates from the lakebed or shoreline were often used to construct the walls. It is probable that many of the retaining walls observed have been constructed without *Water Act* or *Fisheries Act* approvals.

6. Docks were a commonly observed shoreline modification and it is possible that some of these docks have been constructed without appropriate moorage tenures or approvals. 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. While the impact of individual docks appears small, the cumulative impacts are noticeable and measureable (i.e., lakebed substrate modification). Many of the docks included floating structures, most of which had settled upon the dry shoreline due to low lake levels. Floating docks shade substrates and may limit habitat usage by fish, in addition to impacting aquatic vegetation. The presence of floating structures

and docks in shallow water facilitates boat access which may result in propeller scour along the lake bed and impacts to native substrates.

7. The effects of boat wake erosion, Crown Land encroachment (i.e., below the high water level), and moorage buoys were observed. Also, evidence of prop scour was present in some areas. However, detailed assessments and quantification of these impacts was not fully assessed during the field survey.

6.0 RECOMMENDATIONS

The following provides a list of recommendations for Nicola Lake foreshore protection. Some of the recommendations below are similar to other recent FIM reports that have been completed.

6.1 Foreshore Protection

The following are recommendations for development of foreshore protection policies:

1. **An Aquatic Habitat Index (AHI) analysis (Step 2) should be completed for Nicola Lake using the results of this project.** The FIM results provide a basis to complete an AHI for the Nicola Lake shoreline. The results of the AHI will identify and rank the relative habitat value of each shoreline segment and facilitate the completion of the Shoreline Guidance Document, described below.

2. **A Shoreline Guidance Document (Step 3) should be developed by local government, the Province, First Nations bands, and Fisheries and Oceans for Nicola Lake that includes the results of the FIM and AHI analyses.** The FIM and subsequent AHI will provide a basis for a risk based approach to lakeshore management and the framework for development of integrated management policies. The shoreline guidance document will facilitate intergovernmental cooperation for lakeshore management. A staged approach in the development of this guidance document may be required, with a series of interim measures developed to allow sufficient effort in the development of long and short term goals. For example, in the Shuswap, development of guidance documents such as these are being developed and they are considering the numerous different layers of data, including sensitive shore spawning sites, recreation, and water quality. Similarly, documents such as the TNRD Lakeshore Development Guidelines can be incorporated into a single comprehensive shoreline guidance document for Nicola Lake.

3. **FIM and AHI data should be integrated into existing Nicola Lake planning initiatives and policy documents.** A substantial amount of work has already been

completed (e.g., TNRD Lakeshore Development Guidelines) and is ongoing which may benefit from the spatial analysis and documentation of current shoreline habitat condition and modifications.

4. **Maintenance of riparian vegetation should be ensured with the use of riparian management areas, buffers, and setbacks prior to development.** Existing riparian communities should be protected during the development proposal stage and degraded riparian areas should be enhanced or restored. Protection options include SPEA setbacks as per the provincial RAR, No Build / No Disturb covenants, creation of Natural Area zoning bylaws, or by other stewardship mechanisms (e.g., donation to trust). Site specific assessments of individual properties should occur to evaluate proposed activities and ensure maintenance and enhancement of sensitive aquatic and terrestrial ecosystems and habitat features.

5. **A clear set of objectives for the future need to be set and the objectives need to present desired objectives that are achievable.** Previous studies conducted within the Nicola watershed, including the Nicola WUMP and TNRD Lakeshore Development Guidelines, have determined a number of concerns related to water quality, water consumption, shoreline development and the effects on wildlife and fish habitat. Clear objectives should be determined to inform and guide future resource management. Examples of clear targets include identifying the amount of natural and disturbed shoreline that is a desired future condition and then using this methodology to determine if this goal has been met.

6. **Key shoreline linkages or corridors to adjacent sensitive habitats should be identified and protected. Migration corridors 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 areas along the Nicola River and lake tributaries, including Quilchena Creek, Stump Lake Creek, Klup Creek, and Moore Creek provide critical movement corridors for wildlife and provide important migration and spawning habitat for fish. Maintaining intact corridors between habitats mitigates the effects of fragmentation and isolation and helps maintain healthy wildlife populations. Riparian communities make ideal 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 identified around Nicola Lake. Detailed assessments should be conducted along these corridors to identify and inventory the important habitat features present. The resulting information should be incorporated into future policy to reduce potential impacts from land use decisions. 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), and other mechanisms (e.g., donation to trust).

7. **Historical habitat impacts should be restored during development and re-development activities, with measures in place to ensure successful completion**. The completion of an AHI will identify shoreline segments where restoration activities will most improve habitat quality. During the review of development applications, existing shoreline modifications should be addressed with restoration or enhancement of foreshore areas. Further modification to foreshore areas affected by past modifications should be prevented or compensated for (e.g., dismantling retaining walls, placement of large woody debris, restricting cattle access, and riparian restoration). There is significant opportunity for partnerships (i.e., multi agency partnerships with stewardship groups) to be formed to help facilitate habitat restoration around the lakes. Further, it is strongly recommended that local governments develop restoration policies and objectives for disturbed areas to reverse the trends of impacts observed along the lake.

8. **Environmental information collected during the FIM inventory should be available to all stakeholders, relevant agencies, and the general public.** Environmental information, including GIS information and air photos, are an extremely important part of the environmental review process because they provide extensive information regarding the current condition of an area. This information should be made easily accessible to the public.

9. **Compliance and enforcement monitoring of approved works are required, with consequences for failure to follow standard Best Management Practices or failure to acquire necessary permits.** Historical poor practices were observed during the FIM inventory and during surveys of other interior lakes. Compliance monitoring and enforcement at all levels of government are required because current practices do not appear to be working effectively. There is the potential to investigate a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts.

10. **Habitat losses and gains should be monitored to measure management success.** The FIM results provide a baseline to measure change, including the development of indicators, actions, and timelines, and initiation of a detailed habitat monitoring program. Results of the monitoring program should be compared to the original inventory data to determine compliance with Best Management Practices and effectiveness of protection activities.

11. **Development and use of Best Management Practices for construction of bioengineered retaining walls is required.** Concise guidelines and Best Management Practices should be developed to describe the requirements for

bioengineering shoreline retaining walls and to improve compliance with Best Management Practices.

12. **A communication and outreach strategy should be developed to inform stakeholders and the public of the FIM results and improve stewardship and compliance**. Initially, it is recommended that notice of the availability of this report and associated products are available on the Community Mapping Network. The outreach strategy is required because many people are not aware of the impacts of their activities and are also not fully aware of appropriate and governing legislation for development activities adjacent to shoreline areas. Funding should be sought to address outreach activities and address local government implementation.

13. **Shoreline erosion hazard mapping should be conducted for private lands to identify areas at risk. This mapping will streamline the review process and address the trend of construction of non-compliant retaining walls along the shoreline.** The shoreline erosion hazard mapping will also identify areas that are sensitive to boat wake erosion. The province has formalized methodology for lakeshore hazard mapping and this methodology, or some variation of it (e.g., Guthrie and Law, 2005). This mapping should be integrated with the FIM data and be completed for each shoreline segment. Flooding, terrain stability, alluvial fan hazard mapping should also be considered for developing areas along the lakeshore. Reports by engineers or biologists should accompany proposals for shoreline armoring to ensure that works are required to minimize impacts and use bioengineering techniques. It may be possible to utilize the existing FIM maps, plus other associated data to identify areas more prone to shoreline erosion.

14. **Local, provincial, and federal governments should consider development proposals in a lake-wide context and only approve proposed developments with net neutral or net positive effects for biophysical resources.** Shoreline developments are generally considered individually. However, development related impacts should be considered on a lake-wide scale. The results of the FIM indicate that measurable cumulative impacts have occurred and that trends are pointing towards increased or further impacts if management is not revised. This is analogous to the expression “death by a thousand cuts” and local governments should ensure that development proposals do not have the potential for cumulative impacts to the foreshore.

15. **Compensatory works resulting from projects or portions of projects that could result in negative impacts to fish habitat must follow the DFO Decision Framework for the Determination and Authorization of a Harmful Alteration,**

Disruption or Destruction of Fish Habitat (i.e., HADD)[1]. The works must be consistent with the "No Net Loss" guiding principle of The DFO Policy for the Management of Fish Habitat.

16. **Habitat enhancements should not be considered in cases where incomplete or ineffective mitigation or compensation is proposed.**

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

18. **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.**

19. **Low impact recreational pursuits (e.g., hiking, biking, and non-motorized boating), 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.

20. **The FIM results should be integrated with existing and future lakeshore management plans developed by all levels government and First Nations to provide an integrated approach to shoreline.** Previous Nicola Lake studies have indicated that development activity and water demands are having significant effects on the foreshore. Local, provincial, and federal agencies need to identify development limits for Nicola Lake and develop an inter-jurisdictional plan to determine and define these limits. The management plan should incorporate the recommendations described above to provide guidance on whether management practices are successful. Items to consider when developing long-term management objectives include:
    a. Address substrate alteration occurring around the lake to prevent further degradation of important shore spawning habitats, wetland areas, and floodplains. Substrate modification occurred along 31% of the shoreline and was the most significant foreshore impact observed around the lake.
    b. Address the losses of riparian and wetland habitats along the foreshore.
    c. Implement sufficient measures and adequate budget to provide for a long-term watershed management approach.

[1] Note that RAR does not address habitat compensation requirements because they fall under the jurisdiction of DFO.

d. Address shoreline construction in identified sensitive areas.
e. Adjust terms of occupation to ensure foreshore protection measures are incorporated and natural resources are appropriately protected (e.g., salmon stocks).
f. Provide sufficient moorage and boat access (e.g., boat ramps, docks, parking lots) in appropriate locations to offset concerns in sensitive areas.
g. Incorporate land storage facilities for boats with good boat access.
h. Consideration should be given to inclusion of public moorage in all private moorage facilities as a mechanism to offset demands in areas where moorage is not suitable.
i. Identify and preserve key linkages to areas identified as wildlife corridors, linkages, or other important terrestrial areas.
j. Address the presence of critical salmon spawning areas.
k. Address the presence of important waterfowl habitat, including identifying appropriate boating and recreational Best Management Practices to reduce potential impacts.
l. Identify important drinking water and agricultural intakes and incorporate buffers to avoid potential impacts with associated land development activities.
m. Include allowances to address known data gaps, including identification of other key habitat elements that were not included in this analysis. Key elements may include reptile and amphibian access, hibernacula, and rare plant communities.
n. Identify the most appropriate mechanisms for compliance and enforcement monitoring. Consistent and easily enforceable compliance mechanisms are required to address construction activities that are not in compliance with standard policy or Best Management Practices.
o. Include regulations and guidelines for new development, re-development, and management of existing development.
p. Designate protection of critical shoreline areas (e.g., spawning zones, rare species occurrences).
q. Explore a memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities.
r. Consider other shoreline development guidelines and lakeshore plans completed or currently being developed for Nicola Lake.

6.2 Future Data Considerations

Future data management is extremely important to ensure that data collected during this survey is available, accurate, and kept up-to-date. Future data collection should be integrated into the concise GIS database. The following are recommendations for future use of the FIM dataset:

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

2. **A summary column(s) should be added to GIS dataset that flags new GIS datasets as they become available.** Examples of this include new location maps for rare species occurrences and updated fisheries information. Where feasible, these new data sets should reference the unique shoreline segment number.

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

4. **Review and update of the FIM should occur on a 5 to 10 year cycle.** Review and update of the FIM will be required to determine if shoreline management goals and objectives are being achieved. The timing of inventory cycles should be between 5 and 10 years, at a minimum. Ideally, updates to the FIM would occur as projects are approved (i.e., real time). However, at this time, it is unlikely that capacity exists to establish such a system.

6.3 Future Inventory and Data Collection

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

1. **Sensitive Habitat Inventory and Mapping (SHIM) is a GIS-based stream mapping protocol that provides detailed biophysical information and should be conducted on all lake tributaries**. Mapping should focus on significant salmon spawning streams, then on smaller tributaries containing less fish habitat, followed by non-fish bearing 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.

2. **Wetlands are extremely productive and important ecosystems and these features should be inventoried**. Completing detailed Wetland Inventory and Mapping (WIM) of wetland features is recommended. The mapping is also

important to ensure that linkages between foreshore and upland areas are identified and protected.

3. **A carrying capacity analysis of the lake should be completed.** In this case, the carrying capacity refers to a lakes ability to accommodate recreational use (e.g., boating), agricultural activity, residential occupation, and water use, without compromising adjacent upland areas, biological resources, aesthetic values, safety, and other factors. Currently, the fish and wildlife communities are experiencing declines due to a variety of factors including land development, water quality (e.g., low water levels and increasing temperatures), and climate change (Nelitz et al. 2007). Determining the threshold upon which cumulative effects will have measurable and noticeable impacts is very difficult and therefore a conservative or precautionary approach is required. Determining carrying capacities on our large, interior lake systems is currently one of the most significant challenges to lakeshore management because it impacts many cultural, social, and environmental values of residents.

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

5. **The addition of new segment breaks in long segments should be assessed in the future.** Future mapping updates may wish to assess some new segment breaks on longer segments as more information is collected. Additional features, including the locations of small tributaries, seepages, and streams in natural areas, should be considered during more detailed segment mapping.

6. **Native beds of submergent and floating vegetation should be mapped in detail.** Native beds of submergent and floating vegetation were extremely rare. More detailed mapping, such as SHIM and WIM, would help improve identification and characterization these sensitive features.

7.0 CONCLUSION

This Foreshore Inventory and Mapping (FIM) report documents the existing condition of approximately 54 km of shoreline along Nicola Lake in the Thompson region of BC. The assessment provides a summary of background information characterizing the condition of the shoreline and riparian communities that comprise the foreshore of the lake, as well as ongoing issues and concerns identified by public and stakeholder groups related to water use, water quality, and fish habitat. Recommendations are provided to help integrate this information into local land use planning initiatives and management guidelines.

Approximately 55.5% of the Nicola Lake shoreline is in a natural condition, representing approximately 29,818 m of shoreline. Groynes, docks, and retaining walls represent the most common form of shoreline modification, with boat launches representing fewer but still considerable modifications. Of the approximately 44.5% of disturbed shoreline, approximately 68.3% is characterized by Moderate to High levels of impact resulting from shoreline and substrate modification. These impacts, along with riparian vegetation removal, are considered the most significant forms of shoreline degradation observed around Nicola Lake.

Water demands within the Nicola River watershed have already reached a critical level and increased retention of water within Nicola Lake depends largely on snowmelt and spring precipitation. Increasing frequency of drought and a warming climate suggest that reliance upon a constant and consistent supply of water may result in water use restrictions or shortages. The increasing public demand and decisions on how to allocate water resources will have significant effects on the quality and integrity of the Nicola Lake foreshore environment, fish habitat, and the overall health of the watershed. These pressures highlight the importance of assessing and monitoring the state of the foreshore and the development of an Aquatic Habitat Index and Shoreline Management Guidelines to guide sustainable management for Nicola Lake.

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GLOSSARY OF TERMS AND ACRONYMS

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

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

Anadromous – Anadromous fish are sea-run fish, such as coho, chinook, and sockeye salmon.

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

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

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

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

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

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

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

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

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

Foreshore Inventory Mapping (FIM) - FIM is the methodology used to collect and document fish and riparian habitats lake corridors and was performed by the Regional District of Central Okanagan and partners. A full discussion of this mapping can be found in Regional District of Central Okanagan (Magnan and Cashin 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 - A hydrologic term referring to 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 - A hydrologic term referring to a flowing or moving body of freshwater, such as a creek or river.

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

Retaining Wall - A retaining wall is any structure that is used to retain fill material. Retaining walls are commonly used along shorelines for erosion protection and are

constructed using a variety of materials. Bioengineered retaining walls consist of plantings and armouring materials and are strongly preferred over vertical, concrete walls. Retaining walls that occur below the Mean Annual High Water Level pose a significant challenge, as fill has been placed into the aquatic environment to construct these walls.

Riparian Areas Regulation (RAR) - The Riparian Areas Regulation (RAR) was enacted under Section 12 of the provincial *Fish Protection Act* to protect stream health and productivity by providing assessment standards for Streamside Protection and Enhancement Areas (SPEA) along streams, lakes, and other waterbodies.

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 (RAR).

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

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