Nicola Lake Foreshore Integrated Management Planning Assessment and Update

Presented To: **Upper Nicola Band and Living Lakes Canada Society**

Dated: November 2024

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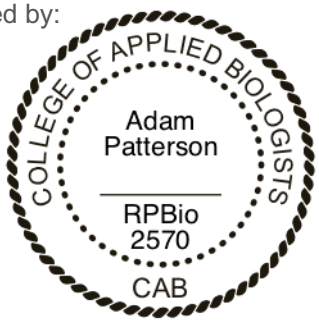

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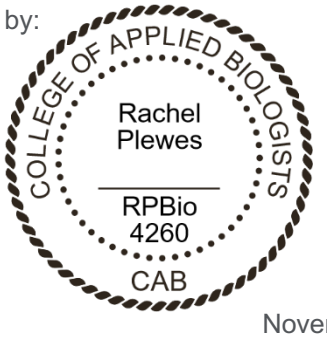

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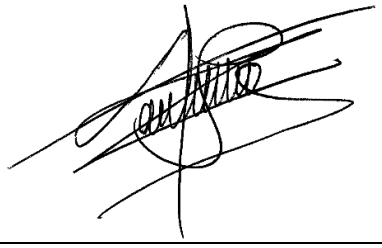

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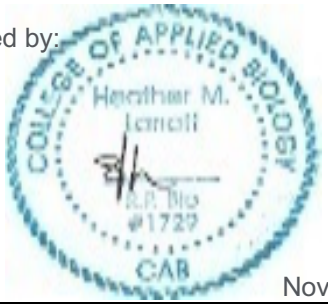

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0	2024-05-31	RP, AP, BC	HL	final
1	2024-11-14	RP, AP, BC	HL	re-issued with minor update

Executive Summary

Nicola Lake and its associated shoreline and waters represent sacred and culturally significant values to the Syilx (Okanagan) people. The lake and surrounding watershed provide an abundance of socio-economic, cultural, and ecological values to all inhabitants of the Nicola Valley. The Nicola Lake area has a rich cultural and spiritual history for the Syilx and Nlaka'pamux people, including known battle sites and pit houses along the shoreline. As the largest lake in the Nicola River watershed, Nicola Lake is a popular destination for recreation and an important water source for agriculture. Nicola Lake also provides important connectivity to spawning and rearing habitats for anadromous salmon that migrate through the Thompson-Nicola River system.

The ecological and cultural values of Nicola Lake have diminished over the last 100 years from extensive ranching, recreation, water withdrawal, and foreshore development. These activities have dishonoured and devalued the sacred nature of Nicola Lake. Ongoing shoreline development and climate change further threaten the important ecological and cultural values of Nicola Lake. The protection of these values is essential for the health of all living things (tmix^{w}) for all future generations. Caring for Nicola Lake requires a collaborative, holistic, and action-oriented approach to foreshore management.

Upper Nicola Band (UNB) and Living Lakes Canada Society (LLC) initiated a collaborative approach to foreshore management through the development of the Local Indigenous Knowledge and Values Framework (Peck, Holmes, and Armstrong, 2023). The framework aims to facilitate the integration of Indigenous Knowledge into the Foreshore Integrated Management Planning (FIMP) methodology for Nicola Lake. A 'Two-Eyed Seeing' approach was adopted that combines Indigenous Knowledge and western scientific knowledge to describe foreshore values. The Syilx oral story of the Four Food Chiefs and "How food was given" form the structure of the framework and their individual values provide guidance to the Nicola Lake FIMP approach.

The primary objective of this project was to update the 2011 Foreshore Inventory and Mapping (FIM) (Patterson and Schleppe 2012) using the FIMP method developed by Schleppe et al. (2021) and informed by the Local Indigenous Knowledge and Values Framework. The FIMP methodology is intended to guide foreshore management for Indigenous communities, government agencies, non-profit organizations, and landowners, as it offers in-depth understanding of habitat values along the lake shoreline and the ecological risks posed by prospective shoreline-altering activities. The FIMP methodology comprises three consecutive steps. First, qualified biologists conduct a field-based FIM survey. The survey data supports calculation of the Foreshore Habitat Sensitivity Index (FHSI) and delineation of Zones of Sensitivity (ZOS). The FHSI represents the relative ecological value and sensitivity of the different shoreline segments comprising the foreshore area of the lake. The ZOS are specific areas within segments that are important habitats for species or ecosystem functions. Lastly, the Foreshore Development Guide (FDG) is prepared, which provides development planning guidelines aimed at protecting sensitive fish and wildlife species and their habitats identified through the previous FIM and FHSI analyses.

This 2023 FIMP and the 2024 Cultural Overview Assessment identified large sections of the Nicola Lake shoreline that have important wildlife, fisheries, cultural, and spiritual values that need to be protected from further degradation. Results of the 2023 FIM survey indicate that 51.3% (26,514 m) of the Nicola Lake shoreline is in natural condition. These natural shorelines are surrounded by open coniferous forest, wetlands, and grasslands. The shoreline rate of change for Nicola Lake was approximately 0.08% from 2011 to 2023. Single family and recreational developments have resulted in disturbance to approximately 517 m of natural shoreline. The historical timeline indicates that most of this disturbance occurred before the 2011 FIM. For example, larger recreational and single-family developments started in the 1950s with the establishment of Monck Park and development of Beaver Point Estates.

A primary goal of this project was to apply a more inclusive and holistic FIMP process that harmonizes Indigenous Knowledge with the conventional scientific approach. A key part of this process was identifying important cultural values that must be protected during future foreshore development activities. The Cultural Overview Assessment identified 19 Culturally Sensitive Areas (CSA) along the Nicola Lake foreshore. The CSA represent important sacred and spiritual values that must not be disturbed because this would result in violation of Syilx law.

The ecological and cultural values of the Nicola Lake shoreline were degraded by Highway 5A, recreational land use, BC Parks development at Monck Park, and single-family developments. RV parks on UNB reserve lands degraded the cultural and ecological values of the shoreline surrounding fish-bearing stream mouths and along Hwy 5A. The ecological and cultural values were degraded by Monck Park, Nicola Estates, and Old Nicola Trails single-family developments. The western side of the lake contains shoreline that has important ecological and cultural values that have been minimally impacted by shoreline development activities. The shoreline south of Monck Park and the shoreline north of Beaver Point Estates is primarily natural with CSAs.

The 2023 Nicola Lake FHSI analysis shows that the shoreline is composed of 4.8% Very High and 46.0% High ecological value areas. Shorelines that are ranked Very High or High have key features that provide habitat for fish and wildlife and contain most of the fisheries, wildlife, and ecosystem ZOS. These shorelines are characterized by stream mouths, wetlands, natural shorelines, and large patches of emergent vegetation. The mouths of Moore, Stumplake, and Quilchena creeks have shorelines with Very High FHSI values. Shorelines with Very High and High FHSI also include the wetlands at the south end of the lake and near Quilchena. The other shorelines with High FHSI occur primarily along natural rocky or cliff/bluff shorelines or disturbed shorelines with emergent vegetation.

Based on the FHSI, the remainder of the Nicola Lake shoreline is composed of 44.7% Moderate and 4.5% Low ecological value. These portions of the shoreline with Low and Moderate ecological values were disturbed by transportation, recreation, park, single-family, and rural land uses. Most of the shoreline with Low and Moderate ecological value is located on the south-eastern side of the lake, along Hwy 5A and within UNB reserve lands. The shoreline with Moderate ecological values on the west side of the lake is associated with the Monck Park Day Use area, Nicola Estates, and Beaver Point Estates. Shorelines with Low ecological values are associated with Harmon Estates on the west side and Nicola Bay Resort on the east side. Some shorelines with Moderate and Low ecological values contain ZOS that represent vegetation and rare species occurrences. Nicola Estates and Old Nicola Trails contain vegetation ZOS. The only rare occurrence ZOS identified is a giant wildrye ecosystem adjacent to Highway 5A, south of the Quilchena boat launch.

The Food Chiefs remind us to widen our foreshore management lens. Successful foreshore management requires a collaborative and action-oriented approach that prioritizes healing relationships with tmixʷ. The Chief Sp̓iɬm̓ (Bitter Root) recommendations are focused on building inclusive relationships between First Nations and all other levels of government. Chief Skəmx̌ist (Black Bear) recommendations focus on honouring the rich cultural and spiritual history of Nicola Lake. Chief Siyáʔ (Saskatoon Berry) recommendations focus on the application of existing tools and emerging technologies in innovative ways to better understand the Nicola Lake ecosystem and how it will respond to climate change. The action-oriented recommendations of Chief N'tyx̌tix̌ (King Salmon) include the protection of ZOS and CSAs through the application of FDG and land acquisition.

The effective protection of the cultural and ecological values of Nicola Lake requires a collaborative approach. The establishment of protection mechanisms for areas of high ecological and cultural values must ensure that First Nations can maintain, protect, and access cultural sites. Overall, any shoreline area that contains a ZOS, CSA, or is represented by a segment with High or Very High ecological values must be avoided by future land use or development.

The following recommendations focus on priority areas that have important ecological and cultural values:

- Establish two conservation zones along the area south of Monck Park (Segments 3 and 4) and north of Beaver Point Estates (Segment 15) to the end of Segment 17.
- Consider acquisition or conservation agreement for private land southeast of Quilchena boat launch to protect CSA and rare occurrence ZOS.
- Establish conservation covenants along Hwy 5A and at Moore and Stumplake Creek mouths for CSAs 3, 4, 5, 17, and 18.

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Acknowledgements

We would like to acknowledge that this project was conducted on the Traditional, Ancestral, and Unceded Territory of the Syilx and Okanagan people, both at Nicola Lake itself, as well as in the Okanagan home and office locations of the project team.

The Nicola Lake FIMP project team would like to thank Brian Holmes and Upper Nicola Band as well as Georgia Peck and LLC for providing cultural teachings, historic knowledge, and technical information sharing throughout the project. LLC is a non-profit society that facilitates collaboration in education, monitoring, restoration, and policy development initiatives for the long-term protection of Canada's lakes, rivers, wetlands, and watersheds. Their mandate is to help residents of Canada understand, adapt, and mitigate the impacts of climate change to water quality and quantity, biodiversity, and healthy human communities through diverse water stewardship activities. LLC bridges the gap between science and action to foster and normalize citizen-based water stewardship.

The following individuals contributed to information sharing, data collection, report preparation, and/or data analysis:

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- Towagh Behr, Kwusen Director of Research
- Mikaela Bennett, Ecora GIS specialist and drone operator
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- Sabrina Hu, LLC Summer Intern
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Acronyms and Abbreviations

AHI	Aquatic Habitat Index
BC	British Columbia
CDC	BC Conservation Data Centre
DFO	Fisheries and Oceans Canada
FDG	Foreshore Development Guide
FHSI	Foreshore Habitat Sensitivity Index
FIDQ	Fish Inventories Data Queries
FIM	Foreshore Inventory and Mapping
FIMP	Foreshore Integrated Management Planning
FWA	Freshwater Atlas
GIS	Geographic Information System
GPS	Global Positioning System
HWL	High Water Level
IR	Indian Reserve
LAC	Larratt Aquatic Consulting Ltd.
LiDAR	Light Detection and Ranging
LLC	Living Lakes Canada Society
masl	metres above sea level
OCP	Official Community Plan
ONA	Okanagan Nation Alliance
RAR/RAPR	Riparian Areas Regulation/Riparian Areas Protection Regulation
RFP	Request For Proposals
R.P.Bio	Registered Professional Biologist
RV	Recreational Vehicle
SMG	Shoreline Management Guidelines
TNRD	Thompson-Nicola Regional District
TUS	Traditional Use Study
UBC	University of British Columbia
UNB	Upper Nicola Band
WUMP	Water Use Management Plan
ZOS	Zone of Sensitivity

1. Introduction

Ecora Engineering & Environmental Ltd. (Ecora), in partnership with Clear Viz Aquatic Consulting (Clear Viz) and Larratt Aquatic, was retained by Upper Nicola Band (UNB) and Living Lakes Canada Society (LLC) to complete a survey of Nicola Lake using the Foreshore Integrated Management Planning (FIMP) methodology and an update to the previous Foreshore Inventory and Mapping (FIM) completed in 2011 (Patterson and Schleppe 2012). The FIMP methodology was updated by LLC in 2021, which has since been applied to Columbia Basin lakes. UNB and LLC have identified Nicola Lake as a high priority lake to apply the updated FIMP methodology and field-verify the Local Indigenous Knowledge and Values Framework FIMP – Nicola Lake (Peck, Holmes, and Armstrong, 2023).

UNB represents the only Syilx community within the Thompson-Nicola region and the most northern extent of the Syilx language and culture (Upper Nicola Band Traditional Use Study, 2014). The requested FIMP update (hereafter referred to as 'the Project') has been completed in partnership with UNB and consistent with the Local Indigenous Knowledge and Values Framework (hereafter referred to as 'the Framework'). The Framework describes core principles embodied by the Syilx four Chiefs of the "How food was given" oral story (captikʷɬ), which explains how the Four Food Chiefs came together to plan how to feed St'elsqilxw (people) after the Kul'nchut'n (the Creator) told Tmixʷ (people, animals, plants, air, and water) that St'elsqilxw (people) were coming. The Four Food Chiefs represent the following:

- Chief Sp̓iʔm̓ (Bitter Root) represents the relationships between Tmixʷ (people, animals, plants, air, and water). This Chief is associated with connection and harmony between plants, animals, water, people, and the land (relationships, connections, inclusive).
- Chief Skəmx̌ist (Black Bear) represents culture and tradition. This Chief is associated with understanding the past and how that relates to the present and future (tradition, knowledge keeper, culture).
- Chief Siyáʔ (Saskatoon Berry) represents all things that grow above the ground. This Chief is associated with creativity and is associated with a youthful perspective (creative, vision, innovation).
- Chief N'tyx̌tix̌ (King Salmon) represents all creatures in the water. He is associated with action and male perspective (action, no barriers, efficient).

In the last century, colonial water management in the Nicola Valley has not prioritized a respectful relationship with water (siwɬkʷ) and tmixʷ. As a result, the water quality of Nicola Lake continues to deteriorate. Annual blooms of potentially toxic cyanobacteria indicate a stressed lake receiving excess nutrients from watershed land use. Vulnerable fish populations of Kokanee, Burbot, and salmon are further stressed by low water levels and warm water temperatures made worse by climate change and water withdrawals. The complex, multi-jurisdictional stakeholder pressures that threaten the health of Nicola Lake require a collaborative, holistic, and action-oriented approach to foreshore management. Nicola Lake foreshore values are expected to continue to deteriorate without an Indigenous-led approach to water and land use within the Nicola watershed.

The Syilx Nation siwɬkʷ Declaration, as summarized in the Syilx Strategy to Protect and Restore Siwɬkʷ states the Syilx Okanagan People "recognize water (siwɬkʷ) as a sacred entity that connects all life (tmixʷ)" (ONA 2021). The Syilx Okanagan Worldview holds that there is a sacred and collective responsibility to care for water to ensure the health of tmixʷ for all future generations (ONA 2021). In recognition of this and in keeping with the values of the Four Food Chiefs, this Project aims to adopt a 'Two-Eyed Seeing' approach that contributes both Indigenous Knowledge and western scientific knowledge to describe foreshore values.

1.1 Project Location

Nicola Lake is part of the Fraser River watershed and occurs in the Thompson-Nicola Regional District (TNRD), approximately 10 km east of Merritt, BC (Figure 1). It is the largest lake in the Nicola River watershed with an

approximate area of 2,500 ha (Patterson and Schleppe 2012). The Project Study Area includes the entire 51-km shoreline of Nicola Lake which was divided into 42 discrete segments during the previous FIM (2011).

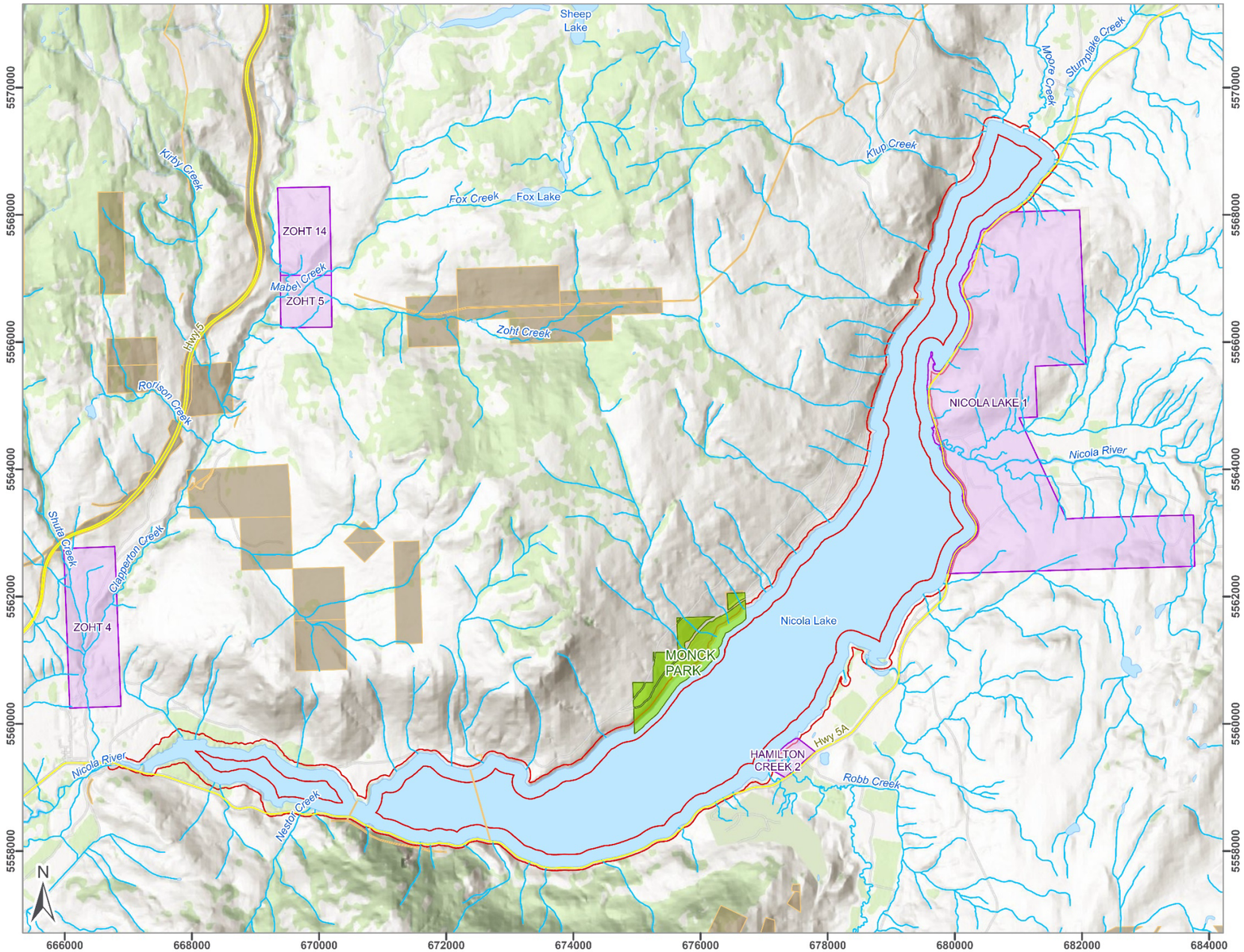
The spatial extents of the Study Area are based upon the High Water Level (HWL) of the lake, including a band that covers an area 50 m upland of the HWL and below the HWL a horizontal distance of 200 m lakeward. This near-shore aquatic area is defined as the littoral zone. The width of the littoral zone is approximate as it varies based upon depth and can range from 10 to 200 m. The Nicola Lake shoreline is primarily adjacent to TNRD Electoral Area M (82%), while the remaining shoreline is adjacent to 15% of UNB Indian Reserve (IR) #1 and #2, and 3.0% of Monck Provincial Park. The jurisdiction associated with each segment is described in Table 1.

Table 1. Segments and their corresponding location in the Study Area.

Segment number	Jurisdiction	Location Description
1	TNRD	Harmon Estates
2-4		
5	BC Parks	Monck Park Day Use Area
6		Monck Park Campground
7	TNRD	South Nicola Estates
8		North Nicola Estates
9		
10		Beaver Point Estates
11		
12		Beaver Point Estates
13		
14		Beaver Point Estates
15		
16		Klup Creek Mouth
17		
18		
19		Moore Creek and Stumplake Creek outlets
20		
21		Highway 5A
22	UNB Reserve (IR #1)	
23		Highway 5A
24		Nicola Bay Resort
25		Highway 5A
26		Nicola River Mouth and RV Park
27		Highway 5A
28		Highway 5A
29	TNRD	Old Nicola Trails
30-31		
32	UNB Reserve (IR #2)	Hamilton Creek RV Park
33	TNRD	Quilchena Creek and Quilchena Point RV Park
34		Quilchena Point RV Park and Boat Launch
35		Highway 5A
36-38		
39		Nicola Dam and Highway 5A Bridge
40-42		

The application of the Framework to the Project is intended to facilitate the consideration of all relevant information and a successful project completion via the establishment of respectful, meaningful, and productive relationships. Traditional and cultural values are highlighted or addressed throughout the report with the intention of describing both Indigenous and conventional FIMP perspectives as they relate to foreshore sensitivities and management considerations.

NICOLA LAKE WATERSHED AREA OVERVIEW



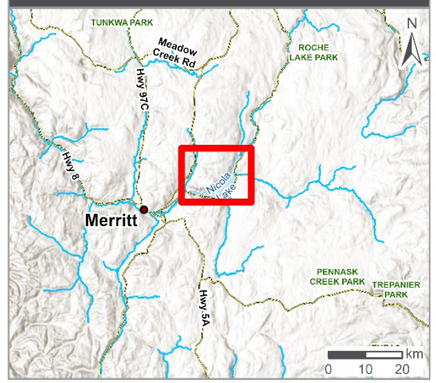
NICOLA LAKE FIMP ASSESSMENT AND UPDATE

- Highways
- Streams and Rivers
- BC Parks
- First Nation Reserves
- Provincial Crown Land
- Nicola Lake Study Area
- Lakes

References

Basemap: Esri Inc 2024-01-12

LOCATION MAP



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Client: Living Lakes Canada and Upper Nicola Band
NAD 1983 UTM Zone 10N

Date: 2024/05/30
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Figure 1.0

Figure 1. Overview Map of Study Area

1.2 Project Planning and Objectives

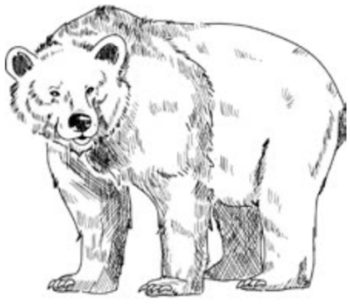
The planning phase of the Project was approached with the values of Chief Sp̓iɬm̓ (Bitter Root), which emphasize inclusivity and relationship building. The planning phase includes work plan development based on the Ecora submission to the Request For Proposals (RFP) issued in April 2023.

The proposal process made it clear that the Framework was integral to the delivery of the Project and that UNB and LLC were seeking a different approach to FIMP from recently completed projects around BC. The Project Team met with UNB and LLC for a kick-off meeting on June 2, 2023. During the meeting, roles and points of communication were established, the schedule was reviewed, and important next steps were identified. UNB graciously shared Nicola history and oral history, including important cultural areas. The future place-based meeting time and location was coordinated by LLC.

The Project objectives are to use the updated FIMP methodology to collect FIM data, derive Foreshore Habitat Sensitivity Index (FHSI), and provide Foreshore Development Guidelines (FDG) for Nicola Lake. The Project builds upon the previous FIM completed in 2012. The updated FIMP methodology includes identifying Zones Of Sensitivity (ZOS) that contain high-value and sensitive habitats or other important features. The FDG summarizes the FHSI and ZOS information while providing specific management guidelines to protect high-value and sensitive features along the shoreline. Most importantly, these conventional FIMP objectives were approached in harmony with Indigenous Knowledge, consistent with the Framework. The FIMP methodology comprises three consecutive steps.

- First, the field-based FIM survey is conducted, which involves mapping land use (e.g., residential development), shoreline modifications (e.g., retaining walls, docks, marinas), and biophysical attributes (e.g., vegetation cover, substrates, large woody debris, and aquatic vegetation) within the foreshore area.
- Second, this data is used to calculate the Foreshore Habitat Sensitivity Index (FHSI) and delineate Zones of Sensitivity (ZOS). The FHSI represents the ecological value and sensitivity of each shoreline segment. ZOS are specific areas within segments that are important habitats for species or ecosystem functions.
- Lastly, the FDG is prepared, which provides development planning guidelines for protection of sensitive fish and wildlife and their habitats identified in the FIM and FHSI analyses.

2. Information Sharing and History



A place-based planning meeting at Nicola Lake was a crucial component of the Project and consistent with the Chief Skəmx̌ist (Black Bear) values that include knowledge sharing, Traditional teaching, and contemplation.

2.1 Place-Based Meeting

The meeting was held at Monck Provincial Park on June 23, 2023, and included attendance from UNB, LLC, and the Project Team. Late afternoon timing and poor weather conditions prevented a field reconnaissance in the meeting. Instead, we focused on the value of face-to-face meeting and open discussions about the Nicola Lake history, Indigenous Knowledge, and specific areas of ecological and cultural sensitivity.

Building upon the place-based planning meeting, the Project Team attended an online teaching session, hosted by Brian Holmes of UNB and LLC on July 28, 2023. The session included an oral history of the Four Food Chiefs, the values each of the Food Chiefs represents, and how they relate to Nicola Lake and the Project approach. This

important information sharing took place in advance of the fieldwork and provided important cultural and historical context for the surveys.

Subsequent Project Team meetings were held online on October 4 and November 23, 2023. These meetings were used to provide status and progress updates, review preliminary findings, and seek feedback from UNB and LLC during the FIMP and FHSI calibration process. Overall, there were at least 15 meetings held, either in person or online, representing approximately 74 person-hours of discussion and information-sharing. Of this time, approximately 40 hours was spent with UNB and LLC during the place-based meeting, online teaching, and review of the draft deliverables. The intent at each of the meetings was to foster trust, respect, and to build relationships between UNB, LLC, and the Project Team.

2.2 Information Sharing

In addition to the information shared at the place-based planning meeting and online meetings, UNB and LLC provided important data, connections, and background material to facilitate a holistic approach to the FIMP process and address the concept of harmonizing Indigenous Knowledge with the highly structured and scientific approach typically followed for FIMP projects. The concept of 'Two-Eyed Seeing' refers to a balance between those two perspectives which is intended to provide a more fulsome and inclusive understanding of the important factors associated with the management of foreshore environments.

A key item shared by LLC is the approach to the collection of cultural and heritage information being completed by Kwusen Research and Media (Kwusen). This includes the draft 'Guiding Questions' that were used for information sharing and interview sessions conducted in 2023. Kwusen has prepared spatial data that represent areas of cultural and spiritual importance. Kwusen has also provided a written summary of the interview and mapping results, provided below.

2.3 Historical Context

To provide additional context and to consider the baseline comparison to historic conditions at Nicola Lake, the Project Team conducted a review of important events that had implications on the management or condition of ecological and cultural values. This included a review of aerial photographs dating back to 1948. Key milestones are highlighted on the timeline below and include the construction of the dam at the Nicola Lake outlet in 1927, as well as subsequent upgrades to the dam in 1987 and 2005. These events had important effects on lake water levels and the timing of high and low water periods, which in turn impacted water temperature, flood conditions, and fish passage.

The Nicola Lake area has long been inhabited by the Syilx Okanagan and Nlaka'pamux people. Pit houses were constructed near Nicola Lake for winter habitation. Colonial settlement of the Nicola Valley started in the 1860s and was followed by the establishment of ranches, including the Quilchena Ranch in 1882. The surveys for Nicola Lake IR #1 and Hamilton Creek IR #2 were completed in 1880. Major agricultural and recreational activities began in the mid to late 1800s with the Quilchena Hotel opening in the early 1900s.

The need for irrigation to support ranching led to the construction of a control dam at the Nicola Lake outlet in 1927. Nicola Ranch (formerly known as Nicola Lake Stock Farm Ltd.) operated the dam from 1927 to 1986 for the purposes of water storage and power generation. Shortly after dam installation, flooding occurred on private land, UNB IR and Crown Land that surrounded Nicola Lake (Ball 2015). In 1948, a change of operations occurred to better manage flow during freshet to reduce the risk of flooding lakeshore lands.

The development of the northwest side of the lake started in the 1950s with the establishment of Monck Provincial Park in 1951, followed by construction of Nicola Lake Road and Beaver Point Estates. The first formal boat launch with multi-slip docks opened in 1963, located on the south-east side of the lake. The development of mobile home parks on UNB IR lands started in the 1970s and continued through the 1980s. The first large single-family subdivision, Harmon Estates, also started development in the 1980s.

Concerns about summer water shortages in dry years emerged in the late 1970s and led to changes in water management through the 1980s (MOE 1983). An Engineer Order was issued in 1983 to improve the water management at the Nicola Lake dam. The Province took over operations in 1986 and developed the Nicola Lake Operation Plan (1987). The dam was reconstructed from 1986-1987 to expand the storage capacity (Urban Systems 2006), which allowed more spring runoff storage and better management of low flows during summer, fall, and winter for fish habitat and irrigation (Costerton 1993).

Recreational use from Nicola Bay to Nicola River intensified through the 1980s and 1990s as the Nicola Bay Resort became more developed. The invasive aquatic weed, Eurasian milfoil (*Myriophyllum spicatum*) was first discovered in 1991 in front of Nicola Bay Resort (Maxnuk and Einarson 1992). There is anecdotal evidence that Eurasian milfoil was introduced in 1989 at one of the northern boat launches (Maxnuk and Einarson 1992). Eurasian milfoil is one of many aquatic invasive species found where launched boats are the primary transport vector.

Water management continued to pose challenges in the early 2000s with summer drought conditions worsened by climate change. The 2003 drought was a catalyst to more water management initiatives within the Nicola Watershed, including the development of the Nicola Water Use Management Plan from 2004 to 2010 (Nicola WUMP 2010). The Nicola dam was upgraded in 2005 to increase storage capacity to support irrigation and environmental flow needs from July to September (Urban Systems 2005).

An increase in residential lakeside development in the 2000s led TNRD to the adoption of Lakeshore Development Guidelines in 2004 (TNRD 2004) and the Nicola Valley Official Community Plan in 2011. This coincided with the start of development of Nicola Estates and Old Nicola Trails in 2005. The construction of homes is still ongoing in both developments. Nicola Estates is currently in Phase 3 of development which includes 39 strata units on smaller lots. Other notable events that contributed to poor lake health and impacts to fish populations include the introduction of invasive species, including Yellow Perch in 2007 and the 2017 flood.

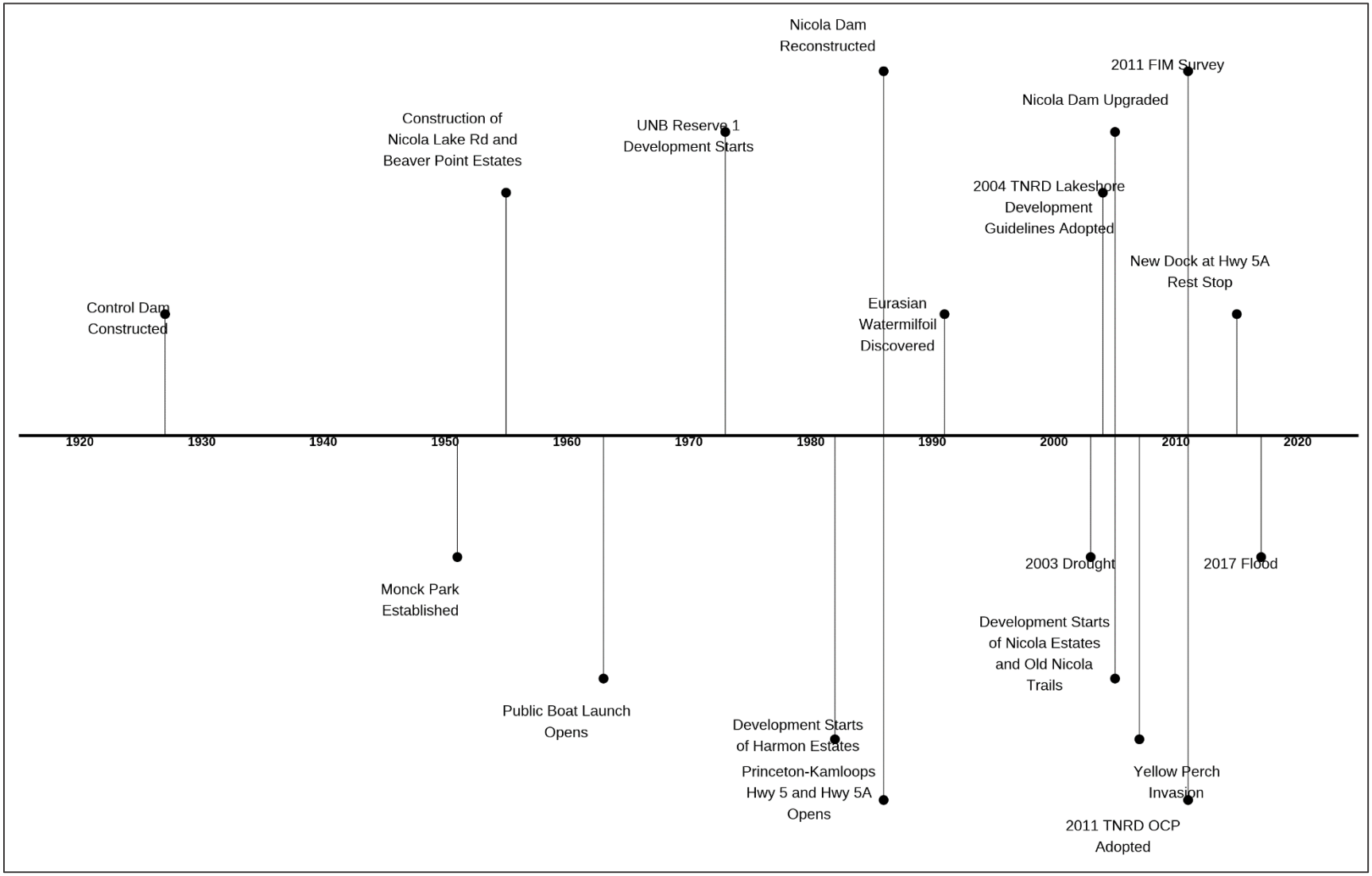


Figure 2: Timeline of key ecological and development events from 1927-2017.

2.4 Hydrometric Data

For additional historical context, we summarized annual mean lake elevation data collected to date from the Water Survey of Canada hydrometric station 'Nicola Lake near Quilchena (08LG046)'. Figure 3 presents this data in three 15-year periods, each of which coincides with a significant lake level management milestone:

- 1965-1980: Period of time prior to dam upgrades;
- 1989-2004: Period following Nicola Lake dam reconstruction in 1987; and
- 2006-2021: Period following Nicola Lake dam upgrades in 2005.

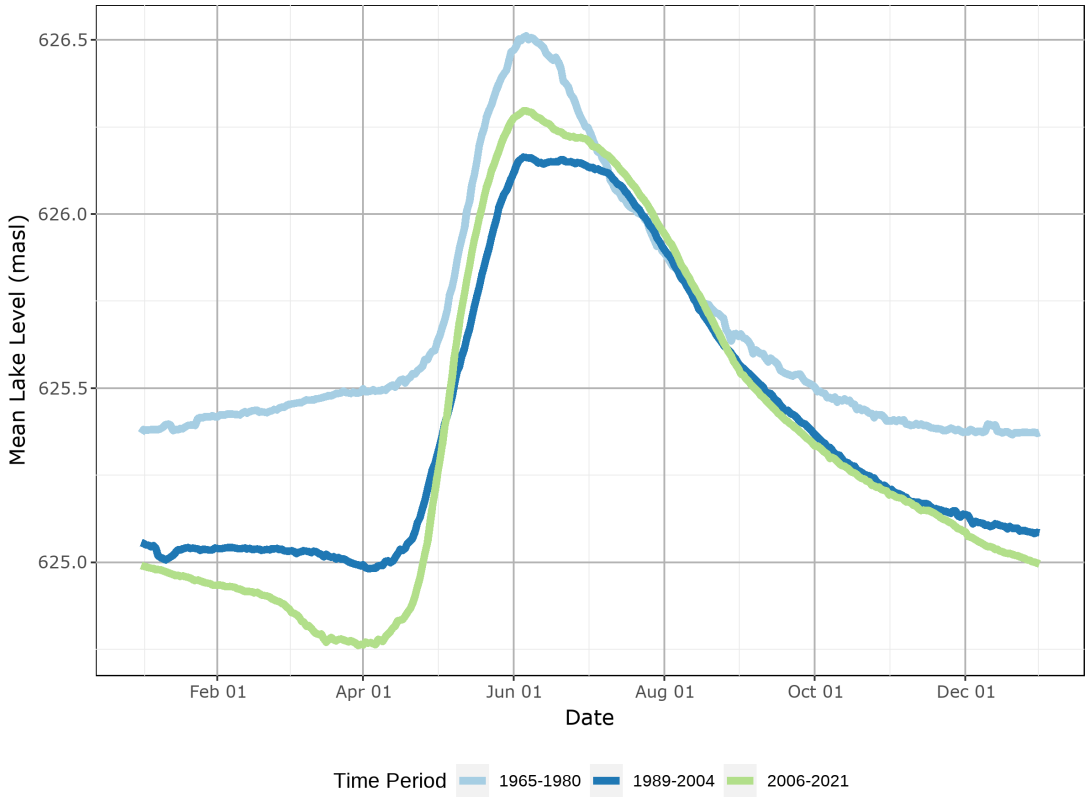


Figure 3: Comparing mean daily lake levels for Nicola Lake near Quilchena (08LG046) for 15- year periods of historical (1965 - 1980), after dam reconstruction (1989 - 2004), and after dam upgrade (2006-2021).

The hydrometric graph shows:

- 1965-1980 before dam upgrades: Water levels remained relatively high on average during the winter and spring months. The mean daily peak lake levels in June exceeded 626.5 metres above sea level (masl).
- 1989-2004: after 1987 dam reconstruction: Winter and early spring lake levels were much lower on average than the earlier period. Average mean lake levels in June were also lower.
- 2006-2021: after 2005 dam upgrades: Average spring lake levels before freshet are very low. The hydrometric data indicates that average winter and spring lake levels decreased over the past 40 years. Peak lake levels in June were managed at lower elevations over the same period to avoid flooding.

2.5 Project Setting

Nicola Lake has a complex history of colonial settlement and associated anthropogenic disturbances to riparian and aquatic environments. Looking back on the past 100 years provides context and information that improves our understanding of change resulting from dam construction and water management decisions. The ecological and regulatory setting associated with Nicola Lake are described below.

2.5.1 Ecological Setting

Nicola Lake occurs in a semi-arid setting, described by the BC Biogeoclimatic Ecosystem Classification (BEC) system as Bunchgrass (BG) surrounded by Ponderosa Pine (PP) along the northern and western sides of the lake and Interior Douglas-fir (IDF) along the south side. These are among the hottest and driest ecosystem types in BC and are dominated by shrubs including sagebrush, rabbit-brush, and saskatoon in the BG zone, with open stands of pine and fir in the PP and IDF zones. Pockets of cottonwood riparian communities exist along the shoreline and floodplain ecosystems, as well as occasional marsh wetlands and floodplains characterized by cattails and other aquatic plants. These communities provide habitats to several terrestrial and aquatic wildlife species, including provincially and federally designated species at risk.

Fish present in Nicola Lake are summarized by others, including the previous FIM report (2012). Species of management concern include Burbot, Kokanee, Bull Trout, Cutthroat Trout, Rainbow Trout, and ocean-run salmonids, such as Steelhead, Chinook, and Coho salmon. Invasive species of management concern within the lake include Yellow Perch and Carp. The issues that contributed to fish population declines and other ecological concerns were well-described over the years. Issues described in the 2012 FIM report are largely the same as the issues observed in 2023 and include management of lake levels and the effects on littoral productivity, near-shore spawning habitats, fish passage, flooding, lake temperature, and cyanobacteria blooms.

2.5.2 Regulatory Setting

The Nicola Lake Water Use Management Plan (WUMP) was issued in 2010, just prior to the 2012 FIM assessment. The WUMP provided 37 recommendations or 'policy instruments' related to water quantity and quality, environment, learning, and management. More recently, the Nicola Characterization Report (ESSA 2019) provided several recommendations in a prioritized order, including 'Improve the Use of Indigenous Knowledge in Decision Making' as the number one priority.

Assessment and permitting of proposed shoreline modifications and land use is currently triggered at municipal, provincial, and/or federal government levels, depending on the jurisdiction of the subject lands. Nicola Lake is surrounded by a mixture of privately-owned municipal lands, provincial Crown Land, provincial park, and UNB IR lands. A substantial portion of the land is designated Agricultural Land Reserve (ALR).

Nicola Lake occurs within the TNRD Electoral Area 'M'. A review of the TNRD online mapping service (https://portal.tnrd.ca/MyRegionView/) indicates that no Development Permit Areas (DPA) are currently designated surrounding Nicola Lake. A TNRD zoning bylaw (No. 2400) prescribes floodplain setbacks of 15 m for Nicola Lake and there are polygons that indicate the 'local authority' must be contacted prior to development. The TNRD Official Community Plan (OCP) Zoning Bylaw No. 2400 (2012) Part 4 states that development applications within 1 km of the natural boundary of a lake may trigger the review and decision making by the TNRD Approving Officer. The OCP also refers to the 2004 Lakeshore Development Guidelines (LDG). Appendix B of the LDG defines Nicola Lake as a 'Critical Lake', based upon concerns related to water quality. The 2004 management guidelines for Critical Lakes states:

- *Lakes in the Critical classification should be subject to no further residential subdivision or development of shoreland to prevent the acceleration of deteriorating water quality or to avoid further development or overcrowding of surface water.*

- *Further development or residential subdivision which is in conformity with existing land use regulations may be considered wherein no additional nutrient input is allowed into the lake.*

The 2013 Regional Growth Strategy (RGS) addresses 'Environmental Protection' in Section 4.0, which includes:

- *Protect and enhance the environment through the adoption and co-operative use of stewardship principles.*
- *Protect and enhance the quality and quantity of the water of the region's lakes, rivers, streams and ground water sources.*
- *Promote conservation and sustainability of watershed ecosystems, wetlands and riparian areas.*
- *Develop policies and regulations to identify, conserve and protect the natural environment, including mapping of sensitive ecosystems and designating development permit areas.*
- *Collaborate in the implementation of invasive terrestrial and aquatic plant management plans and integrated pest management plans to maintain natural biodiversity in the region.*

The subsequent RGS annual monitoring reports only address the 'Environment' as it pertains to the protection of air quality. Other municipal triggers to assess private lands for environmental values at the time of proposed development include:

- Provincial Riparian Areas Protection Regulation (RAPR), that replaced the previous Riparian Areas Regulation (RAR) in 2019. The RAPR applies to municipal lands within 30 m of a surface waterbody within the TNRD. The RAPR provides a local-government mechanism to trigger assessment of riparian and foreshore values in advance of development activities and prescribe measures to conserve, enhance, or restore those values. The assessment must be conducted by a Qualified Environmental Professional (QEP) and be submitted to the provincial organization for review.
- The provincial *Water Act* was replaced by the *Water Sustainability Act* in 2016, which also provides a mechanism to assesses and approve 'changes in and about a stream', pursuant to Section 11 of the act.
- Federal conservation changes include the establishment of designated and mapped Critical Habitat for species at risk such as Lewis's Woodpecker, Great Basin spadefoot (2017), Great Basin gopher snake (2019), and American badger (proposed in 2021).

A summary of fish and wildlife species of management concern, including common, scientific, and Syilx names is provided in Table 2.

Table 2: Fish and Wildlife Species of Management Concern at Nicola Lake.

Type	Common Name	Scientific Name	Syilx Name[1]	Designation[2]		
				SARA	COSEWIC	BC List
Fish	Bull Trout	*Salvelinus confluentus*	xʷəxʷmínaʔ (trout)		SC	Blue
	Burbot	*Lota lota*	spqʷlic (ling cod)			Yellow
	Chinook (Unit 15)[3]	*Oncorhynchus tshawytscha*	n'tyx̌tix̌ (king salmon)		E	
	Coho (pop. 7)	*Oncorhynchus kisutch*	kisúʔ		T	
	Cutthroat Trout clarkii ssp.	*Oncorhynchus clarkii clarkii*	xʷəxʷmínaʔ (trout)			Blue
	Kokanee	*Oncorhynchus nerka*	kəkni			
	Rainbow Trout/Steelhead	*Oncorhynchus mykiss*	xʷəxʷmínaʔ (trout)			
Mammal	American badger	*Taxidea taxus*	yix̌wyəx̌wútxən	1-E	E	Red
Bird	Lewis's Woodpecker	*Melanerpes lewis*		1-T	T	Blue
Amphibian	Great Basin spadefoot	*Spea intermontana*	sminap (toad)	1-T	T	Blue
Reptile	Great Basin gophersnake	*Pituophis catenifer deserticola*	sx̌ʷyups (bull snake)	1-T	T	Blue

1. Source: https://www.firstvoices.com/syilx
2. SC: Special Concern; E: Endangered; T: Threatened;
   BC List: Yellow – Secure, Blue – Of Special Concern, Red – Endangered or Threatened
3. Chinook Salmon - Designatable Unit 15: Lower Thompson, Stream, Spring population

3. Assessment and Analysis Methods

The assessment and analysis phase of the Project aligns with the values of Chief Siyáʔ (Saskatoon Berry) which relates to creativity, innovation, and problem-solving. Although the FIMP process is highly structured and prescriptive, the Project Team undertook field surveys and data collection with a focus on place-based ecological and cultural values.

The 'Standard Methods for Completion of Foreshore Inventory and Mapping Project' (Schleppe and Mason 2009) provided detailed methods that were used for the 2011 Nicola Lake FIM project. The FIMP Methods' (Schleppe et al. 2021) provide updated and expanded methods that follow three steps:

1. Conduct Shoreline Inventory using FIM methods;
2. Quantify Shoreline Habitat Sensitivities using the FHSI (previously referred to as Aquatic Habitat Index or AHI); and
3. Develop the FDG to provide an assessment of risks and land use guideline recommendations to address or mitigate risks (previously referred to as Shoreline Management Guidelines or SMG)

This project utilized the FIMP methods (with FHSI and ZOS) to provide a comparison to the previous FIM results, as well as to provide a baseline for future studies.

3.1 Data Review and Compilation

The Project includes a review of revised FIMP methods, previous foreshore inventory reports, spatial data, and analysis, and other relevant policies, guidelines, and management plans. Important information sources are listed below. Additional documents reviewed or cited in this report are summarized in the 'References' section.

- Local Indigenous Knowledge and Values Framework (Peck et al. 2023);
- Nicola Lake Foreshore Inventory and Mapping (Patterson and Schleppe 2012);
- Previous FIM reports completed at locations other than Nicola Lake (Wood 2021; Schleppe and McPherson 2021, 2022; WSP E&I Canada Limited 2023);
- 2009 Standard Methods for Completion of Foreshore Inventory and Mapping Projects. (Schleppe and Mason 2009);
- 2021 Living Lakes Canada Foreshore Integrated Management Planning Methods; Foreshore Inventory and Mapping Foreshore Habitat Sensitivity Index Foreshore Development Guide (Schleppe et al. 2021);
- Drone Video Standards for Foreshore Integrated Management Planning (LLC 2023);
- Aerial photographs from the UBC Geographic Information Centre Collection (1948 to 2004); and
- Online sources including BC Conservation Data Centre (CDC), Habitat Wizard, Ecological Catalogue (EcoCat), and TNRD Open Data.

3.2 Field Surveys

The foreshore field survey and inventory were conducted from July 31 to August 3, 2023. The survey occurred during a toxic algae bloom advisory that limited the visibility in the water column. The August boat survey of the Nicola foreshore was conducted by a crew of qualified professionals including Adam Patterson, R.P.Bio and

Rachel Plewes, R.P.Bio. A third biologist, Sara Knezevic, operated the boat. David Myers, Mikaela Bennet, and Sara Knezevic conducted the October 12 boat drone survey. Adam Patterson, R.P.Bio and Mikaela Bennet conducted the October 20 land drone survey. Table 3 provides a summary of the weather conditions and Nicola Lake water levels, based on the hydrometric station 'Nicola Lake near Quilchena (08LG046)', during each of the surveys.

Table 3. Summary of field dates and conditions during the Nicola Lake FIM surveys.

Survey Timing	Date (2023)	Weather	Nicola Lake Level (metres above sea level)*
Summer	July 31	Clear, calm, 30°C	625.892
	August 1	Clear, calm, 32°C	625.877
	August 2	Clear, calm, 30°C	625.864
	August 3	Clear, calm, 31°C	625.851
Fall	October 12	Overcast, calm, 17°C	625.174
	October 20	Clear, calm, 18°C	625.138

* Primary sensor water level measurement plus the vertical datum conversion of 623.050 m

We used handheld tablets (iPad mini-6) with digital data collection forms tailored to the FIMP methods and customized for the Project. We equipped one of the tablets with an external antenna (EOS Arrow GPS receiver) to improve the accuracy of spatial data collection. We used a DJI Mini2 drone to collect Drone imagery. We operated the drone from a boat on October 12 and from publicly accessible lands on October 20. We used the Standard Operating Procedures (SOP) for drones that was provided by LLC to determine optimal drone elevation, speed, orientation, and viewing angle of the shoreline.

3.3 FIMP Analysis Methods

We used Survey123 to collect the FIM 2023 database and post-processed with R Studio (R Core Team. 2023). Next, we used ArcGIS Pro to proof spatial points and redraw spatial polygons collected during the FIM field survey. We compared the FIM 2023 database to the FIM 2011 data (Patterson and Schleppe 2012) to ensure consistency and check for field entry errors.

We created segment polygons to delineate an approximate study area for post-processing of FIM data, FHSI, and ZOS analysis. First, we delineated a study area by buffering the segment line (Nicola Lake HWL) by 50 m on the upland side and 200 m on the lake side. Next, we derived segment splitting lines from perpendicular extensions of segment breaks and manual editing. We used the segment splitting lines to split the study area into segment polygons. Then, we split each segment polygon into two zones - the riparian zone and the littoral zone. The littoral zone was approximate because lake bathymetry is needed to define the exact littoral zone for each segment. A 200 m buffer was chosen for the littoral zone to capture all docks and mooring buoys.

We proofed all data collected as part of 2023 FIM survey using air photos, drone imagery, field photos, zoning, and 2011 FIM data. Using FIM 2011 Vegetation Polygons and aerial imagery we redrew all vegetation polygons for emergent vegetation and overhanging vegetation. We did not draw any polygons for submergent vegetation because they spanned large spatial areas that were often not visible from the boat. We used a segment polygon intersection method to count the number of shoreline modifications that were collected as spatial points.

The 2011 Nicola Lake FIM data was collected using the 2009 FIM methodology (Schleppe and Mason 2009). We adjusted the 2011 Nicola FIM data (Patterson and Schleppe 2012) to better align with the revised FIMP methodology (Schleppe et al. 2021). The following summarizes the corrections:

- Segment 4 and 13 were changed to Rural Land Use;
- We changed Segment 10 to 100% Rural Land Use;
- We rounded percent disturbed and natural to the nearest 5%;

- We manually corrected percent disturbed and natural due to inconsistent level of impact categories; and
- We corrected the number of groynes based on spatial point data provided.

The 2011 edited FIM database was used to calculate rates of change and compare shoreline modifications. The rate of change is based on the percent disturbed and percent natural metrics. The percent disturbed is an estimate of the shoreline length and riparian area (0 to 50 m above HWL) that has been altered by development from the removal of riparian vegetation, foreshore substrate modification, and installation of overwater structures (Schleppe et al. 2021). The length of natural and disturbed shoreline in 2011 and 2023 was calculated at the lake-wide scale and used to calculate the rate of natural shoreline loss. The length of natural and disturbed shoreline was also summarized by segment and predominant land use.

The length of shoreline modifiers and shoreline modifications was also compared for 2011 and 2023. The number of docks, groynes, retaining walls, concrete boat launches, and marina rails were compared between 2011 and 2023 on a lake wide scale and by segment. Additional types of shoreline modifications were counted in 2023 because of the revised FIMP methods (Schleppe et al. 2021). These additional shoreline modifications included mooring buoys, swim floats, boat racks, land boat houses, and gravel boat launches. These shoreline modifications were summarized at the lake wide scale.

The standard use of dock density in FIMP was extended by using recent literature. Dock densities for each segment were compared to a 10 docks/km density threshold. This threshold was used to estimate the potential disturbance levels that can adversely impact the aquatic habitat and ecosystem heath. The dock density threshold is based on Dustin and Vondracek's (2017) study that showed a decline in the number of vegetation dwelling fish when the littoral zone had 10-15 docks/km (the study was conducted in 28 Minnesota lakes). This decline was associated with a reduction of structural habitat complexity due the loss of large woody debris and emergent vegetation.

3.3.1 Foreshore Habitat Sensitivity Index

The FHSI is a ranking index designed to quantify the ecological value of each shoreline segment and their sensitivity to development. Segments with a higher FHSI score and ecological ranking are more sensitive to activities associated with development because they provide valuable habitats for fish and/or wildlife species. Development can degrade these habitats by removing trees or altering substrates. Segments with lower FHSI scores lack important habitat features and are more modified.

The index is composed of categories that represent amounts and types of biophysical features, modifications (e.g., docks, marinas), fish habitat, grassland ecosystem, and rare occurrences (Table 4). Each category is composed of sub-groups referred to as criteria for which a dimensionless quantity, or score, is given based on the quantity of the related features estimated during the field survey or calculated from other data sources. The overall FHSI score is calculated as the weighted sum of criteria scores (Table 4). Weights (*Weight* $_{criterion}$) reflect that certain criteria have a stronger influence on habitat quality than others. They are defined based on other FIMP reports and professional judgement (WSP 2023). The Project Team used the FHSI score to assign each segment to one of the following FHSI rankings: Very High, High, Moderate and, Low, and Very Low.

All the criteria within categories, except for the Modifications category, have positive scores and represent the segments' contribution to specific habitats and their sensitivity to modifications. Criteria in the Modifications category were negative because the features they represent deteriorate the ecological value of the shoreline. Table 4 provides the formulas used to calculate the criteria scores (*Score* $_{criterion\ i}$). The criteria scores ranged from 0 to 1 and are based on attributes that are measured in percentages or assigned relative values.

$$\boldsymbol{FHSI\ Score} = \sum_{i=1}^{n} \boldsymbol{Score}_{\boldsymbol{Criterion\ i}} \times \boldsymbol{Weight}_{\boldsymbol{Criterion\ i}}$$

Equation 1. Formula for the FHSI Score, with *n* the number of criteria and *Σ* the summation symbol.

The biophysical criteria scores quantify the value of habitat features that support the productivity of wildlife, fish, and other aquatic life. There were nine biophysical criteria included in the FHSI calculation (Table 4). These criteria represented the quality and/or quantity of riparian and aquatic vegetation, large woody debris, percent natural shoreline, substrate, and shore type. The biophysical criteria scores were calculated from data collected as part of the FIM. For the shore and substrate criteria, if more than one shore or substrate type are present in a segment, the percentage of each type and their relative value are used to calculate the scores (Table 4).

The fisheries category quantifies the value of fish habitat for Burbot rearing and migration of all fish species. The relative values for Burbot juvenile rearing were based on shore type, aquatic vegetation, and substrate. Juvenile Burbot use rocky and cliff/bluff shorelines with large substrates, vegetation, and debris for cover (McPhail and Paragamin 2000; WSP 2023). Rocky, cliff/bluff or gravel shorelines were assigned a High value for Burbot juvenile rearing (Table 4). Segments that provided cover through coarse substrates and patches of aquatic vegetation were assigned a Moderate value. A migration corridor score was attributed to segments that included a known fish-bearing stream mouth and streams with known spawning habitats for anadromous salmonids.

The ecosystem category quantifies the amount of grassland ecosystem coverage in the riparian area. Grasslands along Nicola Lake could potentially provide habitat for the blue-listed Great Basin spadefoot and Lewis's Woodpecker, and the red-listed American badger (Grassland Conservation Council of BC [GCCBC] 2004). The percentage of grassland within the 50 m riparian area of each segment was calculated using the grassland ecosystem mapping that was updated for losses from land use disturbances (Table 4).

The rare occurrences category quantifies the presence of Critical Habitat (CH) or known occurrences for provincially listed species (Table 4). Selected CH polygons, CDC public and masked occurrence data were intersected with the 50 m riparian buffer of each segment to calculate criteria scores. CH polygons for Great Basin Gophersnake and American Badger were excluded; the former due to unavailability of detailed polygons and the latter because it covered the entire study area. However, CH polygons for Blue-listed Great Basin Spadefoot and Lewis's Woodpecker were included. The criteria score for provincially blue-listed Lewis's Woodpecker was calculated from a combination of CH polygons and FIM survey data. Segments received a score if they had a band of coniferous or broadleaf forest with at least one snag or intersected the CH polygon. The FIM vegetation data was included because CH polygons were based on broad ecosystem mapping. Criteria for CDC Red and Blue-listed Species relied on public occurrence data, including Blue-listed alkaline wing-nerved moss and Red-listed giant wildrye Herbaceous Vegetation. The presence of the generalized area for the CDC masked occurrence (Occurrence ID: 576564) was also included as a criteria score.

The modifications category quantifies artificial structures along the foreshore, including retaining walls, docks, groynes, boat launches, and marinas; each represented by a criteria score. The criteria score for marinas is based on the presence of a marina along the segment, although there are no marinas currently present at Nicola Lake. The retaining wall criteria score is based on the percentage of the shoreline occupied by retaining walls. The criteria scores for docks, groynes, and boat launches are based on the density of these features that were categorized as None, Low, Moderate, and High. The. breakpoints splitting the modification densities into the four ranking categories are defined considering Moyie Lake FHSI, professional judgement, and literature. Specifically, the breakpoints used for dock and boat launch densities were obtained from the Moyie Lake FHSI (Wood 2021; Table 4). The High-Moderate breakpoint for docks of 10 docks/km used in the Moyie FHSI was also supported by literature. Dustin and Vondracek (2017) observed at dock densities above 10 docks/km there was a decline in vegetation dwelling fish. The breakpoints for groynes differ from Moyie Lake FHSI due to the high density of this feature on Nicola Lake. The breakpoint used for High and Moderate groynes densities is 20 groynes/km. This High-Moderate breakpoint was used because two groynes often have a similar linear disturbance to one dock.

Table 4. Parameters and Formulas Defined to Calculate the Foreshore Habitat Sensitivity Index (FHSI).

Category	Criteria	Weight Category (%)	Percentage of FHSI (%) (Criteria Weight)	Relative Values (inside the brackets)	Formulas for Score criteria
Biophysical	Shore Type	68	21	Stream Mouth = Wetland (1); Gravel Beach = Rocky Shore = Cliff /Bluff (0.8); Sand Beach (0.5); Other (0.3)	sum(% Shore Length of Shore Type × Relative Value) × Percentage of FHSI
	Foreshore Substrate		10	Cobble = Gravel (1); Boulder = Organic = Mud = Marl = Fines (0.8); Bedrock (0.5); Sands (0.3)	sum(% Shore Length of Substrate × Relative Value) × Percentage of FHSI
	Percentage Natural		11	N/A	% Natural × Percentage of FHSI
	Submergent Vegetation		3		% Submergent × Percentage of FHSI
	Emergent Vegetation		5		% Emergent × Percentage of FHSI
	Overhanging Vegetation		4		% Overhanging Vegetation × Percentage of FHSI
	Large Woody Debris		4	# LWD/km > 15 (1); in]10;15] (0.8); in]5;10] (0.6); in]0;5] (0.4); > 0 (0)	Relative Value × Percentage of FHSI
	Vegetation Band 1		6.7	Vegetation Bandwidth Category:	Vegetation Bandwidth Category × Vegetation Quality × Percentage of the FHSI
				Band width ≥ 20 m (1); in [15;20[(0.8); in [10;15[(0.6); in [5;10[(0.4); < 5 (0.2)	
				Vegetation Quality Category:	
	Vegetation Band 2		3.3	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)	Vegetation Bandwidth Category × Vegetation Quality × Percentage of the FHSI
Fisheries	Migration Corridor	10	7	Present (1); Absent (0)	Relative Value × Percentage of FHSI
	Burbot Juvenile Rearing		3	Rocky Shore = Gravel Beach = Cliff /Bluff (1); % Submergent ≥ 30% OR % Emergent >30% AND Boulder >10% OR Cobble >10% OR Gravel > 10% (0.50); All other combinations (0)	Relative Value × Percentage of FHSI
Ecosystem	Grassland	4	4	Percent Grassland ≥ 75% (1); in [25;75[(0.7);]0;25[(0.35); 0% (0.0)*	Relative Value × Percentage of FHSI
Rare Occurrences	Suitable/Critical Habitat Lewis's Woodpecker	8	2	Present (1); Absent (0)	Relative Value × Percentage of FHSI
	Critical Habitat Great Basin Spadefoot		2	Present (1); Absent (0)	
	CDC Red and Blue Listed Species		2	Present (1); Absent (0)	
	CDC Masked Species		2	Present (1); Absent (0)	
Modifications	Retaining Wall	10	2	N/A	% Retaining Wall × Percentage of FHSI
	Docks		2	# docks/km > 10 (-1); in]5;10] (-0.75); in]0.0;5] (-0.5); = 0 (0)	Relative Value × Percentage of FHSI
	Concrete Boat Launch		2	# boat launches/km > 2 (-1); in]1,2] (-0.75); in]0.0,1] (-0.5); = 0 (0)	Relative Value × Percentage of FHSI
	Groynes		1	# groynes/km > 20 (-1); in]10;20] (-0.75); in]0.0,10] (-0.5); = 0 (0)	Relative Value × Percentage of FHSI
	Marinas		3	Present (1); Absent (0)	Relative Value × Percentage of FHSI

*closed and open brackets signify if the value is included in the range; for example, the range [25,75[comprises values larger or equal to 25 (≥) and strictly smaller than 75 (<).

Finally, breakpoints to determine the FHSI ecological rankings were defined on the distribution of FHSI scores and professional judgement (Figure 4).

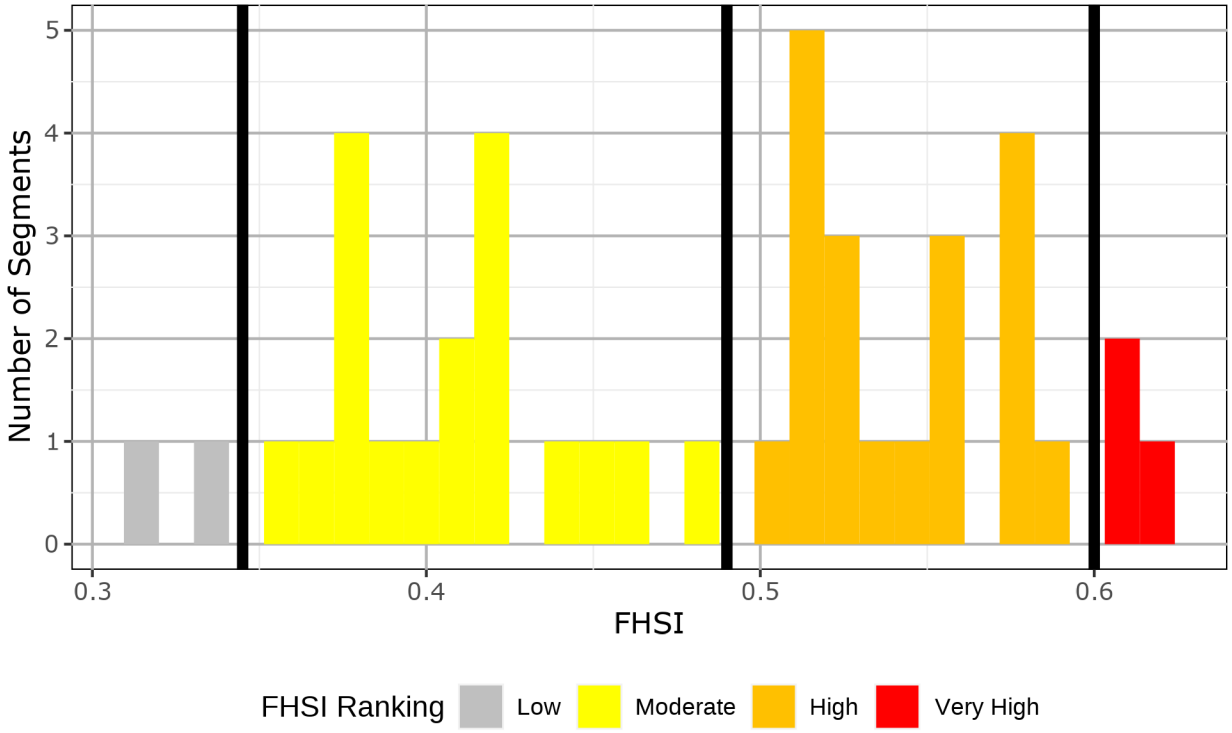


Figure 4: Histogram of FHSI scores with breakpoints for ecological ranking.

3.3.2 Zones of Sensitivity Delineation

The revised FIMP methods involve the delineation of Zones of Sensitivity (ZOS). ZOS are areas that contain unique and high value habitat features along the foreshore (Schleppe et al. 2021). Spatial data from the FHSI calculation, professional judgement, and field observations were used to delineate ZOS. Each ZOS is surrounded by a buffer to account for uncertainties and provide adequate protection from adjacent activities (Table 5). The CDC red-listed occurrence polygon for the giant wildrye ecosystem was redrawn based on aerial imagery and field observation. All rare occurrences ZOS had buffers of 5 m. The aquatic vegetation ZOS was based on field drawn polygons of emergent vegetation. The ecosystem ZOS were based on marsh polygons from Patterson and Schleppe (2012) and adjusted Freshwater Atlas wetland polygons. The ZOS buffers used for aquatic vegetation and ecosystem were 20 m and 30 m, respectively.

Mapped stream mouths from field observations and Freshwater Atlas (FWA) streamlines were used to delineate wildlife ZOS for riparian areas and fisheries ZOS for stream mouths. An additional wildlife ZOS was drawn around a mature band of cottonwood vegetation using aerial imagery. Mapped streams from FWA that had an observed inflow into Nicola Lake were assigned wildlife ZOS by delineating a 30 m wide riparian area on both sides of the stream centerline (Table 5). A buffer of 5 m was used for wildlife ZOS to account for inaccuracies in stream centreline mapping. The fisheries ZOS for streams that had an observed inflow, were defined by a 100 m radius semi-circle from the stream mouth clipped to the area below HWL. A 30 m buffer was used for fisheries ZOS associated with stream mouths.

Table 5: Description of Zones of Sensitivity (ZOS) and associated buffers.

ZOS	ZOS Description	ZOS Area Source	Buffer Width (m)
Aquatic Vegetation	Emergent Vegetation	Field drawn polygons	20
Ecosystem	Wetland	FWA Wetlands/ FIM Vegetation Marsh (2012)	30
Fisheries	Stream Mouth	100 m radius semi-circle from stream mouth outflow extending into littoral zone	30
Rare Occurrences	Red-listed CDC Occurrence Grassland	Redrawn CDC occurrence polygon	5
Wildlife	Riparian Wildlife Habitat	30 m area on both sides of FWA streamline or drawn vegetation polygons	5

3.4 Foreshore Development Guide (FDG)

The FDG template was modified to provide a more inclusive and holistic approach to FIMP, informed by the Framework and the Kwusen Cultural Overview Assessment. The FDG was modified to emphasize the protection of both cultural and ecological values. Culturally Sensitive Areas (CSAs) were defined to identify areas that have important cultural and archaeological values that must be adequately protected from foreshore development activities. As per standard FIMP methods, the FDG template used the Nicola Lake FHSI analysis to give specific recommendations for each colour zone based on FHSI Ecological Rank and ZOS category. The FDG maps include the FHSI Ecological Rank for each segment, ZOS, and CSA. The standard colour palette was used to represent the colour zones (Schleppe et al. 2021). However, an alternate colour palette was used for the ZOS categories to enhance map readability.

3.5 Non-FIMP Analysis

Chief Siyáʔ (Saskatoon Berry) encouraged us to look outside the standard FIMP methodology and use recent literature and cumulative- effects tools to provide a more holistic understanding of Nicola Lake. The FIMP process focuses on the productive littoral areas and essential riparian areas. However, the BC Cumulative Effects Framework (CEF) and the Syilx Okanagan Worldview stress the importance of considering the whole watershed. The Syilx Okanagan Worldview holds that each watershed has its own personality and unique needs (ONA 2021). The Nicola Lake watershed has a history of cumulative impacts that are likely affecting the function and health of the watershed.

The Cumulative Effects Framework (CEF) Human Disturbance data set (2021) was used to quantify the land use in the Nicola Lake watershed. First, we delineated the Nicola Lake watershed by amalgamating all Freshwater Atlas Assessment Watersheds that drain into Nicola Lake. Next, we converted the CEF Human Disturbance dataset to a raster with a 5 m resolution. When disturbance types overlapped, we selected the disturbance type with the lowest CEF Disturbance Group Rank. The percent coverage of each Human CEF Disturbance Group was calculated for the Nicola Lake watershed.

4. Results

The results phase of the Project aligned with the values of Chief Siyá? (Saskatoon Berry) in relation to problem-solving, creativity, and introspection. The other Food Chiefs also provided important guidance in this stage of the Project, such as consideration of Indigenous Knowledge and historical context. The Chief N'tyxtix (King Salmon) values aligned with the standardized, action-oriented, and efficient approach typical with FIMP, whereas Chief Siyá? (Saskatoon Berry) promoted innovative, 'outside the box' thinking and different perspectives.

4.1 Foreshore Inventory Mapping (FIM)

The Nicola Lake FIM was updated in 2023 for all 42 segments for a total shoreline of 51,727 m. The same 42 segments from the 2011 FIM were used in this Project and they ranged in lengths from 161 m to 7,363 m. The predominant land uses and shore types along Nicola Lake remained unchanged since 2011 (Table 6). The predominant land uses along the shoreline are transportation associated with Hwy 5A and agriculture (crop and ranching). Nicola Ranch and Beaver Ranch have range tenures adjacent to the shoreline. Gravel, rocky shore, and wetlands are the most predominant shore types.

Table 6: Comparison of Nicola Lake 2011 and 2023 shoreline percentages by predominant land use.

Predominant Land Use	% Shoreline (2011)	% Shoreline (2023)
Agriculture	33.1	32.0
Transportation	25.3	25.3
Rural	14.1	14.1
Single Family	13.8	13.8
Recreation	5.5	6.6
Natural Area	5.1	5.1
Park	3.1	3.1

4.1.1 Natural versus Disturbed Shoreline

Currently, disturbed shoreline comprises 51.3% (26,514 m) of Nicola Lake, whereas the remaining 48.7% (25,214 m) of shoreline is natural (Figure 5). Most of the natural shoreline occurred along segments with agriculture, natural area, and rural as the predominant upland uses (Figure 6). Segments with transportation, recreation, park, and single-family land uses accounted for most of the disturbed shoreline.

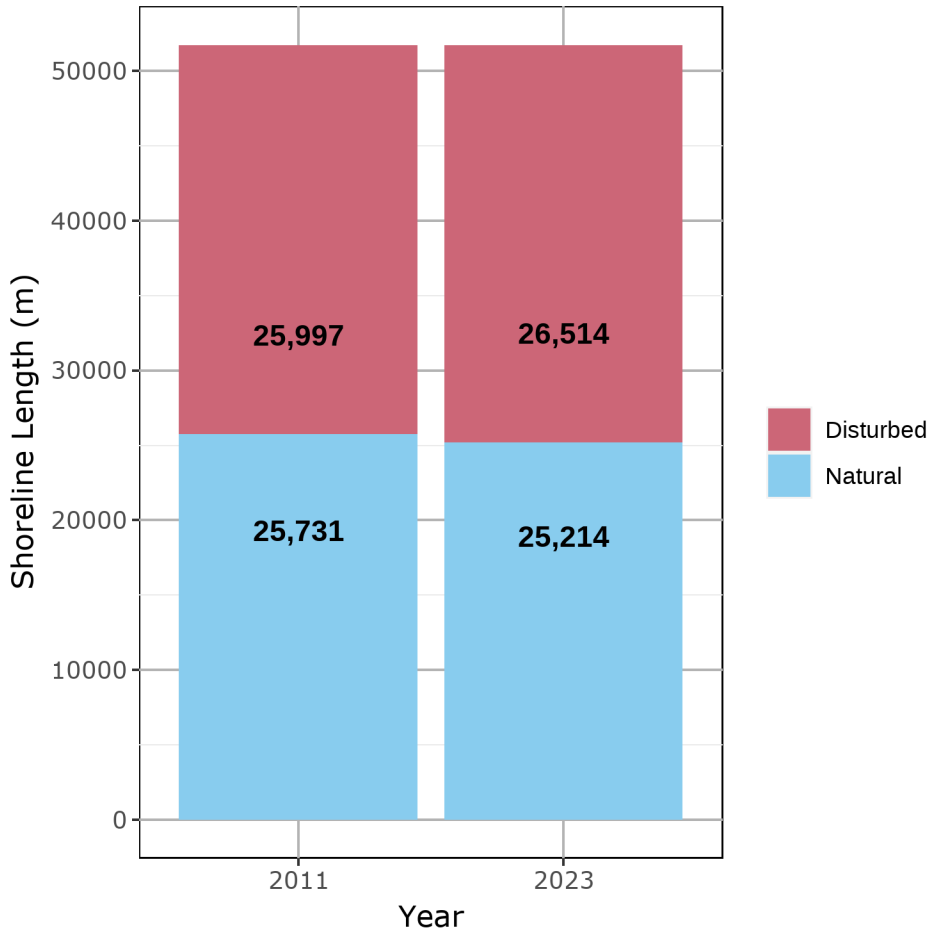


Figure 5: Comparison of Nicola Lake 2011 and 2023 length of natural and disturbed shoreline.

The proportion of natural shoreline decreased by 1% (~517 m) between 2011 and 2023 (from 49.7% to 48.7%), for a -0.08% per year loss rate (-43 m/ year). This slow loss rate is comparable to the -0.071% per year observed in Lake Windermere between 2006 and 2020 (Schleppe and McPherson 2021). This is described further in the Discussion below.

The loss of natural shoreline occurred in segments with predominantly recreation and single-family land uses (Figure 6). The most important loss of natural shoreline, 409 m in total length, happened in single-family segments: with a loss rate of -0.48%/year (-34 m/year). The loss of natural shorelines in single-family areas occurred in segments 7, 8, and 29, from the Nicola Estates and Old Nicola Trails developments (Figure 7). The remaining 108 m loss of natural shoreline was associated with recreational developments, particularly the expansion of Hamilton Creek RV Park and the development of Quilchena Point RV Park (Segments 32 and 33; Figure 7). The development of the Quilchena Point RV Park changed the predominant land use category from agriculture to recreation in Segment 33 (Figure 7).

No significant changes in the proportion of natural versus disturbed shoreline occurred in segments with the predominant land uses of natural area, park, rural and transportation (Figure 6).

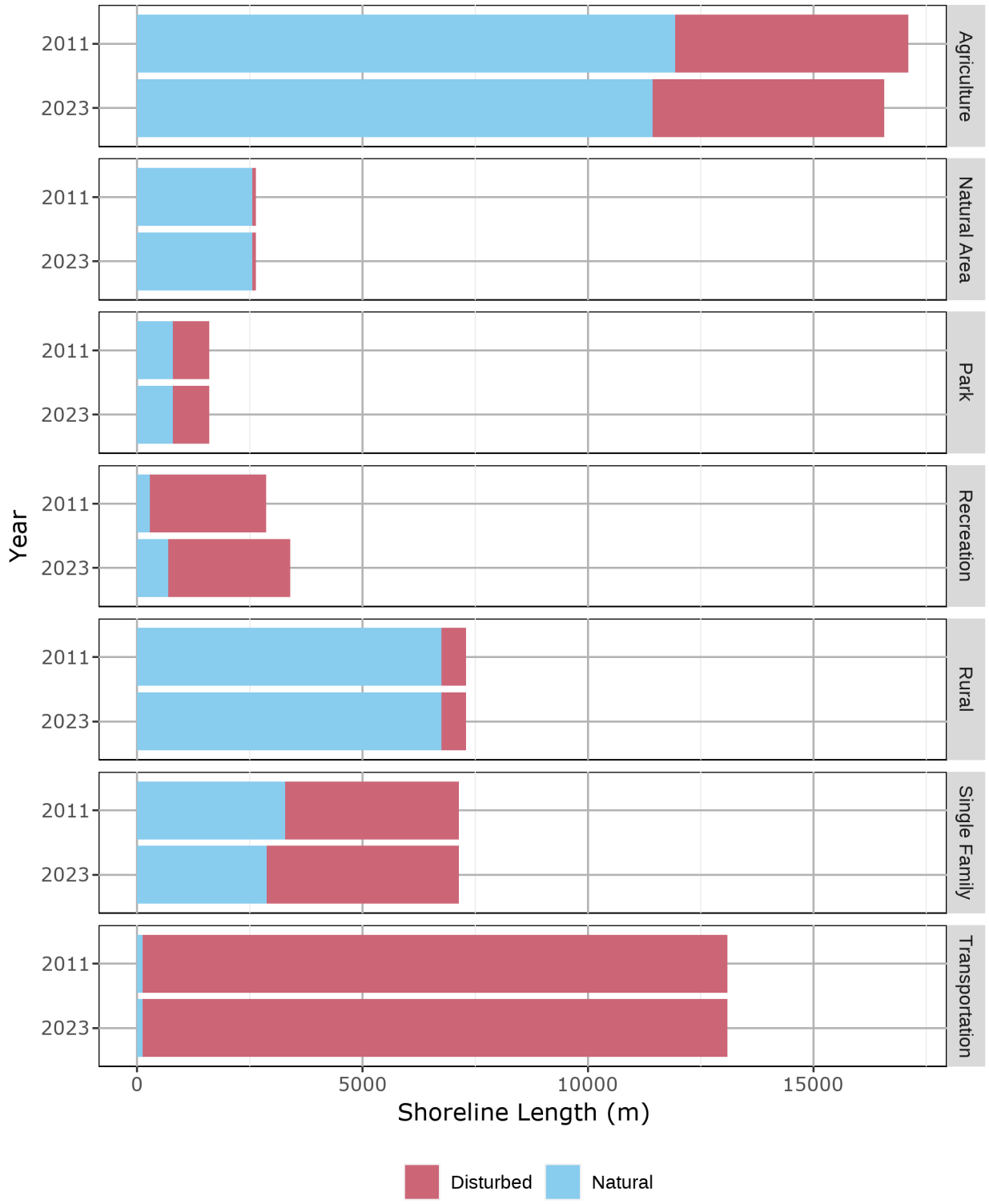


Figure 6: Length of natural and disturbed shoreline by land use types for 2011 and 2023.

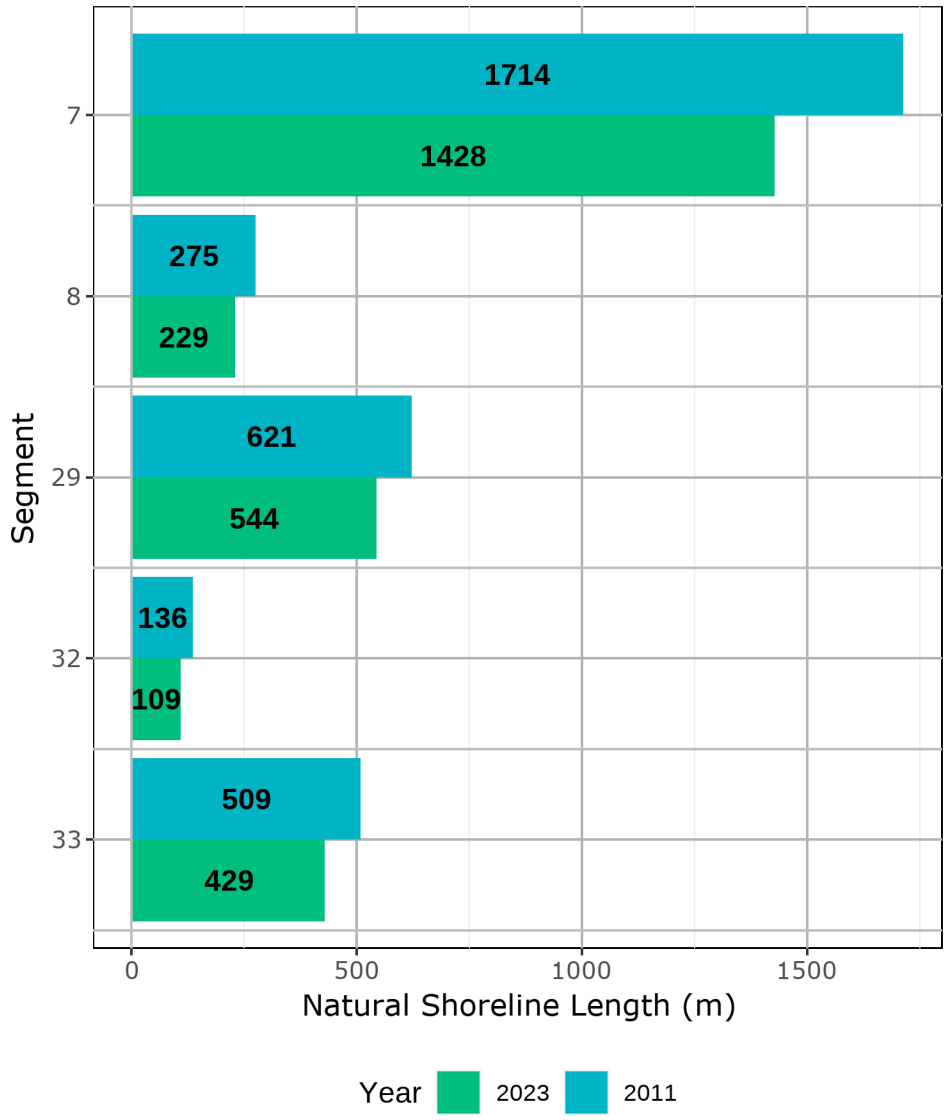


Figure 7: Length of natural shoreline for segments that experienced loss of natural shoreline from 2011 to 2023.

4.1.2 Shoreline Modifications

The most abundant shoreline modifications in 2023 were groynes, docks, retaining walls, and mooring buoys (Figure 8). Groynes were the predominant shoreline modification (n=191) and most of them were observed in single-family and Monck Park segments. Docks were the second most common shoreline modification (n=141). These docks, along with mooring buoys, were mostly observed along shorelines in the single-family developments of Harmon Estates, Nicola Estates, Old Nicola Trails, and the RV parks on UNB reserve lands. Most of the retaining walls (96 of 116) were observed along shorelines featuring RV parks and Harmon Estates (Segment 1).

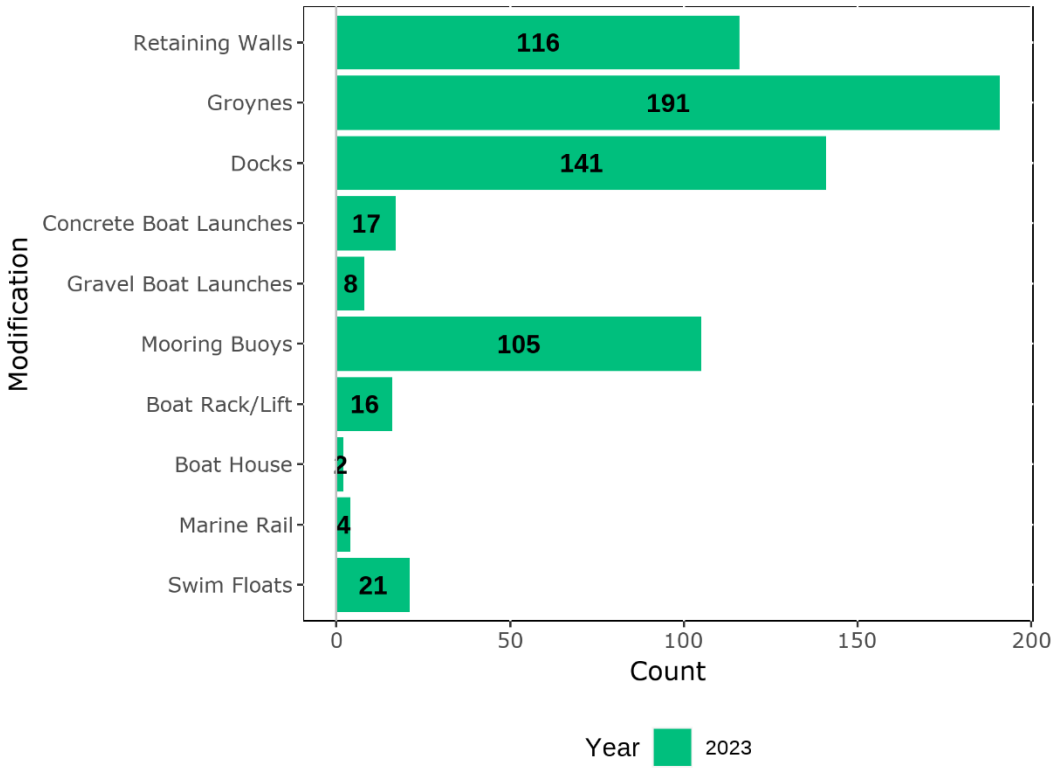


Figure 8: Total number of shoreline modifications observed in 2023.

Other shoreline modifications observed in 2023 were boat launches, swim floats, boat racks, marine rails, and land boat houses. There were 17 concrete boat launches and 8 gravel boat launches (Figure 8), with the majority located along Hwy 5A and some single-family developments (Segments 1, 7, 12). Seventeen of the 21 swim floats were observed along shorelines with single-family developments, while the remaining four were found along the shoreline of Nicola Bay Resort (Segment 24) and Hamilton Creek RV Parks (Segment 32). A total of 16 boat racks were observed along shorelines with single-family and mobile home parks on IR lands. Four marine rails were located along the shorelines of Harmon Estates Rd (Segment 1), Nicola Estates (Segment 7), and Nicola Bay Resort (Segment 24). There was one land boat house along the Old Nicola Trails (Segment 29) shoreline and the rural property along Segment 35.

The abundance of docks, groynes, retaining walls, concrete boat launches, and marine rails along the Nicola Lake shoreline increased between 2011 and 2023 (Figure 10). Docks and retaining walls had the highest percent increases of 33% and 40%, respectively. The total number of docks increased from 106 to 141, while retaining walls increased from 83 to 116. Concrete boat launches and groynes both had percent increases of 13%. Since 2011, concrete boat launches increased from 15 to 17, while the number of groynes increased from 169 to 191. Additionally, marine rails increased from 0 in 2011 to 4 in 2023.

Most of the new docks and groynes were associated with the Nicola Estates and Old Nicola Trails developments (Figure 11). The number of docks doubled from 19 to 38 in the Nicola Estates (Segment 7), and from 9 to 19 in the Old Nicola Trails development (Segment 29; Figure 10). More docks were also seen in 2023 along the shoreline of Nicola Bay Resort (Segment 24). An additional 13 groynes were observed in the Nicola Estates segment (# 7) and 4 in the Old Nicola Trails segment (# 29).

Photo 1: New marina rail, concrete boat launch and dock in Segment 7- Nicola Estates (August 1, 2023).

There were eight segments that exceeded the 10 docks/km threshold established by Dustin and Vondracek (2017). Most of the segments (1, 7, 8, 12, 14, and 29) with greater than 10 docks/km had single-family as the predominant land use (Figure 9). These single-family developments were associated with Harmon Estates Rd (Segment 1), Nicola Estates (Segments 7 and 8), Beaver Point Estates (Segments 12, 14) and Old Nicola Trails (29). The remaining segments that exceeded the 10 docks/km had rural land use (Segment 10) and recreation land use associated with Nicola Bay Resort (Segment 24).

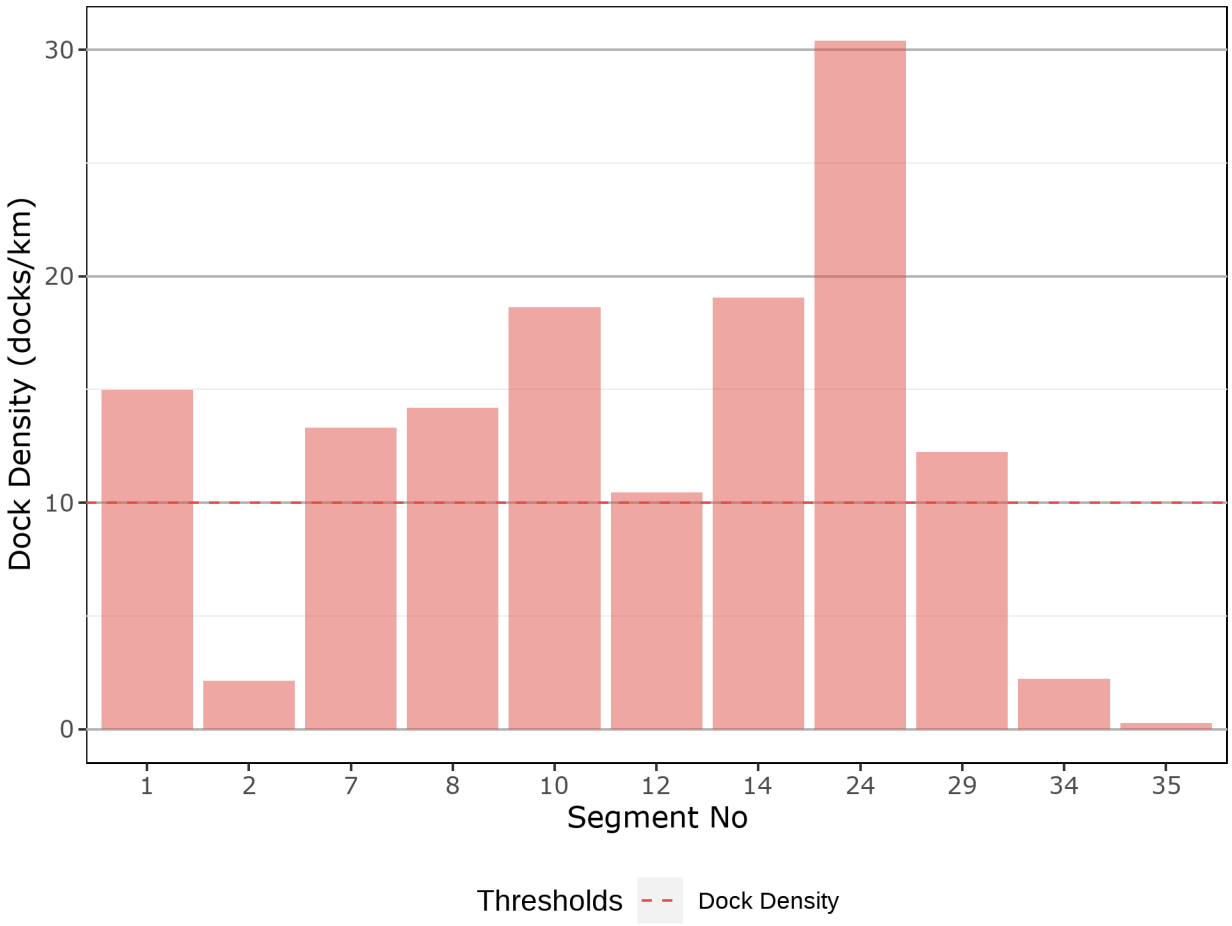


Figure 9: Dock density for all Nicola Lake segments with docks present. The red horizontal dashed lines show the 10 docks/km threshold suggested in Dustin and Vondracek 2017.

The largest increases of retaining walls occurred in the mobile park segments 24, 26, and 32 (Figure 12). Note, however, that the reported number of retaining walls in the Nicola Bay Resort (Segment 24) is potentially overestimated. Counting retaining walls in the mobile home park poses a challenge due to the difficulty in discerning property lines. The increase in retaining walls in the RV Park north of the Nicola River (Segment 26) and Hamilton Creek RV Park (Segment 32) were likely the result of intensified erosion protection measures and the expansion of developments. The Nicola Estates segments (# 7 and # 8) only had an increase of 3 retaining walls (Figure 12).

The new marine rails and concrete boat launches were mostly observed in the Nicola Estates and RV Park segments. Out of the four new marine rails, two were built in the Nicola Estates segment (# 7), one in Segment 2, that was associated with the new dock at the North end of the Harmon Estates Rd, and one in the Nicola RV Park segment (# 24). The two new concrete boat launches were installed in the Nicola Estates segment (# 7) (Photo 1) and the RV Park north of Nicola River (Segment 26) (Figure 12).

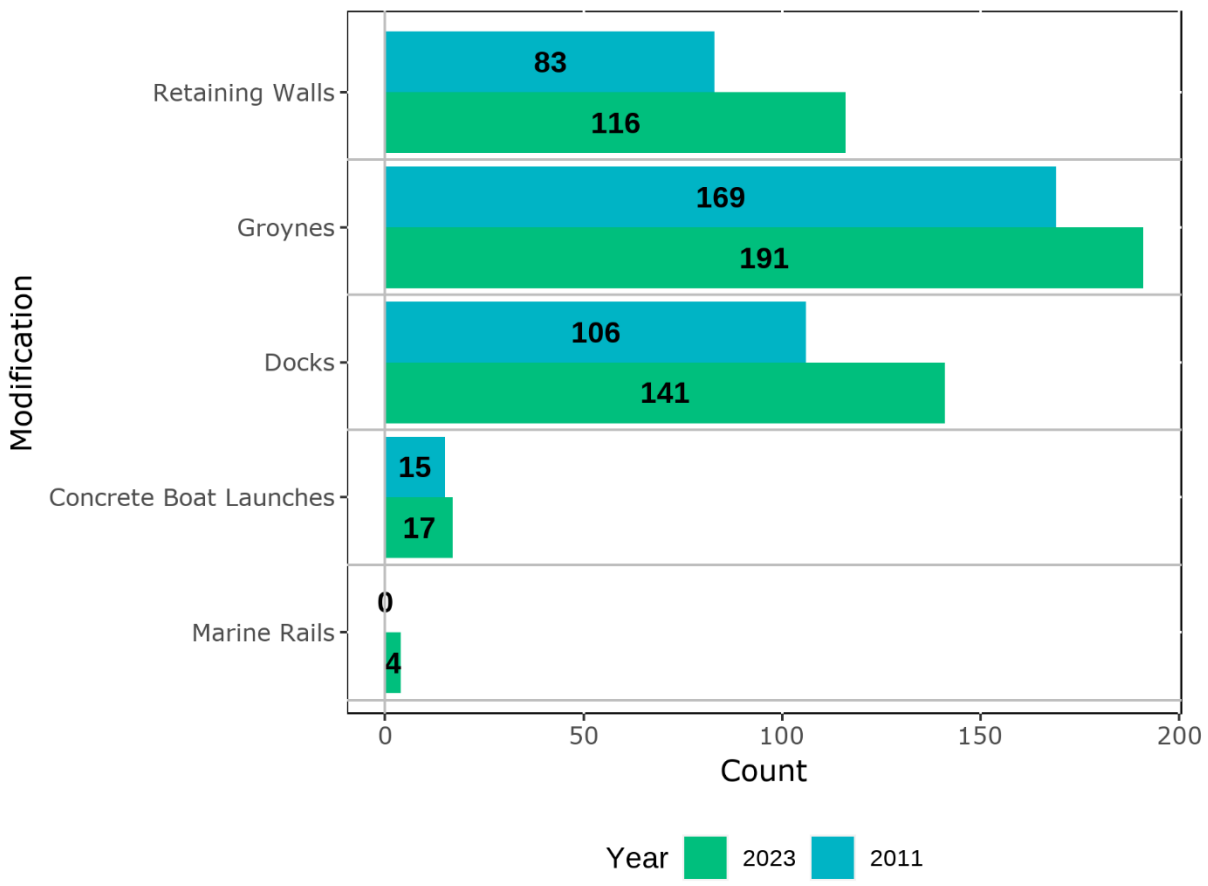


Figure 10: Total number of shoreline modifications observed in both 2011 and 2023.

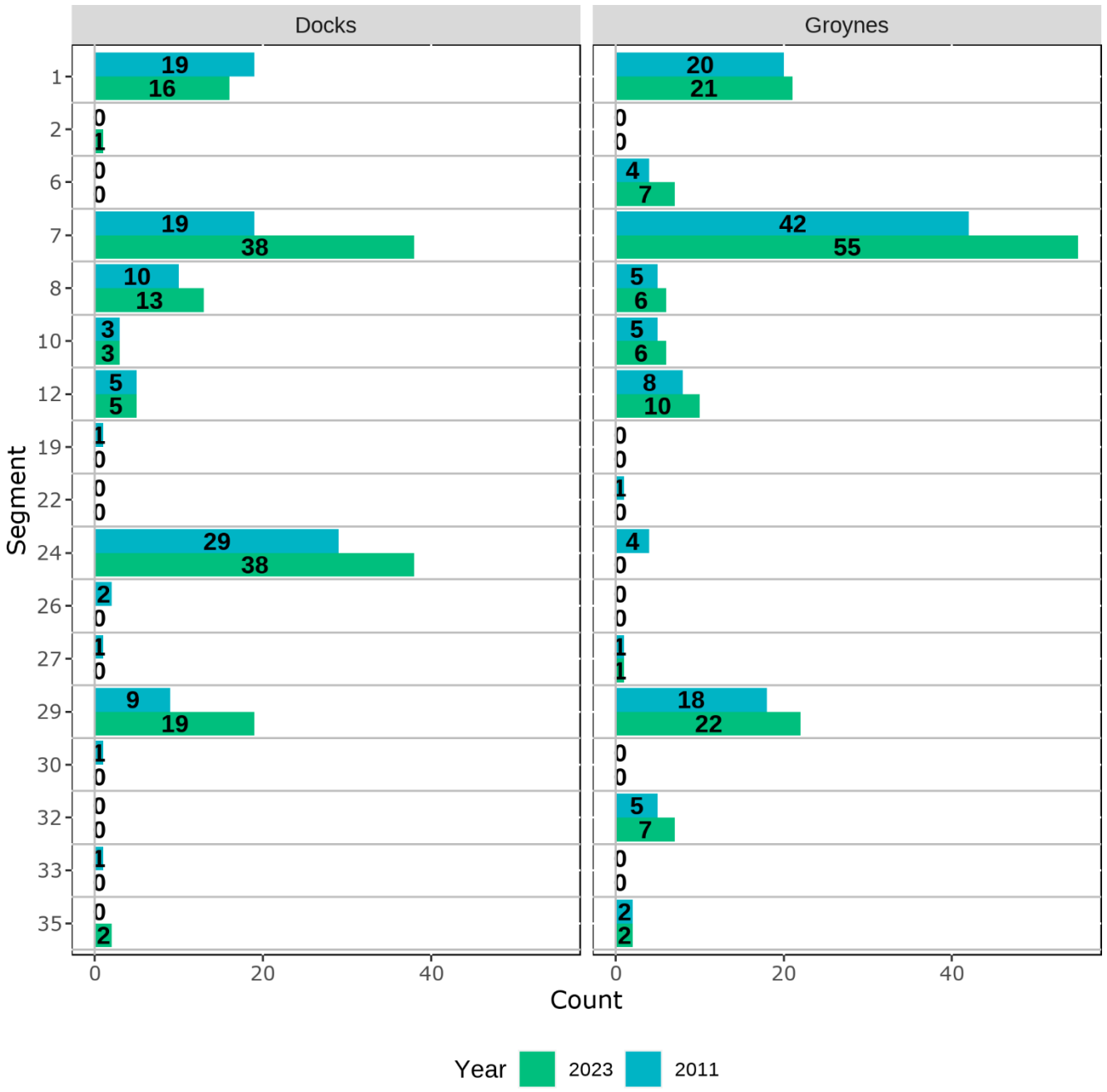


Figure 11: Variations in the number of docks and groynes in segments that underwent changes between 2011 and 2023.

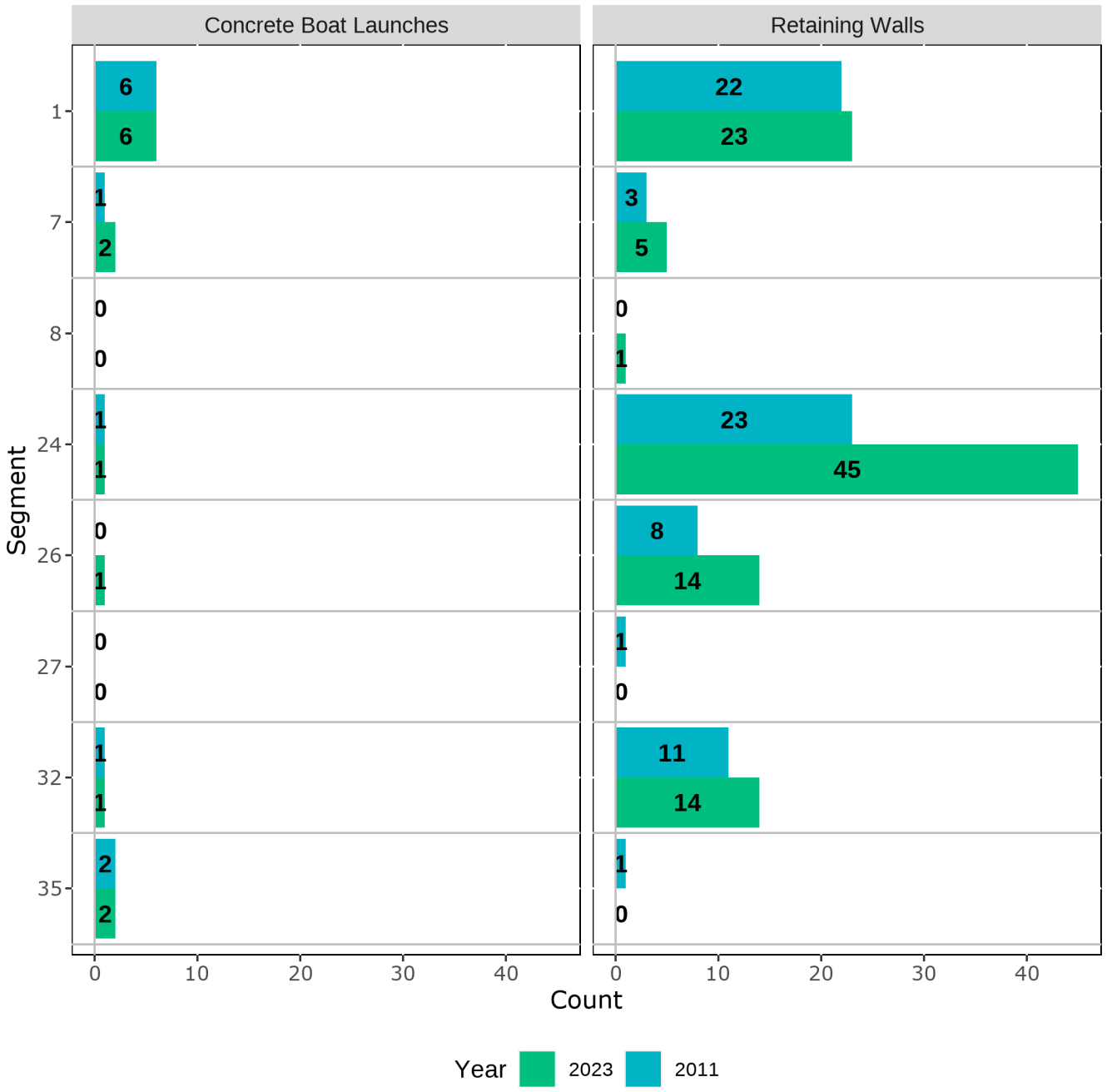


Figure 12: Variations in the number of concrete boat launches and retaining walls in segments that underwent changes between 2011 and 2023.

Substrate modification and erosion protection were the most prominent disturbances along the Nicola Lake shoreline (Figure 13). Approximately 33% of the shoreline (16,857 m) has modified substrate from groynes, rip-rap, retaining walls, and construction of sand beaches. Erosion protection has occurred on 26% of the shoreline (13,686 m). Groynes and rip-rap were most commonly used for erosion protection along Hwy 5A, single-family developments, and Monck Park. Retaining walls were along 5% of the shoreline (2,604 m; Figure 13). Approximately 20% of the shoreline (10,753 m) was adjacent to a road, predominantly along Highway 5A.

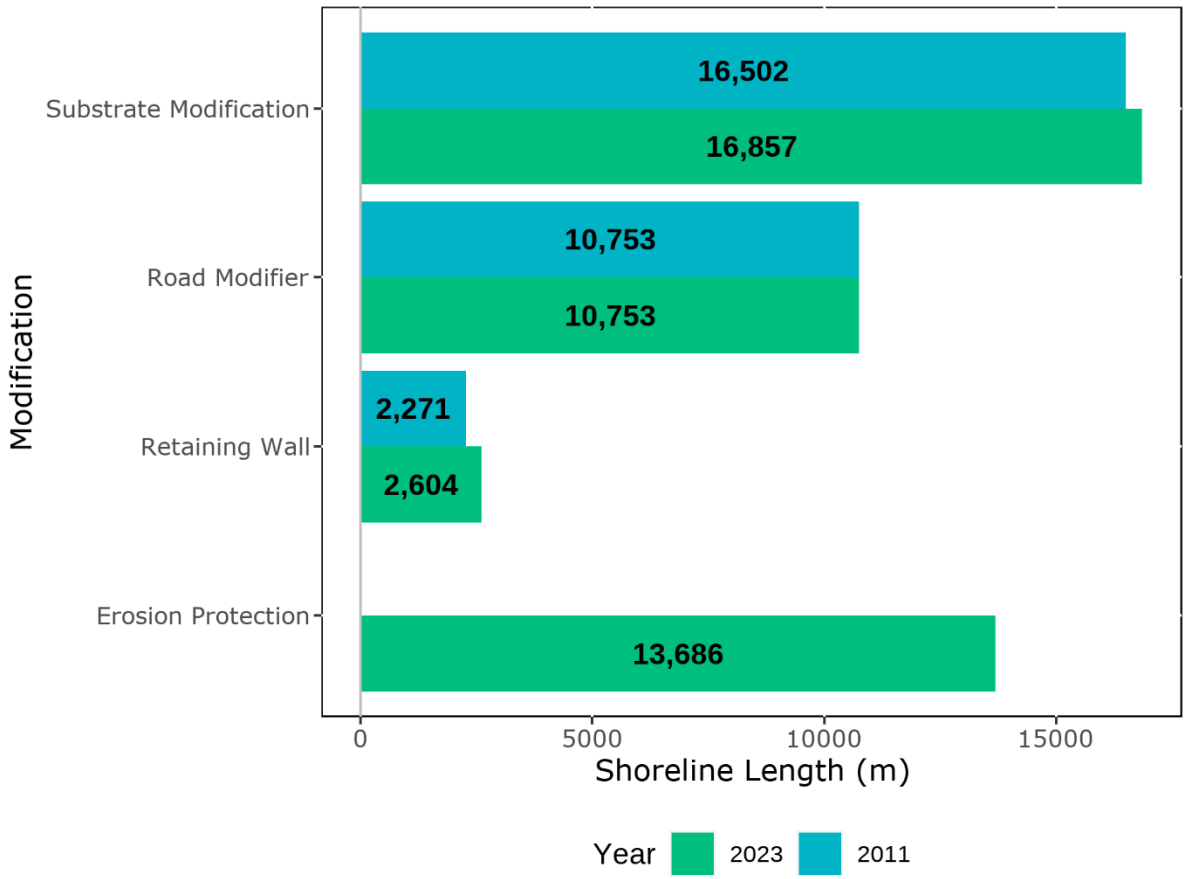


Figure 13: Length of shoreline by modification type for 2011 and 2023.

There was a small increase of the length of shoreline modified by retaining walls and other substrate modifications since 2011. The percentage of shoreline modified by retaining walls increased from 4.4% in 2011 to 5.0% in 2023 (Figure 13). The percentage of substrate modification increased slightly from 31.9% in 2011 to 32.6% in 2023, which primarily resulted from establishing new groynes. The extent of shoreline disturbance caused by roads has remained unchanged since 2011, as no new roads were constructed near the shoreline (Figure 13).

4.1.3 Wildlife Observations

The most common wildlife observations during the FIM survey were raptors and waterbirds. Mammal observations include river otter in Segment 19 and mule deer in Segment 35. Table 7 summarizes all segments with wildlife observations.

Table 7: Summary of wildlife observations during FIM surveys.

Segment No.	Date (2023)	Common Name	Scientific Name	Observation
7	Aug 01	Common Loon	*Gavia immer*	On water surface near littoral zone
11	Aug 02	Red-tailed Hawk	*Buteo jamaicensis*	Perching on wildlife tree
11	Aug 02	American Kestrel	*Falco sparverius*	Perching on wildlife tree
11	Oct 12	Bald Eagle	*Haliaeetus leucocephalus*	Observed by drone perching and swooping at waterfowl
13	Aug 02	American Kestrel	*Falco sparverius*	Perching on wildlife tree
18	Aug 02	Bald Eagle	*Haliaeetus leucocephalus*	Perching on wildlife tree
19	Aug 02	Bald Eagle	*Haliaeetus leucocephalus*	Perching on wildlife tree
19	Oct 12	River Otter	*Lontra canadensis*	Observed by drone along Stumplake Creek
22	Aug 02	Great Blue Heron	*Ardea herodias*	Perching on wildlife tree
29	Aug 03	Common Merganser	*Mergus merganser*	Approximately 10 individuals observed on swim platform near EV
29	Aug 03	Great Blue Heron	*Ardea herodias*	Observed near large patch of EV
30	Aug 03	Red-necked Grebe	*Podiceps grisegena*	On water surface near north end of segment
30	Aug 03	Great Blue Heron	*Ardea herodias*	Pair observed perching in wildlife tree
31	Aug 03	American White Pelican	*Pelecanus erythrorhynchos*	Observed along shoreline near wetland
34	Aug 03	Bald Eagle	*Haliaeetus leucocephalus*	Perching on wildlife tree
35	Aug 01	Osprey	*Pandion haliaetus*	Perching on wildlife tree
35	Aug 01	Mule Deer	*Odocoileus hemionus*	Observed along shoreline
36	Aug 01	Belted Kingfisher	*Megaceryle alcyon*	Perching on wildlife tree
40	Aug 03	Osprey	*Pandion haliaetus*	Observed nest platform
41	Aug 01	Unknown Waterbirds	n/a	Observed near patch of EV

Raptors were observed along the shoreline perching on snags or mature trees. Bald Eagle were observed in segments 11, 18, 19, and 34 (Photo 2). An osprey was observed near the east end of segment 35. A Red-tailed Hawk and American Kestrel were observed in segment 11. In Segment 13, an American Kestrel was also observed perching on a wildlife tree. A Belted Kingfisher was observed in a snag in Segment 36. Overall, the observations were comprised of waterfowl on the lake surface or along the shoreline and raptors flying overhead or perched on wildlife trees, such as snags and mature or veteran trees.

Photo 2: Bald eagle perching on snag in Segment 19 (160 m East of Moore Creek) (August 2, 2023).

Most water birds were observed in areas near wetland shore types or emergent vegetation. The Red-necked Grebe and a group of Common Merganser were observed near EV and a wetland. The Red-necked Grebe was observed near a marsh wetland in Segment 30. Ten mergansers and one BC Blue-listed Great Blue Heron were observed near EV in Segment 29. Three herons were also observed in Segment 30 and one heron was observed in Segment 22. The BC Red-listed American White Pelican was observed close to a marsh wetland in segment 31.

4.2 Foreshore Habitat Sensitivity Index

The Nicola Lake FHSI shoreline ranking is mostly comprised of sections with High ecological value (46.0%), followed by Moderate (44.7%), and Low (4.5%). Only 4.8% of the lake shoreline is ranked with Very High ecological value (Figure 14). The north-western side of the lake contains shoreline that have High FHSI (Figure 15) due to the presence of long natural rocky or cliff/bluff shorelines. The other portions of the shoreline with High FHSI are located mostly along the western side of the lake and were disturbed by agriculture, and park, but have features that provide important habitat for fish or wildlife, such as patches of emergent vegetation and mature trees. There are small portions of the shoreline with Low and Moderate FHSI on the western side of the lake are characterised by single-family and rural land uses (Figure 16). The majority of the shoreline with Low and Moderate FHSI is located in the south-eastern side of the lake, along Hwy 5A and within UNB Reserve lands. These portions of the shoreline with Low and Moderate FHSI were disturbed by transportation, recreation, park, single-family, and rural land uses (Figure 16).

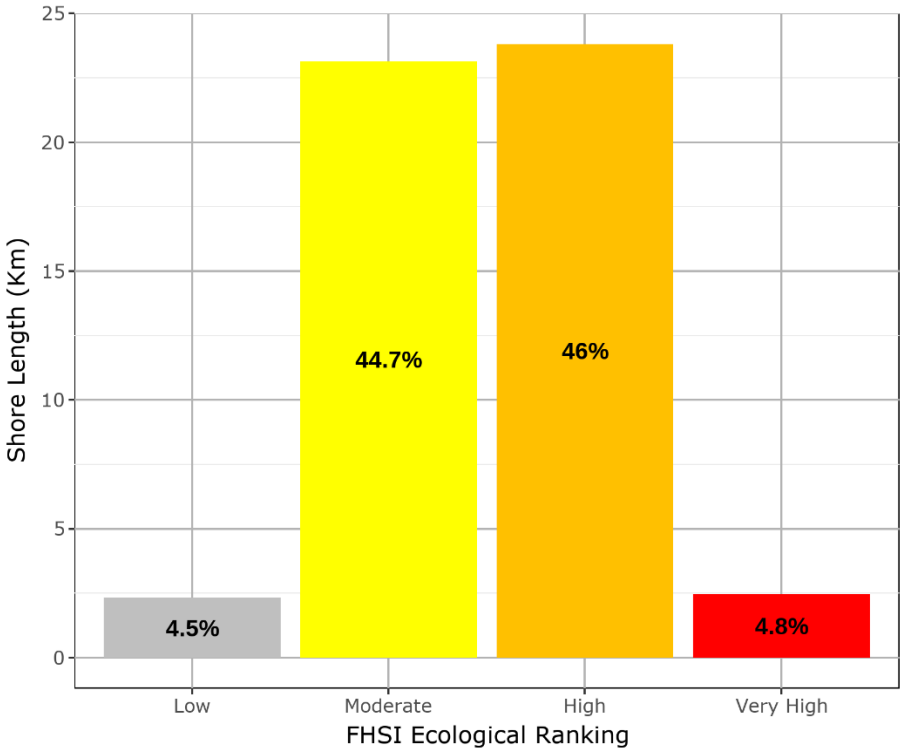


Figure 14. Grouping of the 42 segments by their Foreshore Habitat Sensitivity Index (FHSI) ecological ranking and corresponding length and proportion of the Nicola Lake shoreline.

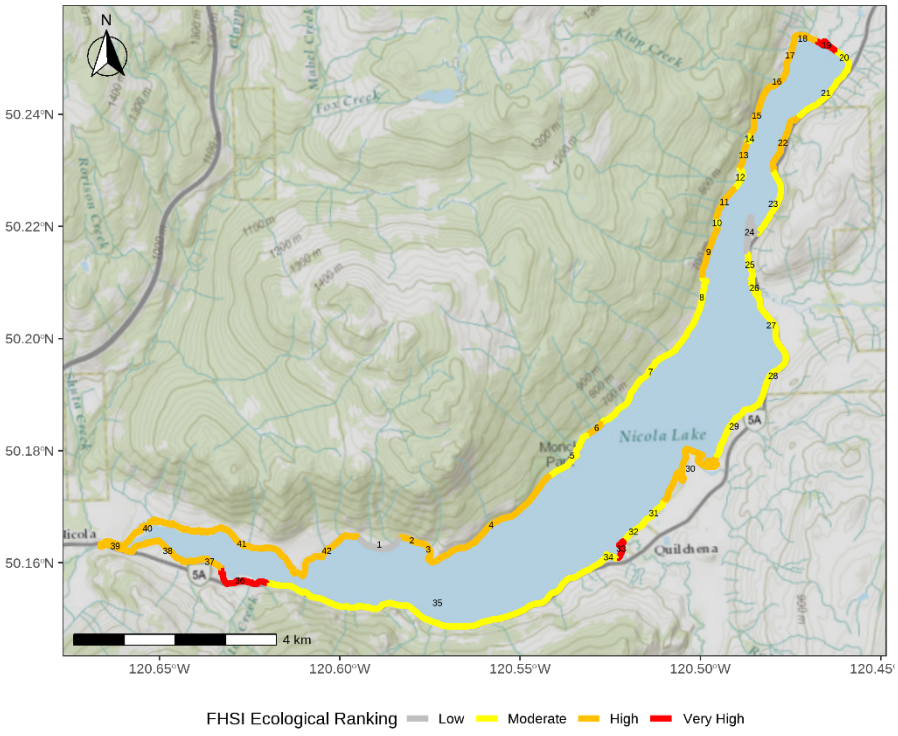


Figure 15: Map of Foreshore Habitat Sensitivity Index (FHSI) ecological rankings for Nicola Lake.

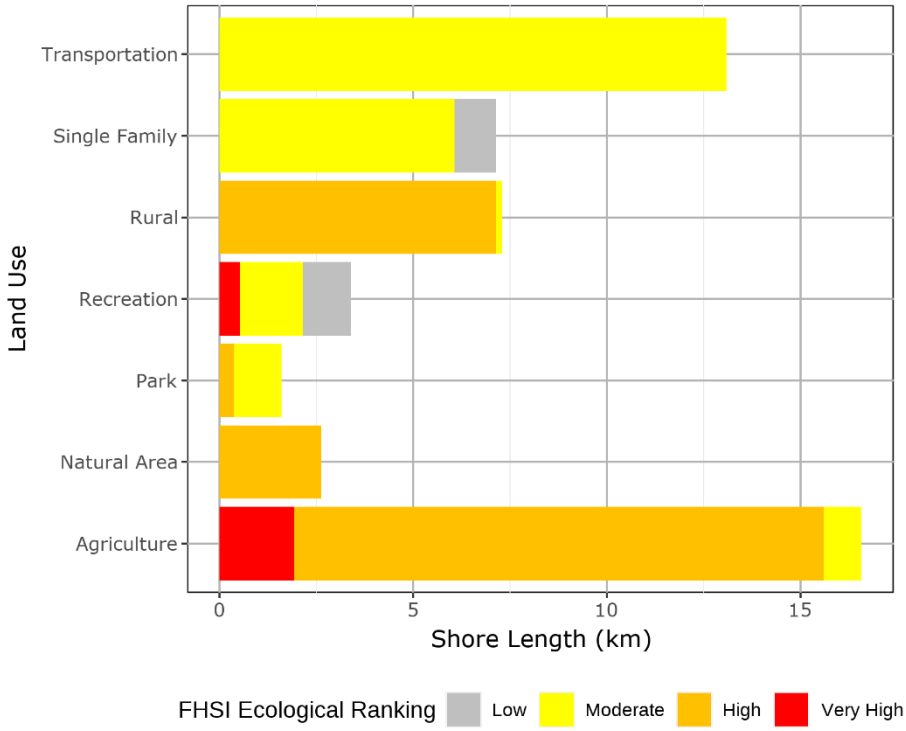


Figure 16. Grouping of the 42 segments by their predominant land use and corresponding length of the Nicola Lake shoreline. Also shown is the Foreshore Habitat Sensitivity Index (FHSI) ecological ranking of the segments.

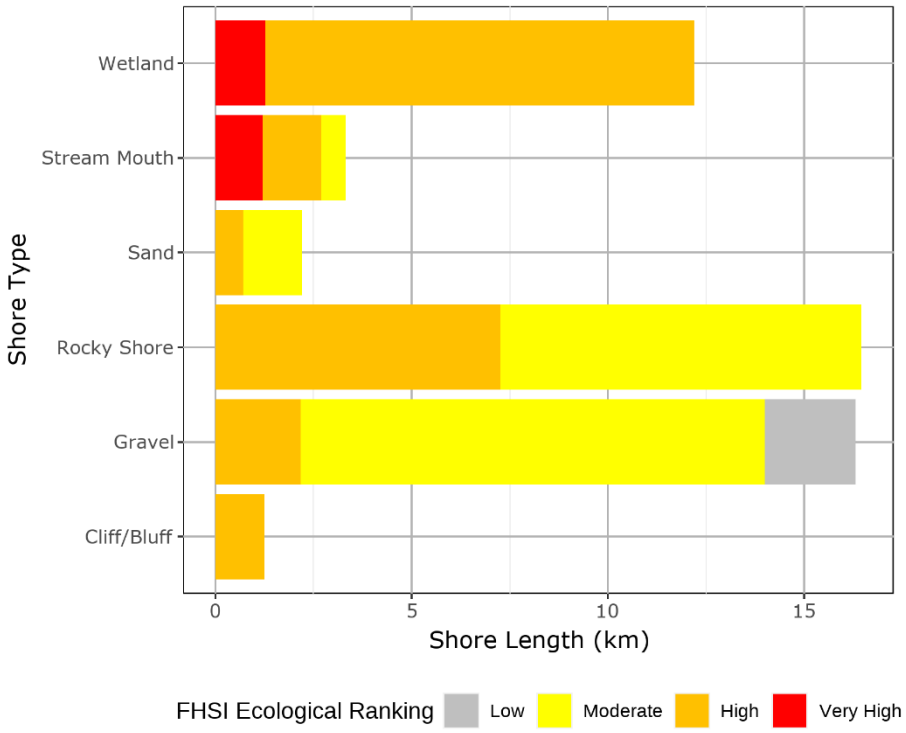


Figure 17. Grouping of the 42 segments by their predominant shore type and corresponding length of the Nicola Lake shoreline. Also shown is the Foreshore Habitat Sensitivity Index (FHSI) ecological ranking of the segments.

Three of the 42 segments had Very High FHSI, representing 4.8 km of shoreline (Figure 15). Two of these segments contained the mouth of Moore and Stumplake Creeks (Segment 19), and Quilchena Creek (Segment 33), Moore and Quilchena Creeks being fish-bearing streams (Photo 3). The other segment (Segment 36) had a wetland shore type with only 10% disturbed by agriculture.

Photo 3: View of the Moore Creek mouth (Segment 19) with large woody debris visible (October 12, 2023).

Nineteen of the 42 segments had High FHSI, representing 23.8 km of the shoreline (Figure 15). Eleven of these segments were minimally disturbed (≤ 10% disturbed shoreline). Seven of them, located along the north-western side of the lake, were composed principally of rocky or cliff/bluff shorelines (Segments 2, 3, 4, 9, 11, 13, 15). Three of the other minimally disturbed segments (16, 17, 18) were located at the northern end of the lake. Segments 16 and 18 both contain broadleaf mature forest, whereas Segment 17 features a grassland and some emergent vegetation. The remaining segment, Segment 41 features a wetland with associated emergent vegetation.

The other eight segments with High FHSI had moderate to high levels of disturbances (between 20% and 80%) and had ecologically relevant features. Four of these segments were wetland shore types that had been disturbed by agriculture land use (Segments 30, 38, 40, 42). The stream mouth Segment 39 had also been disturbed by agricultural land use, along with the Nicola Lake Dam and the Hwy 5A bridge. Two of these segments had gravel shore types with large patches of emergent vegetation but were disturbed by Monck Park (Segment 6), agricultural land use and historic recreation use (Segment 37). The last segment (Segment 22), located near the northern boundary of UNB Reserve 1, was disturbed by rural land use and has a rocky shore with a riparian area that contains a grassland.

Eighteen of the 42 segments had Moderate FHSI, representing 23.1 km of the shoreline (Figure 15). These segments were disturbed by single-family, rural, recreation, park, and transportation land uses (Figure 16). Five segments, located along the western side, were disturbed by the single-family and rural developments of Nicola and Beaver Point Estates (Segments 7, 8, 10, 12, 14). The eastern side of the lake comprised of eight segments that were disturbed by Hwy 5A and agricultural land use (Segments 20, 21, 23, 25, 27, 28, 31 and 35). The Old

Nicola Trails development has disturbed Segment 29. Erosion protection measures associated with Monck Park and recreational land use disturbed four segments (Segments 5, 26, 32, and 34).

The remaining two segments had Low FHSI, representing 4.5 km of shoreline (Figure 15). Harmon Estates (Segment 1) and Nicola Bay Resort (Segment 24) have high levels of disturbance (≥80% disturbed shoreline) caused by landscaped lots with retaining walls and docks.

4.3 Zones of Sensitivity

The five types of ZOS identified for Nicola Lake are fisheries, wildlife, rare occurrences, aquatic vegetation, and ecosystem. ZOS polygons range in size from 19 to 137,666 m^2. Most of the ZOS are within floodplain areas or wide littoral zones. Floodplain areas contain wetlands and stream mouths while wide littoral zones feature patches of emergent vegetation and are often associated with wetland shore types. The Quilchena area, the north and south end of the Lake have the most ZOS.

The fisheries ZOS are associated with stream mouth locations that have visible outflow into Nicola Lake (Table 8). The stream mouth locations associated with Nicola River, Klup, Moore, Stumplake, and Quilchena creeks are assigned fisheries ZOS because of the valuable inputs of water and nutrients to the foreshore, as well as the provision of cold-water refuge, migration corridors, and/or spawning habitats for fish. Nicola River, Moore, Stumplake, and Quilchena creeks are known fish-bearing streams.

Nicola River and Quilchena Creek are known to support both anadromous and non-anadromous salmonids, whereas Moore and Stumplake Creeks support non-anadromous salmonids. Coho Salmon, Rainbow Trout, and Kokanee were observed in Quilchena Creek (FIDQ 2022). Chinook Salmon, Rainbow Trout, and Mountain Whitefish were observed in the Upper Nicola River in September 2003 (Pehl 2004). Moore and Stumplake creeks are known to support Rainbow Trout and have historical observations of Kokanee.

Table 8: Summary of fisheries ZOS by segment.

Segment No.	ZOS Type	ZOS Rationale
16	Stream Mouth	Klup Creek is a 3rd order stream that supplies nutrients and has potential habitat for fish
19	Stream Mouth	Known fish presence in Moore Creek
19	Stream Mouth	Known fish presence in Stumplake Creek
26	Stream Mouth	Known fish presence in Upper Nicola River
33	Stream Mouth	Known fish presence in Quilchena Creek and Coho Salmon observed near Creek Mouth in 2007

Stream riparian areas are considered wildlife ZOS because the riparian ecosystems provide important wildlife corridors as well as cover, foraging, and breeding habitat for birds and other wildlife. The riparian areas of all streams with visible inflows are included as wildlife ZOS (Table 9). A band of mature cottonwoods in Segment 18 is also considered a wildlife ZOS (Photo 4). A summary of the segments with wildlife ZOS and the rationale for selection is provided below (Table 9).

Photo 4: View of wildlife ZOS along Segment 18 with mature black cottonwood and snags (October 12, 2023).

Table 9: Summary of wildlife ZOS by segment.

Segment No.	ZOS Description	ZOS Rationale
16	Stream Riparian Area	Klup Creek riparian area
18	Riparian Vegetation	Mature riparian band of vegetation
19	Stream Riparian Area	Moore Creek riparian area
19	Stream Riparian Area	Stumplake Creek riparian area
26	Stream Riparian Area	Upper Nicola River riparian area
33	Stream Riparian Area	Quilchena Creek riparian area

The north end of Segment 35 is assigned the rare occurrences ZOS as there is a mapped occurrence of a Red-listed giant wildrye ecosystem polygon that overlaps the segment (Photo 5; Table 10).

Table 10: Summary of rare occurrences ZOS by segment.

Segment No.	ZOS Description	ZOS Rationale
35	Mapped Ecosystem At Risk	CDC Red-listed occurrence of giant wildrye Herbaceous Vegetation; confirmed by field visit

Photo 5: View of north end of Segment 35 with red circle indicating where giant wildrye was observed (October 20, 2023).

The ZOS for aquatic vegetation is based on the occurrence of native emergent vegetation, such as bulrush. There are 17 segments that have at least one aquatic vegetation ZOS (Table 11). The aquatic vegetation ZOS are concentrated in the shallow areas at the north and south ends of Nicola Lake. The shallow areas along the north end of Monck Park (Segment 6) and south end of Nicola Lakeshore Estates (Segment 7) segments contain numerous aquatic vegetation ZOS (Photo 6). Some aquatic vegetation ZOS also occur along the Old Nicola Trails area (Segment 29) and the adjacent wetland (Segment 30).

Table 11: Summary of aquatic vegetation ZOS by segment.

Segment No.	ZOS Description
6	Emergent Vegetation
7	Emergent Vegetation
17	Emergent Vegetation
18	Emergent Vegetation
20	Emergent Vegetation
21	Emergent Vegetation
24	Emergent Vegetation
29	Emergent Vegetation
30	Emergent Vegetation
35	Emergent Vegetation
36	Emergent Vegetation
37	Emergent Vegetation
38	Emergent Vegetation
39	Emergent Vegetation
40	Emergent Vegetation
41	Emergent Vegetation
42	Emergent Vegetation

Photo 6: Emergent vegetation in Segment 6 (north end of Monck Park) (August 1, 2023).

The ZOS for ecosystems are based on mapped wetlands and often associated with aquatic vegetation ZOS. Wetlands are valuable ecosystems that provide habitat for terrestrial and aquatic species, improve lake water quality by filtering nutrients and pollutants, and provide flood mitigation through water storage (Kingsford et al. 2016). There are 9 segments that contain at least one ecosystem ZOS (Table 12). Ecosystem ZOS occur along the shoreline of segments 30, 31, and 33 from Quilchena RV Park to south of the Old Nicola Trails development. Marsh wetlands are numerous along the south end of the lake (Segments 36-41).

Table 12: Summary of ecosystem ZOS by segment.

Segment No.	ZOS Description	ZOS Rationale
30	Wetland	Mapped Freshwater Atlas Wetland
31	Wetland	Mapped Freshwater Atlas Wetland
33	Wetland	Mapped Freshwater Atlas Wetland
36-41	Wetland	Mapped Marsh FIM (2012)

4.4 Culturally Sensitive Areas

The Kwusen Cultural Overview Assessment is summarized in a May 24, 2024, memorandum that provides a summary of desktop review, interviews, and field assessment. The overall finding emphasized in the report is that "the entire Nicola Lake, including its foreshore, is a sacred and culturally significant place". In other words, areas that were highlighted as culturally or ecologically important are not meant to suggest that other areas are unimportant or insignificant.

While recognizing that the entire lake is sacred, Kwusen provided mapping that represents Culturally Sensitive Areas (CSAs). These are areas that have important sacred and spiritual values and disturbance of these areas will violate Syilx law. The memo provides categories of these zones, including:

- Non-Human Being Places;
- Ceremonial Places;
- Captíkwł (Four Food Chiefs) Places;
- Ancestral Burials; and
- Pictographs.

The memo also highlights the importance of implementing a Syilx-led decision-making process within the FIMP framework. Although the identified zones do not influence the FHSI scoring, they are used to provide direction to the FDG report and are displayed on the FDG maps.

The Cultural Overview Assessment identified 19 CSAs along the Nicola Lake foreshore (Table 13). A large portion of the northwestern side of the lake contains three CSAs. These CSAs were disturbed by Monck Park, Nicola Estates, Beaver Point Estates, and range tenures. The eastern shoreline contains nine CSAs along Hwy 5A and in the Quilchena area (Table 13). These CSAs were disturbed by Nicola Bay Resort, Old Nicola Trails, and Quilchena boat launch. In the floodplain and wide littoral areas of the north and south end of the lake there are seven CSAs located (Table 13). These CSAs are associated with wetlands, stream mouth, and emergent vegetation.

Table 13: Summary of Culturally Sensitive Areas and associated Segments.

Segment No.	CSA No.	Area Description
3 to 7	1	large area from south of Monck Park to the southern portion of Nicola Estates
8, 9	10	covers a smaller area at the north end of Nicola Estates
14 to 18	2	covers a large portion of natural shoreline on the northwestern side of the lake including a portion of Beaver Point Estates
19, 20	17	area surrounding the mouth of Moore and Stumplake creeks
21	18	located at Hwy 5A pullout
22	3 and 4	small areas along Hwy 5A
23	5	small area along Hwy 5A
24	6	covers a large portion of Nicola Bay Resort
26 to 28	7	includes Nicola River Mouth and portion of Hwy 5A
29, 30	8	Old Nicola Trails and a portion of the Quilchena wetland
32, 33	19	area surrounding the Quilchena Creek mouth
33 to 35	9	area surrounding the Quilchena boat launch
37, 38	11	overlaps wetland

Segment No.	CSA No.	Area Description
38, 39	12	overlaps wetland
39	13 - 15	overlaps wetland and emergent vegetation near Nicola River outflow
39 to 41	16	covers large wetland

4.5 Watershed Land Use

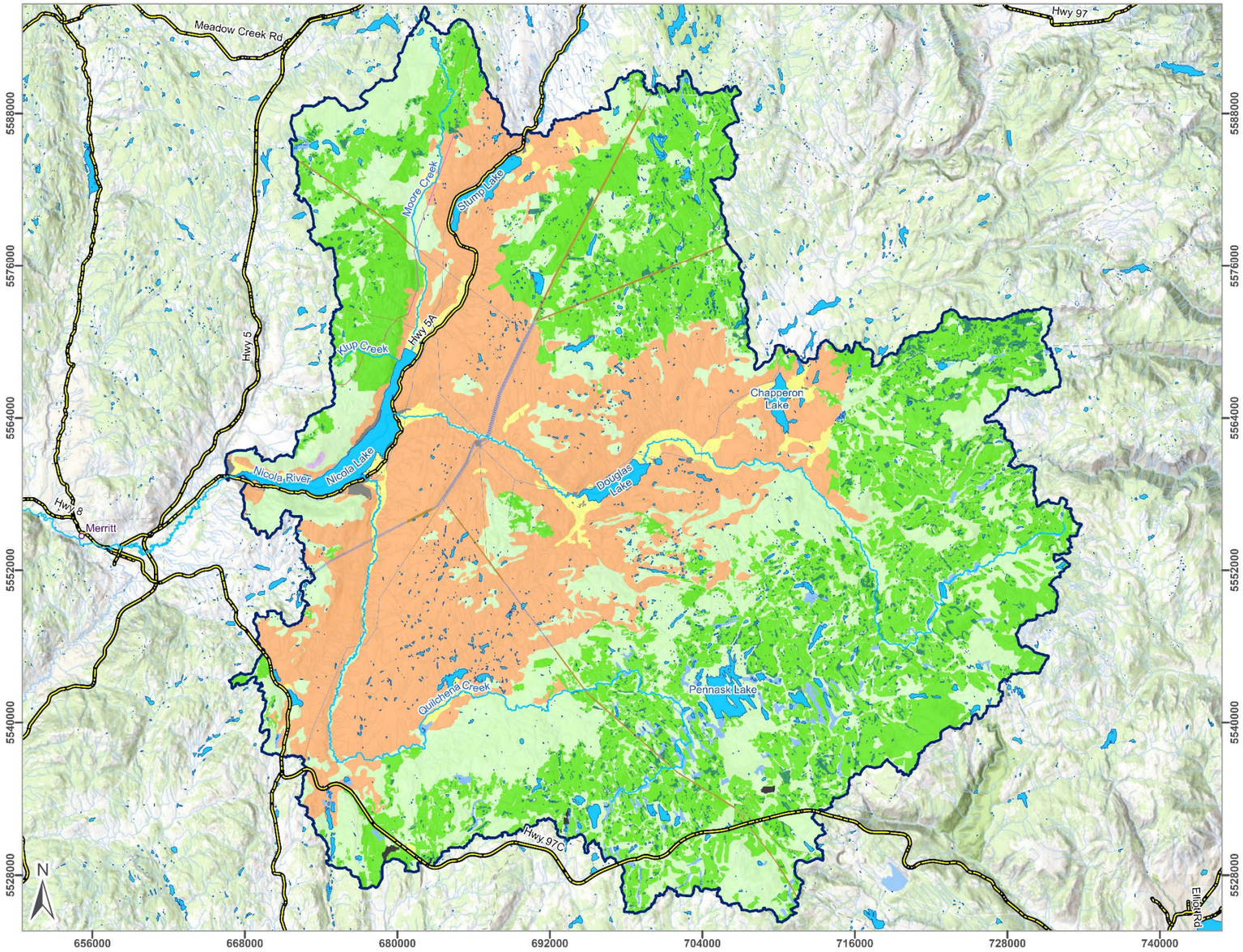
The Nicola Lake watershed is composed of the Upper Nicola River, Quilchena Creek, Stumplake Creek, and Moore Creek sub-basins. There are two unnamed sub-basins located within the Nicola Lake watershed. One of them is the entire drainage area on the north-west side of the lake including Klup Creek. The other one is between the Quilchena and Upper Nicola River watersheds.

Nicola Lake watershed is largely dominated by historic and recent forestry cutblocks (33.1%) and range lands (29.7%) (Table 14). Other land uses with greater than 1% watershed coverage include agriculture (2.1%), and forestry reserves (1.9%). The sub-basins of Quilchena Creek, Upper Nicola River, and Stumplake Creek have primarily agriculture and range land uses at lower elevations and some forestry activities and natural forest at higher elevation (Figure 18). The primary land use in the sub-basins west of Nicola Lake (Unnamed and Moore) is forestry with some range use surrounding the shores of Nicola Lake.

Table 14: Summary of land use types in Nicola Lake watershed.

Land Use Type	Percent Watershed Area
Recreation	0.01
Oil and Gas Infrastructure	0.04
Mining and Extraction	0.06
Urban	0.21
Rights-of-Way (ROW)	0.27
Dams and Transmission	0.40
RESULTS Reserves	1.90
Agriculture and Clearing	2.10
Range Lands	29.70
Cutblocks	33.10

NICOLA LAKE WATERSHED HUMAN DISTURBANCE



NICOLA LAKE FIMP ASSESSMENT AND UPDATE

- Cities
- Fresh Water Atlas - Streams
- Highways
- Lakes
- Nicola Lake Watershed

BC CEF Human Disturbance BTM 2021

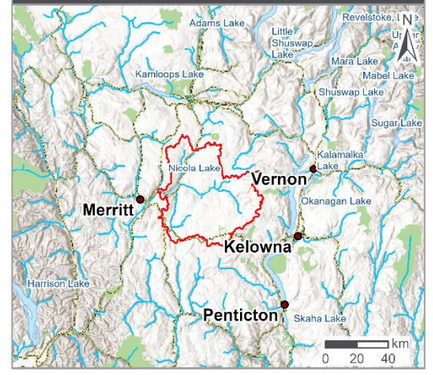
CEF Disturb Group

- 1 Mining and Extraction
- 2 Rail and Infrastructure (rail, airports, etc)
- 3 Oil and Gas Infrastructure (pipeline, ancillary, well sites)
- 4 Power (transmission lines, dams)
- 5 Rights of Way (crown and surveyed)
- 6 Urban or Built-up Areas
- 7 Recreation (ski, golf, etc)
- 8 Oil and Gas Geophysical Lines (seismic surveys)
- 9 Forestry Cutblocks (current and historic)
- 10 Agriculture and Clearing
- 11 Forestry Cutblock Reserves (select reserves)
- 12 BTM - Wetlands and Estuaries
- 12 BTM - Fresh Water
- 12 BTM - Range Lands (grassland, pasture)
- 12 BTM - Salt Water
- 12 BTM - Glaciers and Snow
- 12 BTM - Shrubs
- 12 BTM - Forest Land
- 12 BTM - Alpine, SubAlpine, Barren

References

Basemap: Esri Inc 2024-01-12

LOCATION MAP



1:300,000

0 3 6 9 12 Kilometers

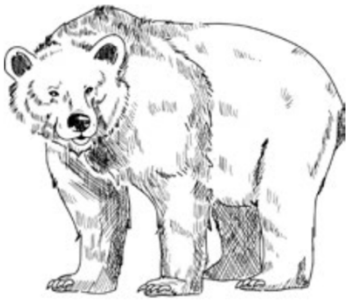
Project No.: 230370
Client: Living Lakes Canada and Upper Nicola Band
NAD 1983 UTM Zone 10N

Date: 2024/05/31
Drawn: MB Check: AP

Figure 18.0

Figure 18: Map of the Nicola Lake Watershed with Baseline Thematic Mapping (BTM) and Human Disturbance Land Classes

5. Discussion



Discussion aligns most with the values of Chief Skəmx̌ist (Black Bear) and Chief Sp̓iɬm̓ (Bitter Root). The writing of the discussion required careful contemplation and reflection on the results and relevant western scientific literature. The results were viewed through a holistic lens that considered connections through space and time.

The ecological and cultural values of the Nicola Lake shoreline have diminished due to extensive ranching, recreational activities, water withdrawal, and foreshore development over the last 100 years. These activities have dishonoured and devalued the sacred nature of Nicola Lake (Kwusen 2024). The 2023 FIMP and the Cultural Overview Assessment have identified large sections of the Nicola Lake shoreline that have important wildlife, fisheries, cultural, and spiritual values that need to be protected from further degradation.

Within TNRD, lakefront subdivisions and Monck Park have reduced ecological and cultural values. The FHSI analysis and Cultural Overview Assessment indicate that the most affected shoreline areas were within Segments 5, 7, 14, and 29. These segments have Moderate ecological values and contain Culturally Sensitive Areas. Intensive recreational use in Monck Park (Segment 5), as well as the ongoing Nicola Estates (Segment 7) and Old Nicola Trails developments (Segment 29), further threaten the ecological and cultural values of these shorelines. The presence of emergent vegetation ZOS in Segments 7 and 29 are of additional concern due to new dock and groyne construction and increased boat traffic.

The FHSI analysis and Cultural Overview Assessment reveal that RV parks on UNB reserve lands and Highway 5A have degraded the ecological and cultural values of the shoreline. Nicola Bay Resort (Segment 24) development severely modified the shoreline area that includes a CSA. The RV Park associated with Segment 26 has modified the Nicola River Mouth, which is an ecological ZOS and a CSA. The FHSI analysis highlights the degradation of ecological values of Segments 23, 27, and 28 by Highway 5A. These segments have Moderate ecological values and contain CSAs. Quilchena boat launch (Segment 34) and Highway 5A (Segment 35) have resulted in degradation of a CSA and grassland ZOS, respectively.

The western side of the lake contains shoreline with High ecological value and CSAs. These important areas should be prioritized for protection to preserve their current values. The segments south of Monck Park (3 and 4) have High ecological values and a CSA that has been minimally disturbed. Segment 6 has been disturbed by Monck Park but retains High ecological value due to the presence of emergent vegetation ZOS. Segments 15 to 18 also have High ecological values and a CSA. Segment 16 features the Klup Creek outlet, riparian community, and associated ZOS.

The shoreline areas with overlapping ZOS and CSA represent areas that have very important cultural and ecological values. These areas include the mouths of Quilchena, Stumplake and Moore creeks that have Very High ecological values. The ecosystem and aquatic vegetation ZOS are associated with CSAs that occur along shorelines at the south end of the lake with High ecological values (Segments 37- 41).

The FHSI analysis identified other areas along natural shorelines and wetlands with High and Very High ecological values. The shoreline of Segment 36 has Very High ecological value and contains ecosystem and aquatic vegetation ZOS. Aquatic vegetation ZOS also occur along Segment 42 that has High ecological value. Natural shorelines with High ecological value dominate the northwestern side of the lake (Segments 9, 11, 13, 15-18).

Like many other BC interior Lakes, Nicola Lake has experienced increased shoreline development pressures since the early 2000s, primarily caused by the establishment of lakefront subdivisions. These pressures persist as of 2023. The Nicola Lakeshore Estates and Old Nicola Trails developments have resulted in a combined incremental loss of natural shoreline since 2011. The rate of change between 2011 and 2023 (12-year period) is 0.08% per year, a trend not uncommon among comparable lakes in BC (Table 15). For instance, Lake Windermere has experienced a rate of change of 0.07% per year between 2006 and 2020 (14-year period). Similarly, these changes were in large part due to the incremental clearings associated with development of single-family lots and construction of shoreline modifications (Schleppe and McPherson 2021).

The loss of natural shoreline in the Nicola Estates and Old Nicola Trails segments (7, 8, and 29) are mostly associated with dock construction and associated shoreline access. Although these developments generally appear to conform to existing regulations, as shown in Photo 7, there are cases where they clearly do not. For example, in Nicola Estates (Segment 7), a concrete boat launch was constructed after the 2011 FIM was conducted. According to the Fishery Protection Covenant (2005), established during the subdivision of Nicola Estates, construction of boat launches is prohibited for residential lots.

Photo 7:Example of typical disturbance from shoreline access and dock construction in Nicola Estates -Segment 8 (August 2, 2023).

Nicola Lake experienced a 33% increase in the number of docks, from 106 in 2011 to 141 in 2023 (an increase of 35 total docks). Such a large increase is not unusual in other similar lakes. Windermere Lake, for instance, saw an even greater increase of 54% from 2006 to 2020. For Nicola Lake, the largest increase in docks is associated with the ongoing development at Nicola Estates (Segment 7) and Old Nicola Trails (Segment 29). The construction of new docks in Segments 7 and 29 have resulted in removal of emergent vegetation. While mooring buoys were not counted in 2011, it's likely that the number of mooring buoys has also increased within these segments, with 105 observed in 2023. These modifications have likely impacted shoreline habitats. The increase in numbers of docks and mooring buoys correlates with the intensification of boat usage. Research indicates that shallow water boating activities near docks and mooring buoys can disturb sediments, uproot plants, and adversely alter water quality (Sagerman et al. 2020).

There is a discrepancy between the increase in the number of retaining walls (40%) and in the corresponding shoreline length occupied by these walls (15%). This inconsistency is likely due to measurement inaccuracy in both the 2011 FIM survey and the current assessment. The challenge of accurately counting retaining walls in densely populated RV Park developments, such as Segment 24, can lead to overestimating their quantity, as previously reported in other FIM updates (Schleppe and McPherson 2021). One prospective approach for future assessments could involve recording retaining walls as spatial lines rather than counting with a thumb counter.

The density of docks observed at Nicola Lake in 2023 is relatively low (~ 2.7 docks/km). However, there are segments with higher dock densities, some of which exceed 10 docks/km. High dock densities are known to diminish habitat values by reducing the structural habitat complexity through removal of large woody debris, emergent vegetation, and natural substrates (Dustin and Vondracek 2017). Nicola Estates (7) and Old Nicola Trails (29) are of particular concern with ongoing development because these segments contain aquatic vegetation ZOS that could be further degraded by dock construction.

Comparing Nicola Lake with other lakes surveyed under FIM that share similar size and complexity highlights the uniqueness of Nicola Lake and its surrounding watershed. About one third of the Nicola Lake shoreline has agriculture as the predominant land use (Table 15), which is the highest proportion of this land use among all other FIM surveyed lakes in the Okanagan and Columbia basin. The high percentage of agricultural land use, at both the shoreline and watershed scale, potentially affect the water quality in Nicola Lake. A recent study of 664 Canadian lakes showed that lakes with watersheds exceeding 30% agriculture land had poor water quality characterized by high concentrations of ions, nutrients, and carbon (Sánchez Schacht et al. 2023).

Table 15: Comparison of Nicola Lake to Columbia Basin lakes by lake size, land use, and rate of change.

Metric	Nicola Lake	Windermere Lake	Columbia Lake
Surface Area (ha)	2500	1610	2500
Lake Shoreline (km)	37.4	51.7	39.6
Number of Segments	42	40	8
Predominant Land Uses	Agriculture (32%)	Transportation (32%)	Conservation (58%)
	Transportation (25%)	Single-family (30%)	Transportation (35%)
	Rural (14%)	Natural Area (15%)	Rural (5%)
	Single-family (14%)	Rural (12%)	Urban Park (2%)
% Natural Shoreline	49	57	59
Survey Year	2011	2006	2009
Re-Survey Year	2023	2020	2021
Rate of Change per year (%)	0.08	0.07	0.02

Data for Windermere and Columbia Lake obtained from Schleppe and McPherson 2021 and Wood 2022

TNRD has long recognized Nicola Lake as an important lake that needs to be protected. Through the years policy and regulation were introduced to preserve the environmental quality and cultural values of the shoreline. The 2004 Lakeshore Development guidelines were effective at preserving riparian habitat. However, emergent vegetation has since been lost due to dock construction and important cultural values were not respectfully considered during development. The effective protection of both ecological and cultural values at Nicola Lake requires a 'Two-Eyed Seeing' approach to foreshore management. This collaboration and action-oriented approach applies the science-based tools provided by FIMP to work on healing our relationships with tmix^{w}.

6. Recommendations

Recommendations were developed by respecting the Chief N'tyxtix (King Salmon) and Chief Siyaʔ (Saskatoon Berry) values, which embody the equally important action-oriented and innovative approaches required for the compilation of the FHSI data with Indigenous values. Collaboration between UNB, LLC, and government representatives aligns with Chief Sp̓iʔm̓ (Bitter Root) values. Recommendations that encompass Chief Black Bear values are related to Traditional and cultural significance.

Broad and consistent recommendations for assessed lakes in BC have emerged over the past three decades. The recommendations provided in this report follow the guidelines and lessons learned summarized in the draft Foreshore Integrated Management Planning (FIMP) in the Upper Columbia Basin: Final Project Evaluation and Summary of Achievements (2023) provided by LLC.

Recommendations are intended to provide guidance related to shoreline developments and activities, ZOS, CSAs, and FHSI ranked shoreline segments. In general, these recommendations focus on protecting existing fish, wildlife, cultural and water quality values, restoration of riparian and foreshore habitats during re-development, and enhancement opportunities. In keeping with the Framework, the recommendations are organized in relation to the associated Food Chief values.

6.1 Chief Sp̓iʔm̓ (Bitter Root) – Relationships

The relationship values associated with Chief Sp̓iʔm̓ (Bitter Root) align with recommendations pertaining to communication, collaboration, and meaningful engagement between First Nations and government representatives. Indigenous governance land use decisions consider the wisdom of three generations past, the present generation, and the impact on three generations to come. Management of land and water are understood as a sacred responsibility and resources are not to be used at will. To achieve this requires relationships built on trust between First Nations governance and other levels of government.

The recommendations summarized below are intended to improve communications between First Nations and local and provincial governments and to promote meaningful engagement and shared decision-making responsibilities for activities that present a risk to Nicola Lake values.

Local Governance - A functional relationship between First Nations and TNRD is important to promote engagement, dialogue, and a shared responsibility in decision-making at the local government level.

- Collaboration should be prioritized amongst local government and First Nations to develop a process facilitating early engagement when a development application or proposal is received. This may involve local government or the proponent submitting a project description to First Nations for review and oversight during the early stages of proposal.
- Collaboratively develop a Terms of Reference (TOR) for environmental and archaeological assessments. This will provide guidelines for QEP to assess values and prescribe mitigation measures to avoid important features, as well as expectations associated with restoration or conservation of existing cultural and environmental values.

Provincial Governance - A relationship between First Nations and provincial government representatives as equals is important to foster meaningful engagement and shared responsibility in decision-making related to land use and development on Crown Lands. The Framework describes a Nicola 'Government to Government' Forum that may be suitable for facilitating frequent and open communication with local First Nations.

- Develop a formal process for joint or consent-based decision-making regarding Crown Land development applications around Nicola Lake. First Nations, the forum, and provincial representatives should be engaged to meet the BC Declaration on the Rights of Indigenous Peoples Act (DRIPA), particularly as it relates to the importance of Indigenous decision-making within the provincial statutory framework.
- Applications for proposed land use changes or development on Crown Land that overlap ZOS, CSA, and/or High and Very High ecological value areas surrounding Nicola Lake should trigger the need for environmental and archeological assessment by independent and appropriately qualified professionals.
- First Nations should be compensated to participate with the province in setting the Terms of Reference (TOR) or parameters involved in Crown Land assessments, as well as in the review of results and decision-making, which may include setting permit conditions or expectations.
- Bring all communities on the conservation journey to protect the Nicola Lake values they all enjoy. Educational initiatives should include:
    - Collaboratively work to promote public stewardship, education, outreach, and landowner incentives to maintain, restore, or enhance riparian and foreshore habitats. This may include using an incentive-based program to support the restoration of shorelines in privately-owned areas that have been heavily modified (e.g., Nicola Estates, IR lands, etc.).
    - Provide educational materials and outreach to foreshore property owners with information about avoidance of activities that can harm Nicola Lake such as fertilizing lawns, powerboating near shore that disturbs sediments, both of which releases nutrients that fuel cyanobacteria blooms.
    - Locate funding for riparian restoration and fencing through ranch lands such as “Farming grants” to reduce tributary nutrient loading.

6.2 Chief Skəmx̌ist (Black Bear) – Tradition

The traditional and contemplative values associated with Chief Skəmx̌ist (Black Bear) help frame the recommendations related to Indigenous Knowledge, historical context, and areas of cultural significance. As noted in the Framework, a clear understanding of the past will help form future development processes. The recommendations and action items provided in this report must be approached in alignment with the Framework and Traditional values.

- The information and knowledge-sharing components of this project have been key to developing a common understanding of values and concerns related to Nicola Lake. Future Nicola Lake FIMP assessments and updates should include a similar scope to account for:
    - A place-based meeting;
    - At least one information sharing or teaching session, held in-person or online;
    - At least two follow-up meetings to review and discuss the draft FIMP report.
- The research and interviews conducted by Kwusen within the UNB communities provide important historical, cultural, and spiritual context to the Nicola Lake setting. The summary memo and mapping of CSAs completed by Kwusen (2024) provides a means to influence development protocols with Indigenous Knowledge.
- Consider a sediment sampling program at Nicola Lake like the program underway at Douglas Lake, to better understand the nutrient budget and lake change over the last 100 years. Other paleo-reconstructions could also assist in the establishment of ‘baseline’ pre-colonial conditions.

- First Nations should continue to share knowledge and Tradition, including the oral history of the Four Food Chiefs with partners, consultants, and community members to relate those values to the conservation and management of Nicola Lake.
- First Nations should continue to involve community elders and youth in restoration and enhancement activities to foster knowledge sharing. Technical efforts and data collection should also involve youth and community members to facilitate a transfer of technical knowledge to the community, as well as Indigenous Knowledge to third-party technical professionals.

6.3 Chief Siyáʔ (Saskatoon Berry) – Innovation

Chief Siyáʔ (Saskatoon Berry) represents innovation and supports a creative approach to complex problems. Although the conventional FIMP process is designed to be easily replicable and comparable by using a quantitative methodology, the project team has made efforts to follow the Framework and the teachings provided by UNB to deliver a FIMP that considers Indigenous Knowledge and Traditional values alongside the scientific metrics. The results of the Nicola Lake FIMP have highlighted the unique lake and watershed characteristics which require a unique approach to management.

- Like other small eutrophic lakes in BC, Nicola Lake is at increasing risk of a lake 'squeeze' where the anoxic deep-water zone extends to the very warm surface zone, leaving no salmonid habitat. Aerial drone surveys with thermal imaging capability could be completed to identify foreshore littoral areas with upwellings may provide crucial spawning habitat and thermal refugia. Adding this feature alongside Indigenous Knowledge of fish distributions in summer will support future FIMP projects and efforts to protect critical shoreline habitats. This work may indicate the need for development of aerated refugia.
- First Nations and the provincial government should use existing tools to consider and plan for the cumulative-effects of climate change, shoreline development, invasive species, and water withdrawal. Existing tools include the Nicola watershed hydrological model and provincial Cumulative Effects Management Framework (CEMF).

6.4 Chief N'tyxtix (King Salmon) – Action

The action-oriented values associated with Chief N'tyxtix (King Salmon) are conducive to recommendations that focus on potential mechanisms to protect and enhance the cultural and ecological values. Action items are focused on direction and guidance regarding land acquisition, areas for potential protection mechanisms through land use agreements, restoration, and enhancement.

- Establish protection mechanisms on Crown Lands with identified ZOS, CSA, High and Very High ecological value shoreline areas. Possible protection mechanisms may include:
    - Wildlife Habitat Areas (WHA) or Wildlife Management Areas (WMA);
    - Strategic Land Use Zones and Protected Areas, such as Conservancies, Cultural Wildlands, and/or Cultural Management Areas;
    - Joint wildlife governance under Section 7 of the 2019 Declaration on the Rights of Indigenous Peoples Act (Declaration Act);
    - Other forms of protected areas, as defined in federal funding programs, such as Indigenous Protected and Conserved Areas (IPCA) or Other Effective area-based Conservation Mechanisms (OECM).
- Establish OECM for CSAs that are culturally appropriate and enable First Nations to maintain, protect, and have access to cultural sites.

- Establish conservation covenants for CSAs 3, 4, 5, 17, and 18. These areas are recommended for conservation covenants because they are smaller areas that are outside of IR lands. The conservation covenants need to ensure First Nations have access to these CSAs.
- Establish conservation zones on the area South of Monck Park (Segments 3 and 4) and the Northwestern part of the shoreline (Segments 15 to 17) by private land acquisition and culturally appropriate conservation measures. The protection of this area is essential due to its High ecological value and cultural significance.
- Consider acquisition or a conservation agreement for private land southeast of Quilchena boat launch to protect CSA and rare occurrence ZOS.
- Conduct restoration/enhancement works in the wildlife ZOS of Upper Nicola River, Moore Creek, and Stumplake Creek. First Nation consultation will be required due to the CSAs associated with these areas. Restoration measures should include re-planting riparian communities and improving the shoreline resiliency to flooding and shoreline erosion with bio-engineering methods. Planting of native cottonwood trees and willow shrubs between agricultural lands and shoreline habitats helps intercept nutrients.
- Work with the local agriculture community to restrict access of cattle in shoreline areas with ZOS, and/or Very High and High ecological value.
- The shoreline areas that are ranked as Very High, and High ecological value by FHSI analysis, or contain ZOS must be avoided by future land use or development.
- Construction of marinas and new concrete boat launches should be prohibited in any area of Nicola Lake. These proposed developments have larger impacts on the foreshore and riparian values of the sensitive Nicola Lake ecosystem.
- Conduct invasive plant species management mapping and identification of problem areas that require management or prescriptions. Management of invasive species such as Yellow Perch should avoid the use of pesticides (e.g., Rotenone) and instead focus on adaptive management or managing them as a food resource.
- Data sharing agreements should be established with First Nations to gather existing SAR survey data on Lewis’s Woodpecker, Great Basin spadefoot, and American badger.

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FIM Maps

FDG Maps