Fraser Lake – Nadleh Bun

Foreshore Integrated Management Plan – 2023

Prepared for:

Living Lakes Canada

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EXECUTIVE SUMMARY

A Foreshore Integrated Management Plan (FIMP) for Fraser Lake was completed by Masse Environmental Consultants Ltd in 2023. This project collected a detailed inventory of the foreshore of Fraser Lake, and identified foreshore habitat values, habitat sensitivities, and impacts from existing foreshore developments. Another main objective of the 2023 FIMP was to update data collected from the original Foreshore Inventory and Mapping (FIM) conducted in 2011 and document the rate of change along the lake foreshore over a period of 12 years. The information presented in this report will provide guidance to governments and developers on future lake foreshore developments while sustaining healthy aquatic and riparian ecosystems.

Fraser Lake is a 5,386 ha lake located in the Regional District of Bulkley-Nechako (RDBN) Electoral Area "D", approximately 42 km west of the Municipality of Vanderhoof and 68 km southeast of the Village of Burns Lake, in Central British Columbia. Communities around the lake include the Village of Fraser Lake near the west end of the lake, the Stellat'en First Nation west of Fraser Lake and the Nadleh Whut'en First Nation east of Fraser Lake. The Fraser Lake watershed drains a large area (~5,880 km^2) and includes the Fraser and Burns/Decker Lake and the François/Tchesinkut sub-drainages.

Fraser Lake supports a diversity of fish species including Burbot, Bull Trout, Kokanee, Lake Trout, Largescale Sucker, Mountain Whitefish, Northern Pikeminnow, Peamouth Chub, Prickly Sculpin, and Rainbow Trout. It also provides critical rearing and overwintering habitat to the Nechako White Sturgeon population, which has been ranked as Endangered under Schedule 1 of the federal Species at Risk Act (SARA) and by the Committee on the Status of Endangered Wildlife in Canada and provincially ranked as imperiled. Fraser Lake is also used by Sockeye and Chinook salmon primarily as a migration corridor to and from spawning areas, but may also use the lake for rearing in some cases (M. Glavas, pers. comm). Three populations of Sockeye and two populations of Chinook are known to have current or historic use of the lake.

Field surveys were conducted from August 7 to 11, 2023 to inventory and describe the land use, shoreline modifications and biophysical attributes along 70.93 km of lake foreshore, defined into 57 segments. More than half of the shoreline was in natural condition (65%, 46,453 m), while the remainder was disturbed (35%, 24,475 m). The predominant level of impact for lake shoreline was high (36.8%), followed by medium (30.6%), low (20.3%), and none (12.3%). Highly impacted areas were generally associated with areas of dense residential developments, the CN railway that runs along the entire length of the lake on the south shore, roads, and areas that had been cleared for agricultural/rural land uses. Other alterations included erosion protection (mainly retaining walls and groynes), substrate modification (fill placement and beach clearing), docks, pilings, buildings/sheds, sitting platforms, mooring buoys and boat launches.

Aquatic vegetation was present in all but one segments, covering approximately 31,285 m (44.1%) of the littoral zone of Fraser Lake with variable cover (ranging from 5% to 100% cover),.. The predominant aquatic vegetation consisted of submergent vegetation (28.5%) and emergent vegetation (26.9%), and floating vegetation with only 2.7%. The highest density of aquatic vegetation was associated with Segments 2, 4, 36 and 37.

The dominant substrate along the foreshore consisted of cobble (20.6%), boulder (18.8%), gravel (17.3%) and sand (17.0%) followed by fines (8.3%), mud (7.3%), organics (6.4%) and bedrock (4.3%), while the substrate in the littoral zone was dominated by sand (22.4%) and cobble (20.2%), followed by fines (14.0%), boulder (13.7%), mud (12.6%) gravel (9.9%), organics (4.1%) and bedrock (3.1%). Large woody debris was present on the foreshore of 52 of the 57 segments, and was most abundant in Segments 8, 3, 43, 14, 18 and 5 (in order of abundance). Most of the Fraser Lake shoreline (54.4%) had a wide littoral zone (>50 m). Medium (10-50 m) and narrow (<10m) littoral zones were present over 26.3% and 19.3% of the shoreline, respectively. The widest littoral areas were associated with Segments 37 and 38 at the east end of the lake where the littoral zone width reached up to 400 m; Segments 1 and 2 on the south shore of the lake downstream of the outlet of the Stellako River where the littoral zone reached up to 165 m; and Segment 7, which was 150 m.

Comparison between the 2011 and 2024 FIM surveys indicated that the total length of disturbed shoreline increased by 1,859 m (~2.6%), representing an annual increase of 155 m or 0.2%.

Shoreline habitat sensitivities were determined using a ranking index (Foreshore Habitat Sensitivity Index, or FHSI) that incorporated criteria from biophysical data collected in the FIMP, fisheries values, terrestrial/ecosystem values, and shoreline modifications. The criteria and ratings used from the original study were adjusted to reflect current methods and adjusted weights were applied to the criteria based on the conditions observed. Most of the shoreline had an ecological rank of Very High (26.9%), followed by High (24.6%), Medium (21.6%), Very Low (15.5%), and Low (11.4%).Thirteen segments had a different shoreline ranking between the surveys, however ten of these changes were mainly attributed to differences in interpretation of categories for vegetation bands B1 and B2 between surveys, which generally resulted in a higher calculated FHSI value in 2023. Three segments were reclassified to a lower FHSI value based mainly on differences attributable to recent development activities, and driven by an increase in shoreline modifications counted in 2023 compared to 2011.

Five Zones of Sensitivity (ZOS), which are defined as specific areas that provide important habitats to either species or general ecosystem function, have been identified for Fraser Lake. These areas consist of Stream Mouths, Wetlands, Shallow/Wide Littoral Zones, and two provincially-blue listed ecosystems

(Douglas-fir lodgepole pine / clad lichens and black cottonwood-hybrid white spruce / red-osier dogwood). Recommended Conservation Zones include the outlet of Stellako River into Fraser Lake, the lake outlet into Nautley River, the mouth of Ormond Creek, Huntly Island, and the mouth of Stern Creek and the associated wetland area at the west end of Simon Bay. Ellis Island is recommended for continued designation as a provincial ecological reserve.

The following recommendations are included for consideration for the protection of sensitive habitats around Fraser Lake:

1. Protection of zones of sensitivity (ZOS);
2. Designation of conservation areas;
3. Update the RDBN and Village of Fraser Lake OCPs with the results of the FIMP;
4. Establish a Waterfront Development Permit Area under the RDBN and Village of Fraser Lake OCPs, and any Land Planning Processes within Stellat'en and Nadleh Whut'en Reserves;
5. Implement a collaborative permitting process for the WDPs;
6. Conduct a formalized archaeological assessment and develop a local Chance Find Procedures document;
7. Implement a co-governed compliance and enforcement committee;
8. Consider climate change during foreshore planning;
9. Educate landowners regarding waterfront property protection, permitting processes, and stewardship;
10. Post signage around the lake encouraging responsible boat use;
11. Encourage communal boat launches and shared docks;
12. Prohibit the placement of mooring buoys and docks in wetland and stream mouth ZOS;
13. Manage livestock access in front of waterfront properties;
14. Encourage riparian restoration efforts in disturbed areas;
15. Protection of freshwater mussels; and
16. Complete a lake wide mussel survey to determine the extent and distribution of mussels throughout the lake.

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Living Lakes Canada Mission Statement

Living Lakes Canada 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. Our mandate is to help Canadians understand, adapt and mitigate the impacts of climate change to water quality and quantity, biodiversity and healthy human communities through grassroots water stewardship activities. Living Lakes Canada bridges the gap between science and action to foster and normalize citizen- based water stewardship.

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1 INTRODUCTION

Masse Environmental Consultants Ltd. (Masse) was retained by Living Lakes Canada to complete a repeat Foreshore Integrated Management Plan (re-FIM) for Fraser Lake in 2023. The FIMP methodology was developed to assess the impacts of foreshore developments on lakes across British Columbia, providing a standardized method (Schleppe et al 2020). The purpose of the FIMP is to identify lake foreshore habitat values, habitat sensitivities and impacts from foreshore developments. The FIMP process can also be repeated and used to determine the rate of change along a lake foreshore over time. This information provides guidance to land managers during foreshore development, while sustaining healthy aquatic and riparian ecosystems.

Fraser Lake was previously surveyed in 2011 (Drieschner and Schleppe 2012). The survey conducted in 2023 updates data collection to the current FIMP standardized methods, assesses the current status of the foreshore, and allows for changes since the 2011 survey to be estimated.

2 BACKGROUND

2.1 Setting

Fraser Lake is a 5,386 ha lake located in the Regional District of Bulkley-Nechako (RDBN) Electoral Area "D", approximately 42 km west of the Municipality of Vanderhoof and 68 km southeast of the Village of Burns Lake, in Central British Columbia (Figure 1). Communities around the lake include the Village of Fraser Lake near the west end of the lake, the Stellat'en First Nation west of Fraser Lake and the Nadleh Whut'en First Nation east of Fraser Lake. Fraser Lake has a surface area of 54 km^2, mean depth of 13.4 m, maximum depth of 30.5 m, and volume of 725,287,400 m^3 (RDBN 2009). The Fraser Lake watershed drains a large area (~5,880 km^2) and includes the Fraser and Burns/Decker Lake and the François/Tchesinkut sub-drainages. The main inlet of the lake is the Stellako River which flows through the François/Tchesinkut sub-drainage, is ~13.5 km long and flows into Fraser Lake at the west end. The Nadina River, with a length of 63 km, is the main inlet of François Lake. The Endako River, which flows through the Burns/Decker Lake sub-drainage, is ~106 km in length and flows into the Stellako River ~ 4 km upstream of Fraser Lake contributing to the inflow into Fraser Lake. In the summer, the west basin of Fraser Lake is typically 1-2 °C cooler compared to the central basin of the lake, likely attributed to inflow of cold water from François Lake (Jacklin and Carmichael 2002). Land use activities in the François and Tchesinkut drainages are believed to have little influence on the water quality in Fraser Lake due to the attenuation effects of both large lakes (Jacklin and Carmichael 2002). The outlet of Fraser Lake is located at the eastern end of the lake and flows into the Nautley River which flows for only 900 m before entering the Nechako River, discharging eventually into the Fraser River at Prince George. A hydrological control structure was constructed on the Nautley River just downstream of the Nautley Road bridge in response to the

construction of the Kenney Dam in 1954 on the Nechako River upstream of the junction with the Nautley River, to prevent lake levels in Fraser Lake from dropping as a consequence of lower water levels in the Nechako River (McCarthey 2017). The control structure is located at the same elevation as Fraser Lake and consists of artificial rip-rap that spans the entire river (McCarthy 2017; Photo 1).

Photo 1. Hydrologic control structure downstream of bridge on Nautley River. Photo taken from bridge (Segment 35).

Other small tributary streams that flow into Fraser Lake include Ormond Creek, Stern Creek, and Perry Creek, which flow south into the north side of Fraser Lake, and Robertson Creek, which flows north into the south side of Fraser Lake, as well as a number of unnamed streams.

Fraser Lake is a mesotrophic lake (neither nutrient-rich nor nutrient-poor) with moderate amounts of total phosphorus (Shortreed et al. 1996, Cumming 2001). Phosphorus has been identified as a likely source of occasional algae blooms and aquatic plant infestations, with the aquatic plant Canadian pondweed (*Elodea canadensis*), which has been reported as being especially problematic since the early 1980s (Jacklin and Carmichael 2002).

There is a hydrometric station at the outlet of Fraser Lake on the Nautley River just downstream of the bridge and upstream of the hydrological control structure. Key physical characteristics of Fraser Lake are provided in Table 1.

Table 1. Fraser Lake physical characteristics (Habitat Wizard, 2023).

Parameter	Amount
Elevation	676 m
Surface Area	5,386 ha (53.86 km^2)
Foreshore Perimeter	67.1 km
Drainage Area	~6,030 km^2
Maximum Depth	30.5 m
Mean Depth	13.4 m
Average Width	3.5 km
Approximate Length	20 km
Volume	725,287,400 m^3

2.2 Biogeoclimatic Characteristics

Fraser Lake is situated within the Stuart Dry Warm Sub-Boreal Spruce (SBSdw3) biogeoclimatic subzone/variant (DeLong et al. 1993). The SBS is a montane zone that dominates the landscape in the central interior of British Columbia. It occupies the gently rolling terrain of the Nechako and Fraser plateaus and the Fraser Basin and fingers into more mountainous areas along its western, northern, and eastern boundaries (Meidinger et al. 1991). The SBS experiences a continental climate, characterized by seasonal extremes of temperature, severe, snowy winters; relatively warm, moist and short summers; and moderate annual precipitation. In the Fraser Lake area, dominant bedrock types are volcanics with a variety of Palaeozoic sedimentary rocks. Coniferous forests in the SBSdw3 tend to be mixtures of hybrid white spruce (*Picea engelmannii x glauca*) with lodgepole pine (*Pinus contorta*) and/or Douglas-fir (*Pseudotsuga menziesii*) on drier sites. Subalpine fir (*Abies lasiocarpa*) increases in abundance at higher elevations. Deciduous forests dominated by trembling aspen (*Populus tremuloides*) are common with localized stands of paper birch (*Betula papyrifera*) forests on dry, warm, and rich sites. Black cottonwood (*Populus trichocarpa*) is common along active floodplains of lakes, and major streams and rivers in the area around Fraser Lake.

2.3 Cultural Significance

Fraser Lake (“Nadleh Bun”) and its surrounding areas lie within the traditional territory of the Stellat’en and the Nadleh Whut’en. Both the Stellat’en and Nadleh Whut’en First Nations have reserves on Fraser Lake (“Nadleh Bun”) which are their primary communities. Stellat’en First Nation has its main community located on the Stellaquo Reserve at the west end of the lake at the outlet of the Stellako (Stella) River (“Lhdula K’oh”). Most of the Nadleh Whut’en members reside on the Nautley Indian Reserve 1, at the east end of the lake along the banks of Nautley River (“Nadleh K’oh”). Additional members also reside in Lejac,

which is on the Seaspunket 4 Reserve on the south shore of the Lake. A third reserve, Fraser Lake 2, is located on the north shore of the lake, just west of Nautley River ("Nadleh K'oh").

The community of Lejac is in the same location as the now-closed Lejac Residential School, which ran from 1922 until it was closed in 1976. During this time, thousands of children of Dakelh descent were sent to the school, along with children from several other surrounding communities and nations. Run by the Catholic Church, this school was part of a Canada-wide system aimed at assimilating Indigenous children into Euro-Canadian culture. The conditions and experiences at Lejac were similarly tragic to those in other residential schools in Canada, and the school has left a legacy of intergenerational trauma to their survivors and descendants (Nadleh Whut'en 2023, NCTR, N.D.).

Both the Stellat'en and Nadleh Whut'en First Nations speak a dialect of the Carrier language. Carrier people refer to themselves as Dakelh, which means "people who travel by water". Fraser Lake ("Nadleh Bun") and its surrounding waterways have provided important transportation routes, social and cultural value, and food sources to local First Nations for time immemorial. Both resident fish and anadromous salmon ("talook") are relied upon heavily as a food source. Until the early 1900's, local First Nations used an intricate system of wood stake weirs, or barricades, in shallow areas around the lake to harvest returning sockeye salmon and several other fish species (CSTC 2006). This weir system allowed for a selective and sustainable harvest method, as unwanted fish were able to be released once the desired fish were harvested. In the early 1900s, this weir system was outlawed by the government officials, who thought it to negatively impact commercial fishing stocks, and local First Nations were ordered to use gill nets instead. This decision negatively impacted both the people and fisheries resources, as First Nation members had to completely change their traditional ways of fishing, and as this method does not allow for selective harvest and can negatively impact non-targeted species (CSTC 2006, Reynolds 2016). First Nations today continue to use a combination of both modern and traditional fishing techniques, and are committed to working towards regaining a healthy and sustainable fishery for future generations.

2.4 Land Use and Recreational Use

Fraser Lake is located in the heart of British Columbia on the Nechako Plateau. Lakes and rivers abound in this area, making it a prime destination for outdoor recreational activities and sport fishing. Pioneering of the area by settlers started in the early 1800's with the establishment of a fur-trading post by Simon Fraser, at Fort Fraser in 1806 near the east end of Fraser Lake (FLDHS 1986. The area at the east end of the lake is recorded as the first land cultivated by settlers in BC (BC 2023). The Village of Fraser Lake, located at the west end of the lake, was established in 1914.

Land use around the lake consists of a mixture of single family, recreational, rural, agricultural, municipal, transportation and industrial use. Agricultural activities consist mainly of hobby farming, forage production and open range grazing. Several areas around Fraser Lake are within the Agricultural Land Reserve and contain farming operations (Appendix 1 and 6). Forestry activities are also prevalent in the surrounding area including timber harvesting, and silviculture. A large sawmill (Fraser Lake Sawmills) has been operating on the south shore of the lake at its current location since the late 1970s, however, the permanent closure of the sawmill was announced in January 2024 with the closure scheduled for May 2024. Operations began in 1919 within the Fraser Lake Village, where Whiteswan Park is now located (FLDHS 1986). The south side of the lake is used as a transportation corridor with the CN rail extending along most of its length, with sections directly next to the lake affecting the lake foreshore.

Fraser Lake sees significant year-round and seasonal residential and recreational use. Some of the lakeshore properties are undersized as they were initially created by the Province as recreational lease properties not intended for residential use. Since the creation of these recreational leases, the Province has allowed lease holders to purchase their leases and these areas are now increasingly being used as year-round residences. This has led to water quality issues from undersized, aging and/or failure of on-site sewage disposal systems (RDBN 2009). Failing on-site sewage disposal systems have been identified as likely the highest source of non-point source pollution affecting water quality in the region (RDBN 2009).

Land use designations around the lake are established by the RDNB (2023) and the Village of Fraser Lake (2018) Official Community Plans (OCPs). Shoreline properties within the RDBN jurisdiction (i.e., outside of First Nation reserves and Fraser Lake Village boundaries) are primarily a mix of Residential, Rural Resource, and Agricultural zoning. Most of the waterfront within the Village of Fraser Lake is owned by the Village and has a land use designation of either Waterfront Area, Parks and Open Space, or Village Reserve with some Low Density Residential areas at the west end of the Village. A large industrial area where the Fraser Lake Sawmills has been operating is also within the Village municipal boundary, however it is separate from the main community, located further east along the foreshore of Fraser Lake. The recent announcement of the Fraser Mill closure for May 2024 may provide other industrial opportunities to establish in this area. A detailed list of land use designations by segment is available in tabular format in Appendix 6.

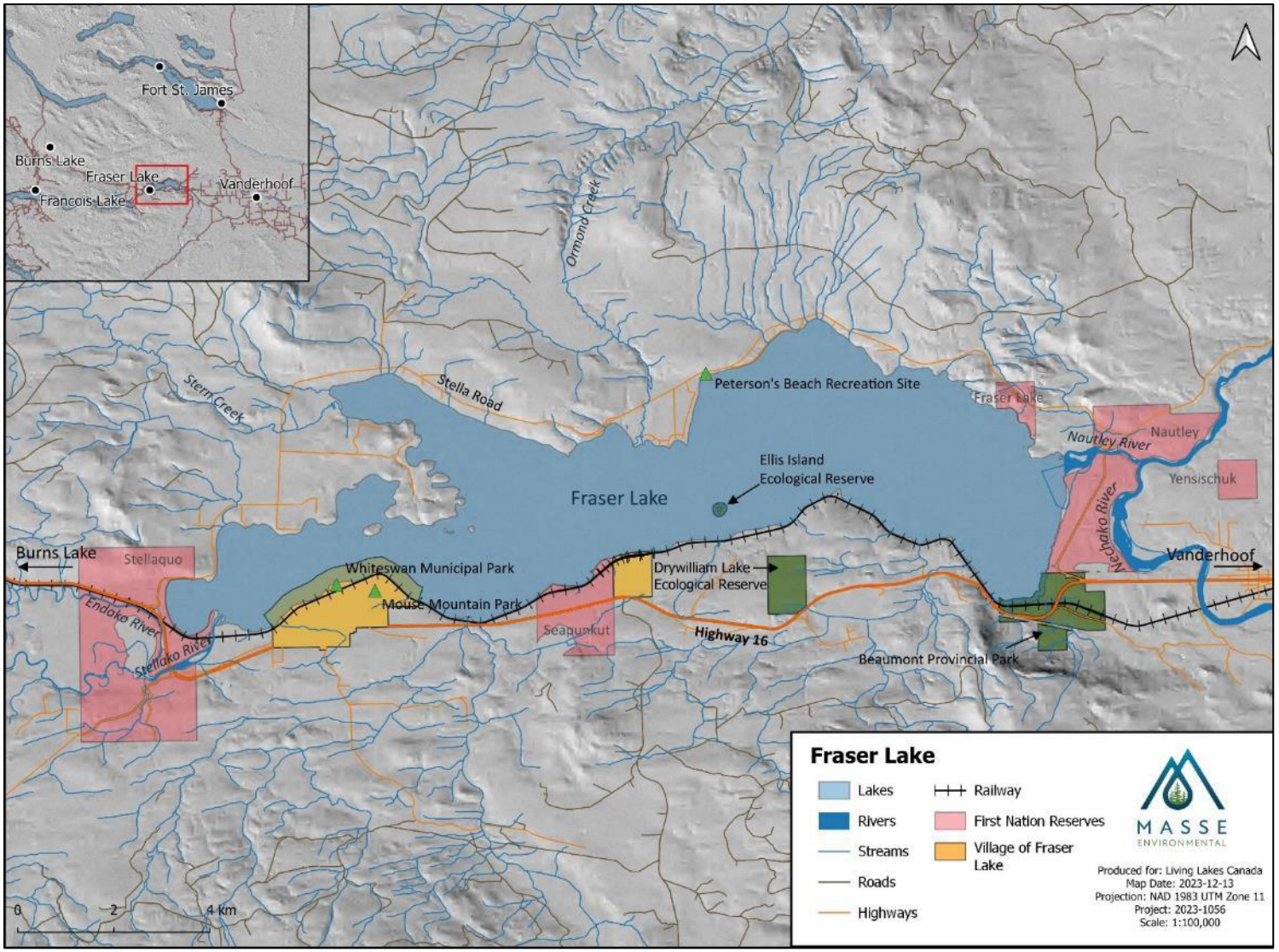

Figure 1. Fraser Lake location map.

2.4.1 Recreational Use

Fraser Lake offers many recreational opportunities including fishing, boating, canoeing, swimming, bird watching, and wildlife viewing. Other recreational activities in the area include hiking, and hunting. Canoeing, rafting and tubing are popular activities on the Stellako River just upstream of Fraser Lake.

There are 3 lakeside camping options around Fraser Lake with public boat launches to the lake: White Swan Park in the Village of Fraser Lake, Beaumont Provincial Park located at the east end of the lake and Peterson's Beach Recreation Site located on the north side of the lake. Piper's Glen Resort, which is privately owned, also offers camping opportunities just west of Beaumont Provincial Park and a boat launch suitable for smaller boats. In addition to the 3 public boat launches, there are several unspecified boat launches along public access roads and private properties.

White Swan Park, located in the Village of Fraser Lake along the shore of Fraser Lake, is a community park that offers walking trails, beach, playground, camping sites (11 RV sites), picnic area and a concrete boat launch. There is also a large pier located at the west end of the park. White Swan Park was the former site of the Fraser Lake Sawmills, which operated at that location from 1919 to the 1970s. Lake infill and remnant pilings are likely vestiges from those operations.

Beaumont Provincial Park was established in 1960. The park has a rich history, as it was established on the site of historic Fort Fraser. The area was traversed by well used trails first by Indigenous Peoples' to trade with other settlements and later by explorers and fur traders that travelled between Fort Fraser, Fort MacLeod and Fort St. James. Today it is a well used park by the public, which offers camping sites (with 49 private sites and 5 walk-in tenting sites), picnic area, a sandy beach, playground and a single lane concrete boat launch.

Peterson's Beach Recreation Site is located in a sheltered bay on the north side of the lake and offers 40 campsites, a sand beach, picnic area, concrete boat launch and hiking trail.

The Stellako and Nechako rivers offer paddlers extensive paddling options for canoeing, kayaking and river floats. The upper part of the Stellako River, from François Lake to a falls located 9 km downstream, is for experts only. The lower part downstream of the falls to Fraser Lake is adequate for beginners. The Nechako River can be accessed for most of its length and is generally considered a beginner class river, with a couple of canyons that are intermediate class, except at high water (Fraser Lake 2023).

There are several hiking trails around Fraser Lake including Mouse Mountain Park, within the Village of Fraser Lake, Fraser Mountain Trail near Piper's Glen Resort, Ormond Creek Trail, located on the north side

of the lake near Peterson's Beach Recreation Site, and Red Rock Mountain, located at the northwest end of Fraser Lake, which leads to an extinct volcano (Fraser Lake 2023).

Sports fishing is a popular activity in the area, with world class fishing along the Stellako River between François Lake and Fraser Lake, especially for Rainbow Trout and during the annual summer salmon runs. Numerous lakes in the area, including Fraser Lake, provide many fishing opportunities. A crown land tenure application was recently submitted for a 565 ha area at the west end of Fraser Lake for the purpose of commercial ice fishing huts on skids to private overnight accommodation for self guided ice fishing on Fraser Lake (Black Press Media 2023).

Wildlife abound in the area surrounding Fraser Lake and provide many hunting opportunities.

2.4.2 Municipal and Industrial Use

The Village of Fraser Lake has operated a community wastewater treatment facility at the west end of the Village since 1967. The facility includes two aerated cells, chlorination facilities, a dichlorination cell, a 400 m outfall, and related appurtenances. The Village of Fraser Lake holds a discharge permit with the Ministry of Environment under the Environmental Management Act (Permit #192), which was amended in 2017 and allows for the discharge of treated effluent into Fraser Lake. The Village of Fraser Lake was recently handed a penalty by the BC Ministry of Environment and Climate Change on December 20, 2023 for multiple instances of non-compliance over the previous two years (Labbé 2024). The Village has added an attenuation lagoon to support the excessive amounts of water during spring freshet and would allow for the additional amount of water to be held in the wastewater treatment facility. The Village is in the process of preparing a quality assurance program that meets regulatory requirements.

Fraser Lake Sawmills, owned and operated by West Fraser Mills Ltd., is a sawmill and bioenergy facility located on the south side of Fraser Lake, with forest licenses in the Lakes and Prince George Timber Supply Areas. At the time of this report, West Fraser Mills Ltd. holds a discharge permit with the Ministry of Environment (Permit #105026), which allows the discharge from the log yard and sawmill treatment systems and discharge of effluent from a planer mill oil/grit separator into Fraser Lake. The log yard and sawmill treatment systems include a runoff diversion system of ditches and culverts, a retention/detention pond, a constructed wetland, an outlet to a combined spillway and related appurtenances. The permit includes best management practices, operation requirements, contingency plan, as well as a monitoring program. These permits will likely be updated since the recent announcement in January 2024 of the permanent closure of the mill scheduled for May 2024.

The Endako mine is one of the largest molybdenum mines in North America and is located 11 km west of Fraser Lake. The mine has been under Care and Maintenance since operations ceased in 2015 due to low molybdenum prices and is authorized to discharge effluent to specified streams under an Environmental Management Act Permit #1307 issued by the Ministry of Environment and Climate Change Strategy (Amended 2022). Environmental impacts from the Endako Mine include effects from the effluent to the aquatic environment of François Lake. The BC Ministry of Environment has determined that elevated levels of contaminants are reaching François Lake and affecting the physiology of fish. Chronic guidelines for the protection of aquatic life were exceeded in the Endako River in both reference and exposure areas for total aluminum, total cadmium and total iron. Federal and provincial drinking water guidelines were exceeded in both reference and exposure areas for colour, and total phosphorus, aluminum, cadmium, iron, manganese, mercury, and zinc. These exceedances have been identified as a concern by local First Nations (CSTB 2014).

The Coastal GasLink pipeline project saw recent construction of the pipeline on the hills north of Fraser Lake as part of the 670 km route from Dawson Creek to Kitimat. In order to support the workers, several camps were constructed along the pipeline corridor, including a work camp at the Lejac property just south of Fraser Lake.

2.4.3 Conservation Areas

The lake is considered an Important Bird Area by Bird Life International (Booth 2001) as it is an important area for fall migrating waterfowl, particularly the American Widgeon (*Mareca americana*), as well as a globally significant wintering site for Trumpeter Swans (*Cygnus buccinator*). Ellis Island (or Seagull Island) was designated as a provincial ecological reserve in 1991 for the protection of gull colonies, especially Ring-billed Gulls (*Larus delawarensis*) and Herring Gulls (*Larus argentatus*). Ellis Island is located near the center of the lake, ~ 600 m from its southern shore. This small island is ~ 0.6 ha in size and consists mostly of bare rock with sparse vegetation including small thickets of aspen-cottonwood stands (BC Parks 1991). Access to the island is not permitted unless a permit is obtained for research and educational activities only.

Drywilliam Lake Ecological Reserve, located south of Fraser Lake, was established in 1975 to preserve a representative stand of Douglas-fir in the SBS Zone for research purposes (BC Parks 1975). The stand includes well-spaced veteran Douglas-fir trees that are large and very old. Associated plants such as redstem ceanothus (*Ceanothus velutinus*) and needle grasses found in the southern part of the reserve occur only in isolated pockets in the SBS Zone. This ecological reserve is open to the public for recreational activities such as hiking, nature observation and photography. Motorized vehicle access is prohibited, as well as activities such as hunting, fishing, camping and foraging.

The Stellako River Wildlife Management Area was established by the Province along the Stellako River from François Lake to ~ 4 km upstream of Fraser Lake in 2011, protecting 503 hectares of river and riparian habitat. The Wildlife Management Area includes two properties owned by The Nature Trust of British Columbia. This area is considered an important area for Rainbow Trout (*Oncorhynchus mykiss*) rearing and is also used by Sockeye (*O. nerka*) and Chinook Salmon (*O. tshawytscha*). The river mouth at Fraser Lake is also important to the red-listed Nechako White Sturgeon (*Acipenser transmontanus*).

3 METHODS

The foreshore inventory and re-assessment of Fraser Lake followed standard methodology presented in the Foreshore Integrated Management Planning Methods (FIMP; Schleppe et al. 2020). The FIMP methodology includes three main components:

1. Foreshore Inventory and Mapping (FIM)
2. Foreshore Habitat Sensitivity Index (FHSI)
3. Foreshore Development Guide (FDG)

This report presents the results and findings of the first two components. The Foreshore Development Guide is provided in Appendix 5.

3.1 Foreshore Inventory and Mapping

3.1.1 Background Review and Pre-field Assessment

A background review was completed to gain a better understanding of the ecological and land use context of the Fraser Lake area. Existing information was collected from the following resources:

- BC Conservation Data Centre (BC CDC)
- EcoCat
- iMap BC / Habitat Wizard
- Global Biodiversity Information Facility
- E-flora BC / E-fauna BC / E-Bird
- iNaturalist
- British Columbia Wildlife Survey Inventory data
- Regional District of Bulkley-Nechako (RDBN) informational brochures, Official Community Plans (OCP) and Zoning Plans and Mapping
- Village of Fraser Lake Official Community Plan
- Ecoscape 2012 FIM report
- Google Earth imagery

The original segment breaks assigned in the 2011 survey were retained with the exception of four segments:

- The break between Segments 23 and 24 was adjusted to better capture the alluvial fan associated with Ormond Creek.
- Segment 45 was subdivided into two segments to account for industrial land use and different shoreline characteristics present on the eastern portion of the original segment.
- Segment 48 was subdivided into 2 segments to account for different topography and shoreline characteristics associated with Mouse Mountain in the western portion of the original segment.

3.1.2 Field Surveys

Field surveys were conducted on August 7 and 11, 2023, to inventory and describe the land use, shoreline modifications and biophysical attributes along the lake foreshore. The shoreline is defined as the area from the edge of the pelagic regions (or limnetic/open water areas) of the lake to an area up to 50 m past the high water mark (HWM) in the upland/riparian zone (Schleppe et al. 2020). This includes the littoral, foreshore, and upland zones. The littoral zone consists of the area below the low water mark (LWM) to a point where light penetration to the bottom of the lake no longer occurs, the foreshore zone consists of the area between the approximate LWM and the HWM, and the upland zone consists of the terrestrial environment above the HWM (Schleppe et al. 2020). The core survey team consisted of Sylvie Masse, MSc, RPBio; Tyson Ehlers, BSF, RPBio; Renae Mackas, RPBio; and Beth Newbery, BSc, BIT. Weather conditions were ideal for the surveys with warm temperatures and clear skies. The entire foreshore was surveyed from a jet boat (Yukon Thunder Jet), operated by Wayne Salewski, travelling at a slow speed generally 20-30 m from the shoreline, however, shallow waters and abundant aquatic vegetation prevented getting close to the shoreline in some areas.

A handheld GPS (Garmin 661) and iPad loaded with Avenza Maps were used for georeferenced data collection. Representative geo-referenced photos were taken for each segment with an iPhone 12. Special features were also photographed using an Olympus TG-6 camera. All data and field observations, such as wildlife and habitat features, were recorded directly into an MS Excel spreadsheet with the data dictionary during field work. The maximum depth of the littoral zone was measured by determining the depth of light penetration using a Secchi disk.

3.1.3 Unpiloted Aerial Vehicle (UAV) Survey

Aerial videography and photography were collected for each segment using a DJI Phantom 4 (Masse) drone and a DJI Mavik 3 Enterprise (Airrays Drone Services) drone from August 9 to 11, 2023. The segments were identified in the field by the drone operator using digital maps and all segments around the lake were filmed, including islands. Drones were flown from the boat for most segments, and

occasionally from the shoreline where accessible. Georeferenced video footage was collected throughout the survey period at elevations not exceeding 122 m above ground. The operator adjusted the height and angle of the drone and camera to appropriately capture the width of the shoreline and any relevant features or disturbances that could not be assessed from the height of water during the surveys on the boat.

Video processing was completed using two programs; DJI Telemetry Overlay and Adobe After Effects. Telemetry files were extracted from the video files in order to overlay gauges such as a compass, a GPS path with UTM coordinates, and a base map for locational reference. Once the videos were overlaid with the gauges, the videos were completed in Adobe After Effects to overlay the title and logo, as well as complete any additional editing. A video editing workflow document, including recommendations, has been provided for these programs.

3.1.4 Communications with Stellat'en and Nadleh Whut'en First Nations

The FIMP process recognizes the importance of integrating cultural knowledge and consultation with the Indigenous Peoples that have inhabited these areas for time immemorial. As part of this assessment, LLC corresponded with Nadleh Whut'en staff members Beverly Ketlo, Brittani Ketlo, Pamela Ketlo and Kirsten Chapman, as well as Isaiah Reynolds, Environmental Monitor Supervisor and Fisheries Coordinator of Stellat'en First Nation. The purpose of these meetings was to collaborate on the project, align project goals with ongoing and local initiatives, and to gather information regarding traditional values and areas of concern for Nadleh Whut'en and Stellat'en peoples. Isaiah Reynolds and Nadleh Whut'en community member, Serina Greene, accompanied the core survey crew for a portion of the surveys, and provided input regarding values of areas and features around the lake. As part of the mapping exercise, Stellat'en and Nadleh Whut'en First Nations were asked to identify areas of culturally valuable zones that warrant appropriate and collaborative considerations for development.

3.1.5 Data Analysis

Data analyses were completed with a combination of MS Excel and R. Biophysical attributes of the foreshore are presented in tabular format and graphs were created to represent percentage of each category for the entire lake foreshore (see Section 4, results). Categories selected include:

- Percent of natural and disturbed shoreline;
- Percent of natural and disturbed shorelines for each shore type segment class[1];
- Percent of natural and disturbed shorelines for each land use segment class[1];
- Substrate type;
- Aquatic vegetation;
- Shoreline modification; and
- Level of impact.

Mapping and spatial analyses were completed using QGIS. All results are presented on the Foreshore Inventory Maps in Appendix 1 and in the Segment Summaries in Appendix 2. JPEG photographs and geo-referenced videos of the foreshore are provided as attachments to this report.

3.1.6 Comparison of 2011 FIM and 2023 re-FIM Datasets

The 2011 and 2023 datasets were reviewed and differences between years were assessed for each segment. Comparisons focused mainly on biophysical attributes that have the potential to change over time rather than the more static categories (for example land use, shore type, substrate type, and littoral zone widths). However, since the FIM methodology developed by Schleppe and Mason (2009) was revised by the technical committee in 2020, some of these categories may have been reclassified due to updated definitions and interpretations in the current methods and are described in the results.

The following shoreline categories were selected for comparison between the 2011 and 2023 datasets:

- Natural vs. disturbed shoreline.
- Land use.
- Aquatic vegetation.
- Level of impact.
- Shoreline modifications.

[1] Note that the dominant segment classifications for shore type and land use (rather than the proportion of these categories for each segment) were used to evaluate the proportion of the segment that was natural or disturbed.

The rate of change analysis was completed by comparing the proportion of natural shorelines to disturbed shoreline over the lake total shoreline and for each segment. An annual rate was then estimated. At the time of this report, photographs and video footage from the 2011 survey were not available. Changes observed in the data were summarized by segment by comparing historic (2012) and current (2023) ortho imagery available through Google, as well as still photos and drone footage from the 2023 survey.

3.2 Foreshore Habitat Sensitivity Index

A Foreshore Habitat Sensitivity Index (FHSI) is an analytical framework used to determine the habitat value or environmental sensitivity of a shoreline segment. The output of the analysis assigns one of five potential "Ecological Ranks" to segments (e.g., Very High, High, Moderate, Low, and Very Low). The FHSI is calculated using a combination of criteria that are field derived and potentially also from desktop studies. Scores assigned to each criterion (Table 3) are tallied for a single habitat segment to determine the Ecological Rank. The rank represents the sensitivity of the shoreline to changes from land use or proposed shoreline activities. In general, ranks will be higher for segments that are natural or have sensitive habitat features than for segments that are disturbed.

The FHSI analysis was developed as follows. Foreshore habitat is comprised of littoral, foreshore, and terrestrial components, each of which have attributes that are measured in FIMP. Modifications and disturbances were incorporated into the index as negative values. Modifications may also alter biophysical attributes (i.e., riparian vegetation, substrates), which should be reflected by lower ratings for these attributes.

Table 2. Summary of criteria and ratings used to calculate the FHSI.

Criteria	% of FHSI	% Within Category	Logic	Uses Weighted FIM Data	Value Categories
FIM					
Shore type	15	22	Sum (% shore $type_i$ * $value_i$) * Maximum Score	Y	Stream Mouth = Wetland (1) > Cliff/Bluff =Gravel Beach = Rocky Shore (.8) > Sand Beach (0.5), Other (0.3)
Substrate	11	16	Sum (% substrate * $value_i$) * Maximum Score	Y	Organic = Mud = Marl = Fines (1) > Cobble = Gravel (0.8) > Sands= Boulder (0.3) > Bedrock (0.2)
% Natural	15	22	% of segment * Maximum Score		% of segment
Aquatic vegetation	6	9	% * Maximum Score		% of segment
Overhanging vegetation	2	3	% of segment * Maximum Score		% of segment
Large woody debris /km	2	3	rating * Maximum Score		>15 LWD (1); 10-15 LWD (0.8); 5-10 LWD (0.6); 0-5 LWD (0.4) 0 LWD (0)
B1 vegetation width and type	11	16	Width rating x Class rating x Maximum Score	Y	Width: < 20 m (1) < 15 to 20 m (0.8) < 10 to 15 m (0.6) < 5 to 10 m (0.4) 0 to 5 m (0.2)
B2 vegetation width and type	5	7		Y	Class: Coniferous = Wetland (1) > Broadleaf = Mixed Forest = Shrubs (0.8) > Herbs/Grasses = (0.6) > Lawn = Landscaped = (0.3) > Exposed Soil = Unvegetated (0.05)
Subtotal	**67**	**100**			
Fisheries					
Juvenile Rearing	5	50	Class rating x Maximum Score	Y	High (1), Moderate (0.4), Low (0.2)
Migration / Staging	5	50		Y	High (1), Moderate (0.4), Low (0.2)
Subtotal	**10**	**100**			
Wildlife					
Veteran Trees	1	25	rating * Maximum Score	Y	> 25 (1), 5-25 (0.6), <5 (0.2), No (0)
Snags	1	25	rating * Maximum Score	Y	> 25 (1), 5-25 (0.6), <5 (0.2), No (0)
Raptor Nest	2	50	rating * Maximum Score	Y	Present (1), Absent (0)
Subtotal	**4**	**100**			
Waterbirds					
Congregation and/or nesting area	7	100			
Subtotal	**7**	**100**			

Criteria	% of FHSI	% Within Category	Logic	Uses Weighted FIM Data	Value Categories
Ecosystem					
Old Growth / Mature Forest	6	100	rating * Maximum Score		Class: Present = 1, Absent = 0
Subtotal	**6**	**100**			
Rare Occurrences					
Ecosystems at Risk	6	100	rating * Maximum Score		Number of Ecosystems at Risk Present within Segment: 4 (1), 3 (0.83), 2 (0.67), 1 (0.5)
Subtotal	**6**	**100**			
Total	**100**	**100**			
Modifications					
% Road modified	-4	40	% of segment * Maximum Score		% of segment
% Rail modified	-4	40	% of segment * Maximum Score		% of segment
% Erosion protection (retaining walls)	-2	20	% of segment * Maximum Score		% of segment
Boat launches/km			-0.5 * # modifications/km		Presence
Groynes/km			-0.2 * # modifications/km		Presence
Dock Groynes/km					Presence
Boat basins/km					Presence
Other modifications/km			-0.1 * # modifications/km		Presence
Subtotal	**-10**				

The initial ratings and weightings were guided by the FIMP methods document (Schleppe et al. 2020). As no FHSI was completed as part of the 2011 survey, the criteria and ratings developed for this report were also applied to the 2011 data, where possible, for comparison. Several iterations were completed with different weightings and with or without specific attributes until the FHSI calculated for each segment was consistent with the professional opinion of the team's biologists. The ratings and weighting used for each attribute are presented in Table 3. The rationale for the weighting of each criteria is provided in Table 4 and the rationale for including additional criteria is provided in Table 5.

The FHSI is heavily weighted towards attributes that are collected as part of the FIM for the following reasons:

- FIM attributes (shore type, substrate, disturbance and vegetation) can be consistently collected in the field.
- FIM attributes represent habitat potential and sensitivity to disturbance.
- FIM attributes do not require any additional species or site-specific information that may or may not be available.

Additional attributes can be added and/or relative weightings adjusted if the FHSI does not adequately represent foreshore sensitivity, or if new site-specific information becomes available. Additional values are summarized in Table 5.

Table 3. Rationale for values assigned to FHSI criteria.

Criteria	Value Categories	Rationale
FIM		
Shore type	Stream Mouth = Wetland (1) > Cliff/Bluff =Gravel Beach = Rocky Shore (.8) > Sand Beach (0.5), Other (0.3)	Values are based on habitat quality and sensitivity to disturbance. Streams and wetlands provide high value habitat for a wide variety of species and are extremely sensitive to disturbance. Gravel beach and rocky shores can provide spawning and rearing habitat and are easily modified by development. Cliffs and bluffs are often used for perching by birds.
Substrate	Organic = Mud = Marl = Fines (1) > Cobble = Gravel (0.8) > Sands= Boulder (0.3) > Bedrock (0.2)	Substrates provide habitat, cover, and potential spawning habitat. In general, the substrates within Fraser Lake had value in terms of their contribution of biomass rather than spawning value. Greater value was placed on soft, organic substrates based on the foraging habitat value they provide for fish within the lake.
% Natural	% of segment	Natural shorelines tend to provide higher value habitat given the ecological function of intact ecosystems found in undisturbed areas.
Aquatic vegetation	% of segment	Aquatic vegetation contributes to aquatic productivity, provides high quality habitat, and is sensitive to disturbance.
Overhanging vegetation	% of segment	While not overly abundant at Fraser Lake, overhanging vegetation can provide shade and cover, and contributes leaf and insect drop.
Large woody debris/km	>15 LWD (1); 10-15 LWD (0.8); 5-10 LWD (0.6); 0-5 LWD (0.4) 0 LWD (0)	Woody debris can provide cover/rearing for fish and provides additional substrate for periphyton/benthic invertebrates.
B1/B2 vegetation width and type	Width: < 20 m (1) < 15 to 20 m (0.8) < 10 to 15 m (0.6) < 5 to 10 m (0.4) 0 to 5 m (0.2) Class: Coniferous = Wetland (1) > Broadleaf = Mixed Forest = Shrubs (0.8) > Herbs/Grasses = (0.6) > Lawn = Landscaped = (0.3) > Exposed Soil = Unvegetated (0.05)	Riparian vegetation represents the interface of the aquatic and terrestrial environment and contributes to shoreline stability. Wetlands and coniferous vegetation generally provided the greatest habitat diversity and value for most species around Fraser Lake.

Table 4. The rationale for criteria that were added to develop the FHSI.

Criteria	Value Categories	Rationale
Fisheries		
Juvenile Rearing	High (1), Moderate (0.4), Low (0.2)	The juvenile rearing potential was based on professional judgement and considered known rearing habitat requirements for fish species in the lake (substrates, proximity to spawning streams, littoral area and cover present, etc.)
Staging / Migration	Present (1), Absent (0)	Fish will typically congregate, or stage, in areas to wait for appropriate conditions prior to migrating to new habitat. The presence of staging and migration areas was based on professional judgement, and typically limited to the areas around the inlet and outlet of Fraser Lake and streams supporting fish.
Wildlife		
Veteran Trees	> 25 (1), 5-25 (0.6), <5 (0.2), No (0)	Veteran trees are those that are significantly older than the dominant forest cover and provide increased structural diversity through unique habitat features for wildlife. They also provide recruitment for snags.
Snags	> 25 (1), 5-25 (0.6), <5 (0.2), No (0)	Snags are dead standing trees that can provide cavity nesting and denning habitat for birds and small mammals, as well as perching habitat for raptors.
Raptor Nests	Present (1), Absent (0)	Raptors play an important ecological role around Fraser Lake and are valued by society for their spiritual, aesthetic, and recreational values. Large raptor nests are frequently reused by raptors for several years.
Waterbirds		
Waterbird congregation or nesting area	Present (1), Absent (0)	Fraser Lake is an Important Bird Area for migrating and moulting waterfowl, as well as wintering Trumpeter Swans. Waterfowl are reported to congregate at the west and east ends of the lake, as well as in isolated areas along the north and south shores (Booth 2001). Ellis Island is also considered for its importance for gull colonies.
Ecosystem		
Old Growth / Mature Forest	Class: Present = 1, Absent = 0	Old forests provide unique habitat, structure and ecological features that are not available in younger stands. These areas play several important roles in several ecological processes, including provision of wildlife habitat, species diversity, nutrient cycling, and hydrological regimes.
Rare Occurrences		
Ecosystems at Risk	Number of Ecosystems at Risk Present within Segment: 4 (1), 3 (0.83), 2 (0.67), 1 (0.5)	Six provincially blue-listed ecosystems were identified around Fraser Lake, in some cases with up to four identified in a particular segment.

3.3 Ecological Ranks

After the FHSI values for each segment were calculated, segments were assigned a five-class ranking system with categories of Very Low, Low, Moderate, High and Very High (Table 5). The ranking system was developed by reviewing the range of FHSI values for the different segments of the lake (Appendix 4, Figure 10) and creating appropriate boundaries for each ranking. This process considered conditions observed during the 2023 survey, as well as the rankings previously assigned to the segments and changes that were observed in each segment between surveys. The ranking system was assigned such that segments that scored >66 were assigned a Very High ranking, with lower ranks assigned at increments of 8.

Table 5. Five class ranking system based on FHSI scores.

Rank	FHSI Score
Very High	>66
High	58 - 66
Medium	50 - 58
Low	42 - 50
Very Low	<42

4 RESULTS

4.1 General Survey Conditions

At the time of the survey, the lake level was ~ 0.54 m below the normal high water mark as determined in the field. The hydrometric station located at the outlet of the lake in the Nautley River just downstream of the bridge recorded a high of 2.068 m on May 18, 2023, and a low of 1.002 on January 28, 2023, experiencing a fluctuation of 1.066 m. The depth of light penetration was 3.5 m as measured with a Secchi disk on August 8, 2023.

4.2 Foreshore Inventory and Mapping

4.2.1 Natural vs. Disturbed Shoreline

The foreshore of Fraser Lake had a total length of 70,928 m and was divided into 57 segments ranging in length from 309 m to 3,340 m (Appendix 2). The total length of disturbed shoreline was 24,475 m (34.5%), while the total length of natural shoreline was 46,453 m (65.5%; Figure 2). Most of the disturbances along the foreshore of Fraser Lake are related to development on residential and rural properties, as well as the presence of railway and roads. Cottages are prevalent in Segments 13, 15, 19, 22, 25, 28, 29, and 38, which most see seasonal use with an increase in year-round uses. Related appurtenances included docks, retaining walls, boat launches and gazebos. Segments 49, 34 and 48B had the highest level of disturbance with 98%, 95% and 90% respectively, due to the presence of White Swan Park in Segment 49, agricultural

use in Segment 34 and presence of the railway in Segment 48B. Segments 22, 25, 28 and 29 also had high levels of disturbance (80%) due to single-family developments.

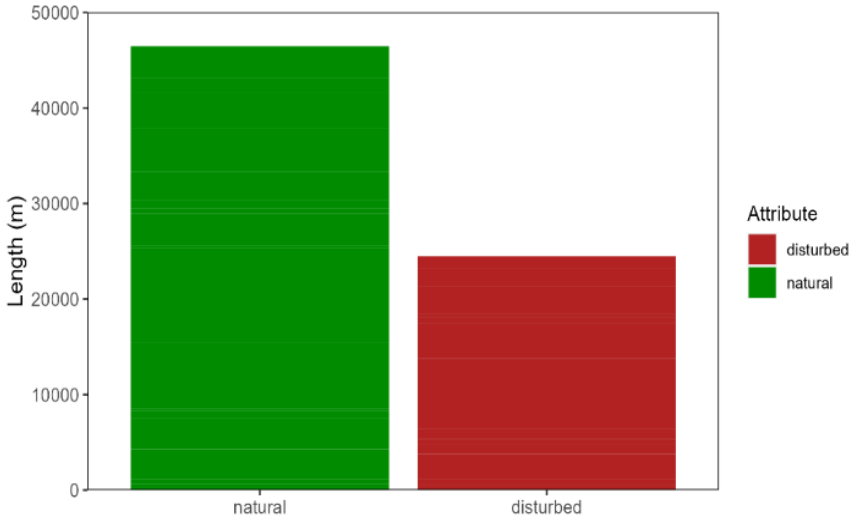

Figure 2. Amount of natural and disturbed shoreline on Fraser Lake.

4.2.2 Shore Type

The predominant shore type was rocky shore with 28,334 m of shoreline (39.9%), followed by wetland, (19,987 m; 28.2%) gravel (13,558 m; 19.1%), stream mouth (5,308 m; 7.5%), and sand (3,432 m; 4.8%) respectively (Table 6; Figure 3). Sand shore type was present in Segments 22, 23, and 25 on both sides of the mouth of Ormond Creek. Only Segment 53 (309 m; 0.4%) was classified as cliff/bluff shore type, however several small sections of cliffs are also present on the north shore of the lake. The most disturbance to the overall shoreline was along rocky (11.8%), wetland (9.6%), and gravel (7.5%) shore types; however, the greatest disturbance as a proportion of each shore type was within sand shore type (71.0%), followed by gravel (39.4%), wetland (34.1%), rocky (29.5%), and stream mouth (28.5%).

Table 6. Shore type along the Fraser Lake foreshore and amounts of natural and disturbed shoreline relative to the overall shoreline.

Shore Type	Total (m)	Percent (%)	Natural (%)	Disturbed (%)
Rocky Shore	28,334	39.9	28.2	11.8
Wetland	19,987	28.2	18.6	9.6
Gravel	13,558	19.1	11.6	7.5
Stream Mouth	5,308	7.5	5.4	2.1
Sand	3,432	4.8	1.4	3.4
Cliff/Bluff	309	0.4	0.4	0.0
Total	70,928	100.0	65.5	34.5

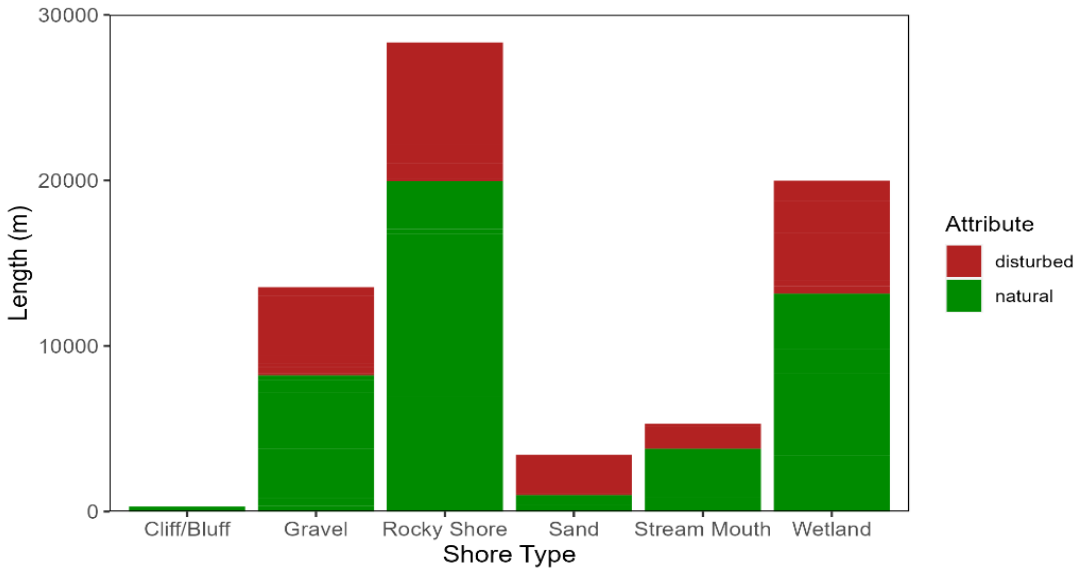

Figure 3. Shore types along the Fraser Lake foreshore relative to the amount of natural and disturbed foreshore.

4.2.3 Land Use

The predominant land use along the foreshore of Fraser Lake was rural (32,367 m; 45.6%; Table 8; Figure 4), transportation (i.e., roads and railway at 15,438 m; 21.8%), single-family residential (11,151 m; 15.7%), and natural area (6,813 m; 9.6%). Land uses present in small amounts were park (1,921 m; 2.7%), agriculture (1,565 m; 2.2%), industrial (828 m; 1.2%) urban park (536 m; 0.8%) and conservation (309 m; 0.4%). The greatest percentage of overall shoreline disturbance was associated with transportation (12.3%), single-family residential (11.3%), and rural (7.3%) uses. Relative to land use types, the most disturbed shorelines were associated with urban park (98%), agricultural (74.5%), single family residential (71.8%), and transportation (56.3%) land uses.

Table 7. Land use along the Fraser Lake foreshore and relative amounts.

Land Use	Total (m)	Percent (%)	Natural (%)	Disturbed (%)
Rural	32,367	45.6%	38.3%	7.3%
Transportation	15,438	21.8%	9.5%	12.3%
Single Family	11,151	15.7%	4.4%	11.3%
Natural Area	6,813	9.6%	9.6%	0.0%
Park	1,921	2.7%	2.0%	0.8%
Agriculture	1,565	2.2%	0.6%	1.6%
Industrial	828	1.2%	0.7%	0.5%
Urban Park	536	0.8%	0.0%	0.8%
Conservation	309	0.4%	0.4%	0.0%
Total	**70,928**	**100.0%**	**65.5%**	**34.5%**

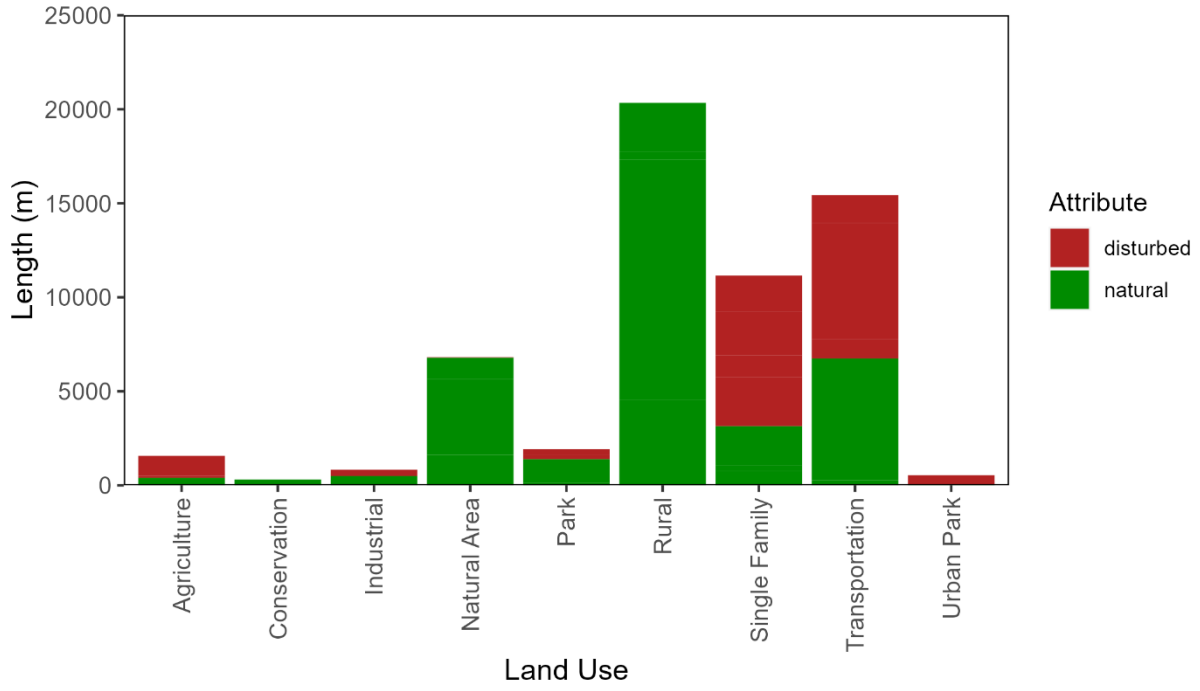

Figure 4. Land use along the Fraser Lake foreshore relative to the amount of natural and disturbed foreshore.

4.2.4 Culturally Sensitive Areas

Several sites of cultural and spiritual importance were identified around Nadleh Bun (Fraser Lake) during communications with Stellat'en and Nadleh Whut'en First Nations[2]:

- The Rose Prince memorial is at the location of Rose Prince's grave at the Lejac Residential School cemetery, located just beyond the riparian zone of Segment 44. Rose Prince was a Carrier woman who attended the Lejac school and was known for her serene presence and strong sense of faith and compassion. Rose Prince died in 1949, but when her body was uncovered two years later, it remained perfectly preserved. Many Catholics believe that she was a saint, and her grave is the site of an annual pilgrimage where people across Canada come to pray and celebrate their faith (Vancouver Sun 2017, DPG 2024). A road leads from the cemetery down to the shoreline of the lake, where a natural spit extends into the water. The volcanic rock on this spit is also an important prayer area (I. Reynolds, pers. comm.).
- Mouse Mountain (Lhkwetsilhchola) along Segment 48B is the site of the legend of where two young girls returned to their village only to find that a cannibal had eaten all of the people there. After initially becoming the cannibal's slaves, the girls one day tricked him into falling into a fire they had made. As he burnt, the cannibal put a curse on the girls, and his ashes became

[2] Note that this list is not necessarily exhaustive, and additional culturally sensitive areas may be present around Nadleh Bun.

mosquitoes that would rise up and eat them forever. His pinky finger, which held his heart, could not be burnt. The girls threw it across the lake and where it landed it turned into the mountain (Baker, N.D.)

- Red Rock Mountain (Tselk'un'k'ut), located off of Segment 5 at the west end of the lake is a sacred spiritual site where men can undergo mental, spiritual and physical journeys to become medicine men. Some areas of the mountain are only able to be accessed with permission from true healers. Tsekoo shunk'ut is a sacred area on Red Rock Mountain that is not open to the public and can only be accessed by medicine women. Walking trails exist on Red Rock Mountain, but the public is asked to not disturb sacred sites (Baker, N.D.)
- Several pictographs are present on the shoreline of Fraser Lake (I. Reynolds, pers. comm.). The exact location of these is not public.
- The area of what is now Peterson's Beach (Segment 26) was once a traditional village site (pers. comm. Nadleh Whut'en Knowledge Keepers, 2023).
- Traditional prayer areas found in some areas along the shoreline where obvious colour gradients are present in the natural rock (I. Reynolds, pers. comm.).
- Ellis (Seagull) Island holds spiritual and cultural significance for the Nadleh Whut'en people, as legends tell of a spiritual shapeshifter residing there (S. Greene, pers. comm.)
- Several traditional fishing sites are located in shallow areas between the shore and islands. These areas were traditionally used for net setting to harvest migrating fish (I. Reynolds, pers. comm.).

4.2.5 Aquatic, Wetland and Flood Ecosystems

4.2.5.1 Ecosystems

Wetland ecosystems occur where water-saturated soils result in vegetation communities dominated by hydrophytic plants adapted to growing in low-oxygen (anaerobic) conditions associated with prolonged saturation or flooding (McKenzie and Moran 2004). Wetlands identified for Fraser Lake were classified as marshes (Wm), which are permanently to seasonally flooded sites dominated by emergent graminoid vegetation, and shallow waters (Ww), which are aquatic wetlands permanently flooded by still or slow-moving water and dominated by rooted submerged and floating-leaved aquatic plants. These wetland classes were further classified to site units, which represent sites capable of supporting a similar plant association at climax (Table 8). Flood ecosystems are non-wetland ecosystems that occur on regularly flooded riparian sites with well-drained soils (Mackenzie and Moran 2004). Flood ecosystem classes identified for Fraser Lake include active channel (Fa), flood fringe (Ff), low-bench (Fl), and middle-bench (Fm). Flood ecosystem classes and site units are described in Table 9. Several of these site units represent ecological communities with provincial conservation concern and are discussed in Section 4.2.9.

Table 8. Wetland ecosystems identified for Fraser Lake.

Site Unit	Name	Description
Wm01	Beaked sedge - Water sedge	Seasonally flooded sites with some late-season drawdown, typically adjacent to water bodies with slow-moving flood water. Sedge-dominated with low plant diversity. Beaked sedge (*Carex utriculata*) usually present.
Wm02	Swamp horsetail - Beaked sedge	Characterised by high cover of swamp horsetail (*Equisetum fluviatile*).
Wm05	Cattail	Characterized by high cover of cattail (*Typha latifolia*).
Wm06	Great bulrush	Characterized by high cover of soft stemmed bulrush (*Schoenoplectus tabernaemontani*) with low plant species diversity.
Wm15	Bluejoint – Beaked sedge	Characterized by high cover of bluejoint reedgrass (*Calamagrostis canadensis*) and/or beaked sedge.
Ww	Shallow-water	Also referred to as "aquatic wetlands", typically occupy depths from 0.5 to 2 m within the littoral zone; species-poor and dominated by either Rocky Mountain pond-lily (*Nuphar polysepala*), pondweeds (*Potamogeton* spp.), arum-leaved arrowhead (*Sagittaria cuneata*) and/or water smartweed (*Persicaria amphibia*).

Table 9. Flood ecosystems identified for Fraser Lake.

Site Unit	Name	Description
Fa	Active Channel	Occurs along the edges of the lake and rivers where prolonged flooding creates scouring and limits vegetation development to annual plants and sparse shrub cover.
Ff	Flood Fringe	Sites that are sub-irrigated but rarely flooded by surface waters. Characterized by a tall shrub vegetation community (typically cottonwood and willows) occurring along the immediate lake margin.
Fl01	Mountain alder – Common horsetail	Low-bench flood ecosystem identified along the mouth of Ormond Creek. Mountain alder (*Alnus incana*) is the dominant species, along with horsetails (*Equisetum* spp.). Other plant species present include cow-parsnip (*Heracleum maximum*), red-osier dogwood (*Cornus sericea*), and stinging nettle (*Urtica gracilis*).
Fm02	Cottonwood – Spruce - Dogwood	Predominant forested riparian ecosystem type occurring on sandy or gravelly fluvial materials adjacent to lake and river margins; black cottonwood stands with minor amounts of hybrid white spruce and a diverse and abundant shrub layer that includes red-osier dogwood, black twinberry (*Lonicera involucrata*), and roses (*Rosa* spp.)

4.2.5.2 Vegetation

Aquatic vegetation was present over 31,285 m (44.1%) of the littoral zone of Fraser Lake with variable cover, and was present in all segments except Segment 53, ranging from 5% to 100% cover. The predominant aquatic vegetation consisted of submergent vegetation (20,209 m; 28.5%) and emergent vegetation (19,114 m; 26.9%), with floating vegetation only present over 1,935 m (2.7%). The highest

density of aquatic vegetation was associated with Segments 2, 4, 36 and 37. The most common aquatic and wetland vegetation species were beaked sedge (*Carex utriculata)*, swamp horsetail (*Equisetum fluviatile*), Siberian water-milfoil (*Myriophyllum sibiricum*), Rocky Mountain pond-lily (*Nuphar polysepala*), water smartweed (*Persicaria amphibia*), grass-leaved pondweed (*Potamogeton gramineus*), Richardson's pondweed (*Potamogeton richardsonii*), arum-leaved arrowhead (*Sagittaria cuneata*), soft-stemmed bullrush (*Schoenoplectus tabernaemontani*), hemlock water-parsnip (*Sium suave*), emersed bur-reed (*Sparganium emersum*), and common cattail (*Typha latifolia*). Other common species included mountain alder (*Alnus incana* ssp. *tenufolia*), willows (*Salix* sp.), bluejoint reedgrass (*Calamagrostis canadensis*) and reed canarygrass (*Phalaris arundinacea*).

4.2.6 Shoreline Characteristics

4.2.6.1 Foreshore Areas

Cobble (14,646 m; 20.6%), boulder (13,328 m; 18.8%), gravel (12,283 m; 17.3%) and sand (12,037 m; 17.0%) were the predominant substrates within the foreshore areas of the lake. Fines (5,903 m; 8.3%), mud (5,163; 7.3%), organics (4,523 m; 6.4%) and bedrock (3,044 m; 4.3%) were also present in lesser amounts (Table 9, Figure 5). Large woody debris was present on the foreshore of 52 of the 57 segments, and was most abundant (i.e., #LWD/distance of shoreline) in Segments 8, 3, 43, 14, 18 and 5 (in order of abundance).

Table 10. Substrate type along Fraser Lake foreshore.

Substrate Type	Percent (%)	Length of Shoreline (m)
Cobble	20.6	14,646
Boulder	18.8	13,328
Gravel	17.3	12,283
Sand	17.0	12,037
Fines	8.3	5,903
Mud	7.3	5,163
Organic	6.4	4,523
Bedrock	4.3	3,044
Total	100	70,928

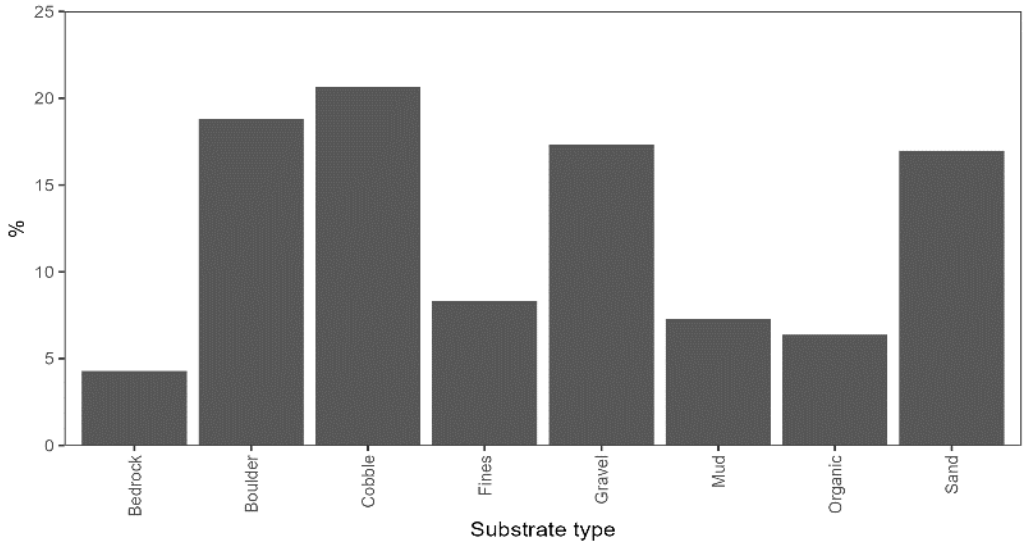

Figure 5. Substrate type along the Fraser Lake foreshore.

4.2.6.2 Littoral Areas

Most of the Fraser Lake shoreline (36,693 m; 54.4%) had a wide littoral zone (>50 m). Medium (10-50 m) and narrow (<10m) littoral zones were present over 16,541 m (26.3%) and 17,694 m (19.3%) of the shoreline, respectively. The widest littoral areas were associated with Segments 37 and 38 at the east end of the lake where the littoral zone width reached up to 400 m; Segments 1 and 2 on the south shore of the lake downstream of the outlet of the Stellako River where the littoral zone reached up to 165 m; and Segment 7, which was 150 m. Substrates within the littoral zone were dominated by sand (22.4%) and cobble (20.2%), followed by fines (14.0%), boulder (13.7%), mud (12.6%) and gravel (9.9%). Substrates present in trace amounts were organics (4.1%) and bedrock (3.1%). Large woody debris in the littoral zone was generally sparse, with Segments 50 (Huntly Island) and 17 having the highest density.

Table 11. Substrate type along the Fraser Lake littoral area.

Substrate Type	Percent (%)	Length of Shoreline (m)
Sand	22.4	15,867
Cobble	20.2	14,362
Fines	14.0	9,926
Boulder	13.7	9,747
Mud	12.6	8,910
Gravel	9.9	7,002
Organic	4.1	2,917
Bedrock	3.1	2,197
Total	100	70,928

4.2.6.3 Riparian Vegetation

Young seral-stage forests dominate the landscape as a result of historic wildfires, human settlement, agriculture, and commercial logging. Gently rolling aspen parkland are predominant upland forests on the south side of the lake, while the north side of the lake is mainly coniferous forests with Douglas-fir, lodgepole pine, hybrid white spruce, and some paper birch. Some very dry south-facing slopes along the shoreline on the north side of the lake have shallow bedrock and rock outcrops with mature stands of Douglas-fir. Gentler terrain and cooler aspects on the south side of the lake support more dense mixed forest with more spruce. Mature black cottonwood stands occur along the immediate shoreline, with varying amounts of paper birch and mixed conifers. The shrub layer is diverse and well-developed with mountain alder, red-osier dogwood (*Cornus sericea*), and willows occurring on wetter sites, and choke cherry (*Prunus virginiana*), dwarf juniper (*Juniperus communis*), prairie saskatoon (*Amelanchier alnifolia*), Rocky Mountain juniper (*J. scopulorum*), and soopolallie (*Shepherdia canadensis*) occurring on drier sites.

The nearshore riparian vegetation band (Vegetation Band 1) ranged from 5 – 50 m and was typically shrubs (81.2%) or natural wetland (13.5%), with smaller areas of unvegetated sites in Segment 25 (3.1%), herbs/grasses in Segment 34 (1.6%) and broadleaf forest in Segment 23 (0.7%). Riparian vegetation distribution was continuous in approximately half of the segments (n=24), and patchy in the remainder, typically due to the presence of rocky sections of shoreline, and areas of riparian clearing for development. Overhanging vegetation was present along ~15.4% of the lake shoreline in relatively sparse amounts, except Segment 25 where it was absent.

A distinct second band of riparian vegetation (Vegetation Band 2) was present within 50 m of the shoreline for 49 of the 57 segments and was generally a mixture of broadleaf forest (43.4%), and mixed forest (32.3%). Shrubs (3.8%), coniferous forest (4.8%), herbs/grasses (2.0%), and landscape/lawn (0.8%) also made up smaller areas of Vegetation Band 2. Just over half (n=26) of the segments had veteran trees, and 43 segments had snags.

Intact riparian terrestrial ecosystems in Vegetation Band 2 included dry coniferous forests and seral aspen-dominated forests. These ecosystems were not intensively surveyed, but some species were noted from dry forest types proximal to the shoreline, allowing for identification of the Blue-listed SBSdw3/102 (Table 12).

Table 12. Terrestrial riparian ecosystems identified at Fraser Lake.

Site Unit	Name	Description
SBSdw3/102	Douglas-fir – Lodgepole pine - Cladonia	Open forests dominated by Douglas-fir on shallow soils over bedrock with abundant *Cladina* /*Cladonia* spp. lichens, typically on warm aspects in exposed locations. Vegetation includes choke cherry (*Prunus virginiana*), fescues (*Festuca* spp.), Rocky Mountain juniper (*Juniperus scopulorum*), spreading stonecrop (*Sedum divergens*), three-toothed saxifrage (*Saxifraga tricuspidata*), western cliff fern (*Woodsia oregana*), and white cinquefoil (*Drymocallis convallaria*).
SBSd3/00	Aspen-dominated upland forest	Seral stands of young to mature aspen-dominated forests.

4.2.7 Fish Species Information

Fraser Lake provides habitat to a diversity of fish species including Burbot (*Lota lota*), Chinook Salmon (*Oncorhynchus tshawytscha*), Bull Trout (*Salvelinus confluentus*), Kokanee (*O. nerka*), Lake Trout (*S. namaycush*), Largescale Sucker (*Catostomus macrocheilus*), Mountain Whitefish (*Prosopium williamsoni*), Northern Pikeminnow (*Ptychocheilus oregonensis*), Peamouth Chub (*Mylcheilus caurinus*), Prickly Sculpin (*Cottus asper*), Rainbow Trout (*O. mykiss*), Sockeye Salmon (*O. nerka*), and White Sturgeon (*Acipenser transmontanus*) (Habitat Wizard 2023; Dreischner and Schleppe 2012). In general, there is not much published information available regarding distribution or habitat-specific use of fish within Fraser Lake and its tributaries. Information that was found during the background review is summarized below.

Fraser Lake has been identified as providing critical rearing and overwintering habitat to the Nechako White Sturgeon population, which has been ranked as Endangered under Schedule 1 of the federal Species at Risk Act (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This population is also provincially ranked as imperiled and red listed[3] (BC CDC 2018). After a 5-year study conducted from 1994 to 1999, the Nechako White Sturgeon population was determined to be in a critical state of decline, which prompted the preparation of a recovery plan (NWSRI 2004). This led to the closure of the catch and release sport fishery for white sturgeon in the Nechako River in September of 2000. At the time, the number of mature females was estimated at 150, with an expected decline to ~ 25 by the year 2025, which emphasized the urgency of the implementation of recovery efforts, especially due to the lag time for female white sturgeon to reach maturity (25-40 years, Korman and Walters 2001, W. Salewski, pers. comm). The entirety of Fraser Lake, the Nautley River, and a portion of the Stellako River

[3] **Red**: Includes any native species or ecological communities that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. Extirpated species no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered species and ecological communities are facing imminent extirpation or extinction. Threatened species and ecological communities are likely to become endangered if limiting factors are not reversed. Not all Red-listed species or ecological communities will necessarily become formally designated. Placing species or ecological communities on these lists flags them as being at risk and requiring investigation.

have been identified as providing critical habitat for the Nechako White Sturgeon population (Fisheries and Oceans Canada 2014). Fraser Lake has been identified as an essential feeding area and productivity of the lake and access to the lake have been determined as essential to their survival and recovery (Fisheries and Oceans Canada 2014). The Stellako River mouth at Fraser Lake has also been identified as important habitat (Government of BC 2023; Photo 2). The Fraser Lake designation therefore took into consideration both direct use of the lake for feeding and indirect benefits such as connectivity and food production/abundance. Adult fish were reported to spend significant amounts of time in these areas usually between spawning periods. White Sturgeon were historically captured around the islands at the outlet of Fraser Lake to the Nautley River (Photo 3), at the confluence of the Stellako River, and along the south shore at Lejac (Cadden 2000). The Ministry of Forests has been conducting a multiple year study since 2021 which aims to better understand the movement and interactions of juvenile White Sturgeon and Burbot within the lake in relation to water temperature and oxygen conditions (MOF 2023). At the time of this report, little information was available regarding shoreline use by these species, however it was noted that all Burbot captured during the spring (May) tagging season were captured at relatively shallow (~3-10 m) depths (N. Gantner, pers. comm.).

The Nechako White Sturgeon Recovery Plan includes the development of a fish culture program to address the short- and medium-term goals to mitigate for the lack of juvenile recruitment. This led to the establishment of the Nechako White Sturgeon Conservation Centre in Vanderhoof, which houses one of the most state-of-the-art hatchery facilities in North America (NWSRI 2004). Juvenile fish are released at several sites on the Nechako River including Riverside Park, and in Fraser Lake at Beaumont Park and White Swan Park. Schools are invited to participate in the releases, providing a great educational experience.

Fraser Lake is also used by Sockeye and Chinook salmon. Three populations (managed as Designatable Units (DU) by Fisheries and Oceans Canada) of Sockeye and two populations of Chinook use or have used the lake. Shore spawning is not documented in Fraser Lake; habitat value associated with the lake for salmon is primarily as a migration corridor to and from spawning areas, as well as rearing in some cases:

- The Nadina-François ES (early summer) Sockeye population (DU8) is a population that spawns in several sites upstream (west) of François Lake, including the Nadina River Spawning Channel (COSEWIC 2017). This population is thought to rear in Nadina and François Lakes, though there is some potential for overlap with Fraser Lake rearing (M. Glavas, pers. comm.). The most recent conservation status assessment of this population by COSWEIC (2017) was “Not at Risk”.
- The François-Fraser S (summer) Sockeye population (DU7) is composed of Sockeye that spawn in the Stellako River, Uncha Creek (a tributary creek at the east end of François Lake), as well as

Ormond Creek (Photo 4), however salmon have not been observed in the latter since 2010 (GOC 2024). This population is thought to mainly rear in Fraser Lake, but may have some overlap with François Lake (M. Glavas, pers. comm.). This population has seen systematic declines in recruitment since the 1990s, and was most recently assessed by COSEWIC (2017) as "Special Concern".

- A third Sockeye population, Fraser-ES (DU 28) historically spawned in Endako River and Ormond Creek, but has not been recorded in Ormond Creek since 1976 or Endako River since 1991. Although considered likely to be extinct, this population is still ranked by COSEWIC as "Endangered" because less than 50 years have passed since the last credible record (Grant et al., 2011, COSEWIC 2021).
- The Middle Fraser stream spring (DU9) and summer (DU10) populations of Chinook are stream-type (i.e., spend one or more years in freshwater before migrating to the ocean) populations. Among many tributaries to the Middle Fraser River, these populations are known to spawn in Endako River and previously spawned in Ormond Creek, though they have not been observed here since the 1980s (GOC 2024). There is no documentation of rearing within Fraser Lake. These populations have been subject to recent declines, and were both assessed by COSEWIC as Threatened in 2018.

Several of the mid-sized tributary streams of Fraser Lake also have records of fish presence: Rainbow Trout are reported in Deserter and Stern Lakes (the headwaters of Perry Creek and Stern Creek). Prickly Sculpin, Rainbow Trout and juvenile Chinook Salmon are reported from a 2018 fish salvage at the mouth of an unnamed creek in Segment 29. Largescale and Longnose Suckers, Northern Pikeminnow, Rainbow Trout and Sculpin are reported in Drywilliam Lake, which drains into Fraser Lake via an unnamed tributary stream in Segment 40. Robertson Creek, which flows into the lake at Segment 47, has records of Lake Chub, Longnose Sucker, Rainbow Trout and Redside Shiner. Species reported in Ormond Creek include Bull Trout, Burbot, Kokanee, Peamouth Chub, Lake Whitefish, Longnose Sucker, and Rainbow Trout (Habitat Wizard, 2023).

The Western/Oregon Floater mussel (*Anodonta kennerlyi/oregonensis* clade) were widespread, with observations in 17 segments (Photo 16). It is likely that they are also present within additional segments, however a more detailed survey would be required to confirm distribution. Freshwater mussels provide many important ecological services: they help maintain water quality through filter-feeding; they provide a food source for other animals; their shells create habitat for other species and a slow-release source of calcium, phosphorous, and nitrogen; and, because they are sensitive to environmental changes, they are excellent bioindicators. In addition, mussels were and continue to be an important food source to local

First Nations. Though it was beyond the scope of this project to investigate mussel population health, mussels appear to be widespread and abundant at Fraser Lake.

Photo 2. Lake inlet and Stellako River (Segment 3).

Photo 3. Outlet of Fraser Lake at Nautley River (Segments 34 to 36).

Photo 4. Mouth of Ormond Creek (Segment 24).

Photo 5. Mussel (*Anodonta kennerlyi/oregonensis* clade; Segment 3).

4.2.8 Biodiversity

A list of 626 species across multiple taxonomic groups was compiled from field observations, a literature review, and from GBIF (2023) based on a search for all species occurrences in the GBIF database for the immediate area (~1 km) surrounding Fraser Lake (Table 13). A complete list of all documented taxa and the information source is provided in Appendix 3.

Table 13. Total number of taxa within taxonomic groups identified for Fraser Lake and the immediate surrounding area.

Taxonomic Group	Number of Taxa
Amphibians	3
Birds	185
Fish	14
Fungi	11
Invertebrates	126
Lichens	10
Mammals	19
Plants	252
Reptiles	1
Slime Moulds	5

4.2.8.1 Wildlife and Wildlife Habitat

Wildlife observations from field surveys included four mammal species: American Beaver (*Castor canadensis*), American Black Bear (*Ursus americanus*), Moose (*Alces alces*), and North American River Otter (*Lontra canadensis*). Beaver lodges (Photo 6) were noted in Segments 3, 11, 12, 13, 24, 35, 36, 39, and 55; only two of which appeared active (live animals present in Segment 3, well-used trails present in Segment 55). American Black Bears were sighted during boat surveys (Photo 7) and from UAV videography from Segments 8, 12, 14, 15, 18, 21, 22, 24, 34, 35, and 46. Moose scat was noted along the shoreline in Segment 23 and animals are known to frequent Segment 36 (S. Greene, pers. comm.) where large animal trails were observed in wetlands. North American River Otters were observed in Segment 27 and suspected to be present in Segment 9 where large mussel shell middens were noted.

Fifteen additional mammal species documented for the Fraser Lake area were identified from GBIF (2023): Bushy-tailed Woodrat (*Neotoma cinerea*), Common Muskrat (*Ondatra zibethicus*), Coyote (*Canis latrans*), Ermine (*Mustela richardsonii*), Meadow Jumping Mouse (*Zapus hudsonius*), Meadow Vole (*Microtus pennsylvanicus*), Mule Deer (*Odocoileus hemionus*), North American Deermouse (*Peromyscus maniculatus*), Red Fox (*Vulpes vulpes*), Red Squirrel (*Tamiasciurus hudsonicus*), Southern Red-backed Vole (*Myodes gapperi*), Vagrant Shrew (*Sorex vagrans*), Western Jumping Mouse (*Zapus princeps*), White-tailed Deer (*Odocoileus virginianus*), and Yellow-Pine Chipmunk (*Neotamias amoenus*).

Photo 6. Beaver lodge (Segment 9).

Photo 7. American Black Bear along shoreline (Segment 48; Mouse Point).

4.2.8.2 Birds

A total of 185 bird species were identified with occurrences in the Fraser Lake area (Appendix 3). Twenty-three species were observed during field surveys. Commonly observed species include American Crow (*Corvus brachyrhynchos*), American Widgeon (*Mareca americana*), Bald Eagle (*Haliaeetus leucocephalus*), Belted Kingfisher (*Megaceryle alcyon*), Black Tern (*Chlidonias niger*), Blue-winged Teal (*Spatula discors*), Bufflehead (*Bucephala albeola*), Canada Goose (*Branta canadensis*), Common Loon (*Gavia immer*), Common Merganser (*Mergus merganser*), Herring Gull (*Larus argentatus*), Mallard (*Anas platyrhynchos*), Osprey (*Pandion haliaetus*), Red-necked Grebe (*Podiceps grisegena*), Ring-billed Gull (*L. delawarensis*), Solitary Sandpiper (*Tringa solitaria*), Spotted Sandpiper (*Actitis macularius*), and Western Grebe (*Aechmophorus occidentalis*). Twenty-two provincially and/or federally listed bird species at risk are known to use Fraser Lake and the immediate surrounding area (Appendix 4; Section 4.2.9).

Fraser Lake is recognized as an Important Bird Area (IBA), which is a “discrete site that supports specific groups of birds: threatened birds, large groups of birds, and birds restricted by range or by habitat (IBA Canada 2023). Fraser Lake was selected because it supports habitat for COSEWIC listed species, particularly as it is a globally significant overwintering site for Trumpeter Swans (*Cygnus buccinator*), and because it is a continentally important site for migrating waterfowl in the fall and a nationally significant site for fall migrating American Wigeon (Booth 2001). High waterfowl concentrations are noted for extensive shallow littoral areas with abundant aquatic plants, particularly at the west end of the lake (Booth 2001; Figure 6). Trumpeter swans congregate at both the inlet and outlet of the lake during the winter, as these areas generally remain free of ice throughout the winter.

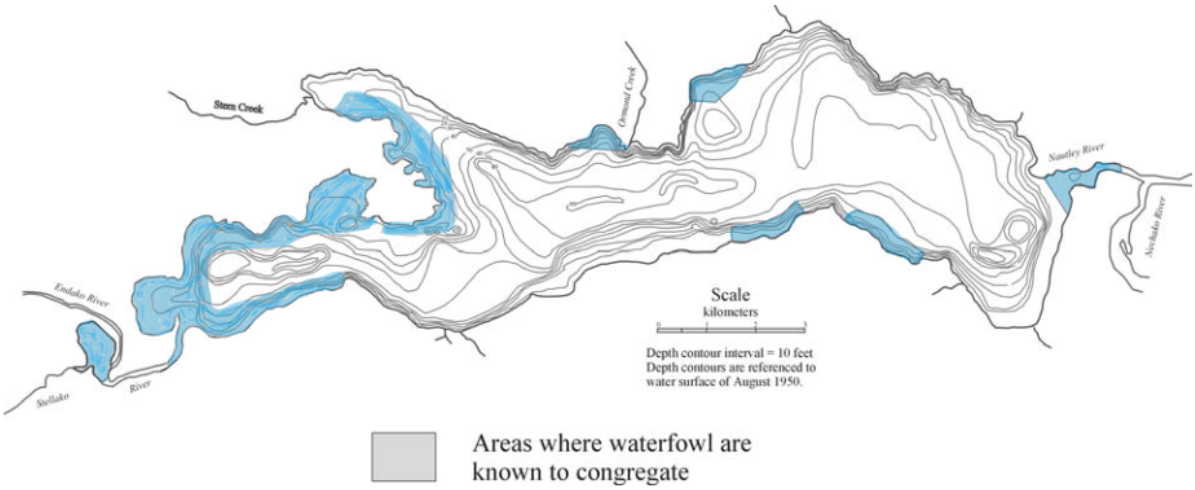

Figure 6. Bathymetric outline of Fraser Lake showing important waterfowl congregating areas associated with large littoral zones (adapted from Booth 2001).

Ellis Island (Segment 53) is a small rocky island (Photo 8 and Photo 9) that was designated as an ecological reserve in 1991 for the protection of nesting colonies of both Herring Gulls and Ring-billed Gulls, the latter of which has only two active breeding colonies in BC (BC Parks 1991). Other species that also nest on the island include American Crow, Common Loon, Mallard, Northern Pintail, and Spotted Sandpiper, as well as a variety of songbirds which probably nest in the shrubby vegetation that is present.

Nineteen stick nests were observed during field surveys, located in 13 Segments (3, 7, 11, 12, 31, 33, 36, 40, 42, 44, 48B, 50, and 51). Nest trees were typically large, dominant black cottonwood, Douglas-fir, or trembling aspen trees in close proximity to the lake. Active Bald Eagle nests were observed in Segment 36 (in large cottonwood; Photo 10), Segment 50 (2 nests in old growth Douglas-fir; Photo 11), and Segment 51 (in large cottonwood with juveniles present). Active Osprey nests were observed in Segment 7 (in large aspen) and Segment 48B (in large Douglas-fir vet; Photo 12). Nests of Bald Eagle and Osprey, as well as those of Great Blue Heron (*Ardea herodias*) and Peregrine Falcon (*Falco peregrinus*), are protected year-round under Section 34(b) of the British Columbia *Wildlife Act*. Great Blue Heron was observed foraging at the mouth of the Stellako River (Segment 3; Photo 13) and flying elsewhere, though no heron nests were confirmed during the 2023 survey. Peregrine Falcon was tentatively identified from a flyover in Segment 19 and there are records of the species occurring in the immediate area of Fraser Lake (GBIF 2023).

Photo 8. Ellis Island Ecological Reserve (Segment 53).

Photo 9. Ellis Island Ecological Reserve (Segment 53).

Photo 10. Bald Eagle flying above nest (Segment 36).

Photo 11. Eagle nests in old growth Douglas-fir (Segment 50).

Photo 12. Osprey nest in Douglas-fir (Segment 48B).

Photo 13. Great Blue Heron (Segment 3).

4.2.8.3 Reptiles and Amphibians

Reptiles and amphibians documented for Fraser Lake and the immediate surrounding area include Common Gartersnake (*Thamnophis sirtalis*), Columbia Spotted Frog (*Rana luteiventris*), Long-toed Salamander (*Ambystoma macrodactylum*), and Western Toad (*Anaxyrus boreas*). A single adult Columbia Spotted Frog was observed at the mouth of Ormond Creek (Segment 24; Photo 14), and Common Gartersnake was observed in Segments 8 and 36 (Photo 15). Long-toed Salamander is reported from near the shoreline of Segment 13, and Western Toad has a documented occurrence along Ormond Creek above Stella Road (GBIF 2023).

Photo 14. Columbia spotted frog (Segment 3).

Photo 15. Common Gartersnake (Segment 8).

4.2.8.4 Plants

Plant species, including algae, bryophytes, and vascular plants are the largest taxonomic group, with 252 taxa compiled for Fraser Lake and the immediate surrounding area (Appendix 3). Only characean (stonewort) algal species were included in the species list at this time. A study by Larratt Aquatic Consulting Ltd. (2022) identified 91 species of microalgae that are part of the phytoplankton community forming large algal blooms in Fraser Lake. The B.C. Volunteer Lake Stewardship and Monitoring Program identified algal blooms and the spread of aquatic plants, particularly Canadian pondweed, attributed to phosphorus loading and temperature increases as one of the greatest management challenges in Fraser Lake (Jacklin and Carmichael 2002). Thirty species of bryophytes were documented for the Fraser Lake area, all recorded in the GBIF (2023) database. Vascular plants comprise the largest group of plant species recorded, with 208 identified to species and 10 identified to genus. Eighty-eight taxa were identified during field surveys. Vascular plant species most relevant to shoreline vegetation communities are discussed in Section 4.2.5 and 4.2.6 of this report.

4.2.8.5 Other Species

Invertebrates were the third largest group of organisms documented from Fraser Lake, with 126 taxa (Table 13, Appendix 3). In addition to freshwater mussels (see Section 4.2.7), other molluscs documented for Fraser Lake include a bladder snail (*Physa* sp.; iNaturalist 2023), a pond snail (Lymnaeinae; iNaturalist 2023), a ramshorn snail (*Planorbis* sp.) found in Segment 18 during field surveys, a smooth land slug (*Deroceras* sp.; iNaturalist 2023), and Western Glass-snail (*Vitrina pellucida*; GBIF 2023). An unusual invertebrate observed during field surveys was the common freshwater sponge (*Spongilla lacustris*), with a specimen retrieved from the littoral zone at the mouth of the Stellako River (Segment 3; Photo 16). To our knowledge, this is the first record of the species occurring in Fraser Lake. The only other invertebrate observation made during field surveys was crackling forest grasshopper (*Trimerotropis verruculata*), observed in the dry forest/grassland habitat along the shoreline at Segment 21. Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*) is the only recorded invertebrate species at risk, with a BC Conservation Data Centre mapped element occurrence at the west end of the lake (BC CDC 2023; Section 4.2.9).

In addition to the above taxa, the species list compiled for Fraser Lake includes:

- Eleven species of macrofungi, four of which were identified during field surveys: *Amanita muscaria* var. *flavivolvata*, *Calocera cornea*, *Calvatia gigantea*, and *Chlorophyllum rhacodes*.
- Ten species of lichen, including *Xanthoria* sp. which forms an orange crust on exposed rocks that is often indicative of bird roosting sites, since the species thrives on guano-enriched substrates (Photo 17).
- Five species of slime mould, including coral slime (*Ceratiomyxa fruticulosa*; Photo 18) and the first record of *Badhamia ovispora* in British Columbia.

Photo 16. Common freshwater sponge (*Spongilla lacustris*; Segment 3).

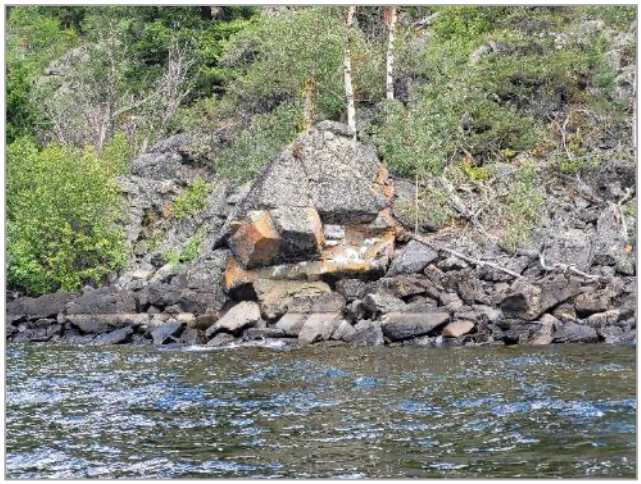

Photo 17. Xanthoria lichens and guano on rock outcrop (Segment 31).

Photo 18. Coral slime mould (*Certatiomyxa fruticulose*; Segment 32).

Species and Ecosystems at Risk

Species and ecological communities at risk are tracked provincially (Red- and Blue-listed) by the BC Conservation Data Centre (CDC), and federally (designated as 'Special Concern', 'Threatened', 'Endangered', 'Extirpated' or 'Extinct') by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Legal protection for species and their habitats in Canada is enacted through the *Species at Risk Act* (SARA) based on research and recommendations from COSEWIC. A query of the CDC iMap database (BC CDC 2023a) resulted in two species at risk (SAR) with confirmed occurrence in the Fraser Lake area, both of which are BC Red-listed and SARA Schedule-1 Endangered: Gypsy Cuckoo Bumble Bee (*Bombus bohemicus*;) and White Sturgeon (*Acipenser transmontanus* pop. 5 (Upper Fraser River Population)).

This species list generated for Fraser Lake was cross-referenced with the BC Species and Ecosystems Explorer database (BC CDC 2023b) and COSEWIC status reports, yielding 30 taxa/populations with provincial and/or federal at-risk conservation rankings confirmed to occur in and around Fraser Lake (Appendix 4). The list includes 1 amphibian, 22 birds, 6 fish populations, 1 insect, and 1 plant. In general, species at risk observations were not isolated to specific areas or associated with specific segments.

Six provincially Blue-listed (Special Concern) ecological communities at risk were identified from field observations (Table 14). These included three wetland marsh communities (Wm02, Wm05, Wm06), two flood ecosystems (Fl01, Fm02), and one upland terrestrial community (SBSdw3/102; Photo 19 to Photo 24).

Table 14. Ecological communities at risk identified for Fraser Lake.

Scientific Name	English Name	Name Code	Prov Status	BC List	Occurrence by Shoreline Segment
Equisetum fluviatile - Carex utriculata	swamp horsetail - beaked sedge	Wm02	S3	Blue	Frequent, widespread – segments 1-4, 6, 10, 34-40, 42-45, 55
Populus trichocarpa - Picea engelmannii x glauca / Cornus sericea	black cottonwood - hybrid white spruce / red-osier dogwood	Fm02	S3	Blue	Frequent, widespread – Segments 23-24, 29-30, 36-42, 44-46
Schoenoplectus acutus Deep Marsh	hard-stemmed bulrush Deep Marsh	Wm06	S3	Blue	Infrequent, patchy – segments 10, 15, 36-39, 42
Typha latifolia Marsh	common cattail Marsh	Wm05	S3	Blue	Frequent, patchy – segments 1-4, 6, 10, 36-40, 42-45, 55
Pseudotsuga menziesii - Pinus contorta / Cladonia spp.	Douglas-fir - lodgepole pine / clad lichens	SBSdw3/ 102	S3	Blue	Infrequent on warm aspects with shallow soils/rocky outcrops, mostly on north side of lake– segments 31-33, 50. Also includes sparsely treed/rock outcrops/ grassland in Segment 21)
Alnus incana / Equisetum arvense	mountain alder / common horsetail	Fl01	S3	Blue	Rare – one site at Ormond Creek Mouth (segment 24) tentatively classified; type not listed for the SBSdw3 in BC CDC 2023b)

Photo 19. Swamp horsetail - Beaked sedge marsh (Wm02; Segment 36).

Photo 20. Common cattail marsh (Wm05; Segment 16).

Photo 21. Bulrush Deep marsh (Wm06; Segment 10).

Photo 22. Mountain alder / common horsetail low-bench floodplain (Fl01; Ormond Creek; Segment 24).

Photo 23. Black cottonwood - hybrid white spruce / red-osier dogwood high-bench floodplain (Fm02; Segment 23).

Photo 24. Douglas-fir - lodgepole pine / clad lichens (SBSdw3/102; Segment 30).

4.2.9 Shoreline Modifications

The predominant linear shoreline modification consisted of rail; the CN Railway runs along the south shore of Fraser Lake and is within 5 m of the HWM for ~ 8,997 m (12.7%) of the lake shoreline. In several areas associated with rail modification, shoreline substrates have been historically modified by the placement of riprap for rail ballast (Photo 25). Roads are also present within 5 m of the HWM along 1,505 m (2.1%) of the lake shoreline, resulting in reduced riparian buffers and substrate modification in most of these areas (Photo 26). Modifications for erosion protection, mainly retaining walls and groynes, were present along ~ 1,016 m (1.4%) of the shoreline. This was mainly attributed to retaining walls, which were observed in 9 segments, and were present within 5 m of the HWM for ~ 943 m (1.3%) of the shoreline. Many of these retaining walls are for newer houses and were noted to even extend below the highwater mark in some cases (Photo 27 and 28). Substrate modification was also noted in 19 segments over a total

distance of ~ 3,523 m (5%) of the shoreline. This was often in the form of fill placement for roads or railway, as well as clearing of rocky substrate to make smoother beaches in front of residential areas (e.g., Photo 29).

Docks were the most prevalent shoreline modification (Figure 7), with 128 docks observed in 21 segments. The highest densities of docks were observed in Segment 22 (~15 docks/km; Photo 29), Segment 25 (~13 docks/km) and Segment 15 (~10 docks/km). In some instances, impacts to aquatic vegetation and wetlands associated with docks were observed (Photo 30). Pilings (n=75) were present in 6 segments, most notably around White Swan Park in Segments 49 and 1 (Photo 32). Twenty-one segments also had modifications classified as "other" (a total of 58 modifications), including abandoned docks, RV trailers, sitting platforms, fire pits, and solar panels (Photo 31). Following docks, "other", and pilings, the most frequent shoreline modifications were retaining walls (n=51), building/sheds (n=48), mooring buoys (n=37), and boat launches (n=28). The majority of boat launches observed were on private property (Photo 33), though a few public boat launches are present around the lake (e.g., White Swan Park, Beaumont Park (Photo 34), Peterson Beach, and Patten Road). Several instances of recent development at or even below the high water mark were observed during the survey (e.g., Photo 35, Photo 47, Photo 48). Many of these developments had large areas of exposed soil immediately adjacent (or in) the water and could present an ongoing risk of erosion and sediment input into the lake. It is not known whether these works were reviewed and/or permitted by the appropriate regulatory bodies.

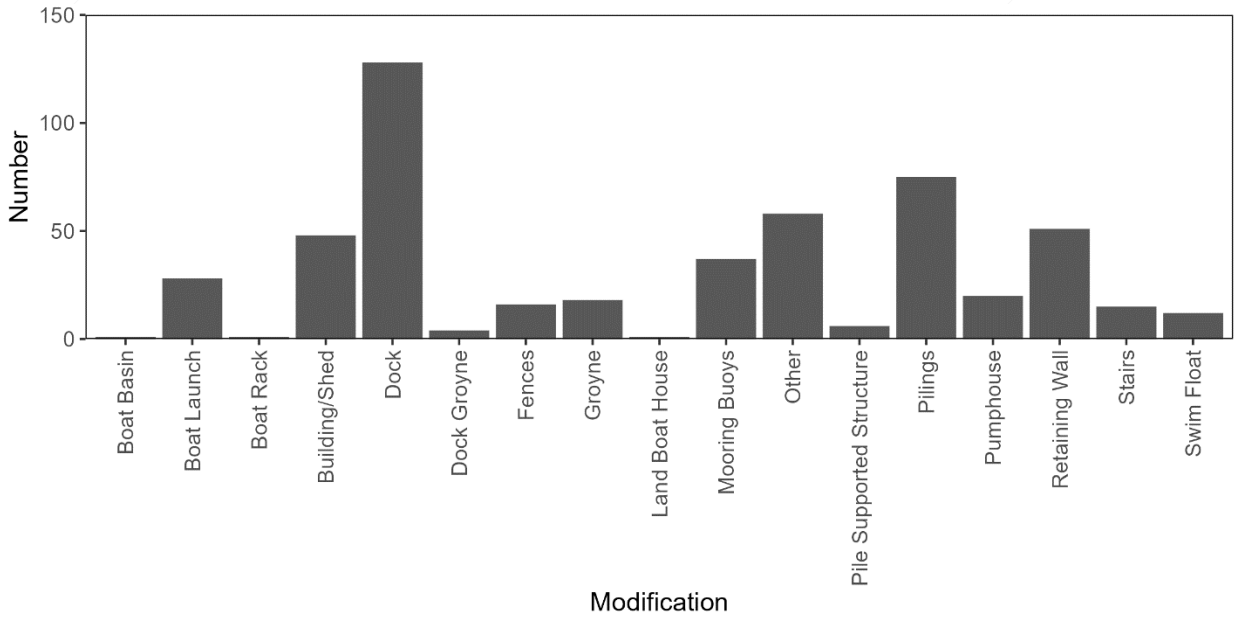

Figure 7. Foreshore modifications at Fraser Lake.

Photo 25. Shoreline and substrate modification associated with rail ballast (Segment 40).

Photo 26. Stella Road running along foreshore (Segment 5).

Photo 27. Example of retaining walls built along the shoreline (Segment 29).

Photo 28. Example of a retaining wall built below the high water mark of the lake (Segment 28).

Photo 29. High density of docks and evidence of beach grooming along shoreline (Segment 22).

Photo 30. Example of impacts to aquatic vegetation associated with a dock and boat access.

Photo 31. Example of sitting platforms and RV trailers along shoreline (Segment 28).

Photo 32. Old pilings along shoreline of White Swan Park (Segment 49).

Photo 33. Example of a private boat launch (Segment 25).

Photo 34. Public boat launch at Beaumont Provincial Park (Segment 39).

Photo 35. Example of recent development at/below high water mark (Segment 12). Note large pile of soil in close proximity to edge of water.

4.2.10 Level of Impact

In total, 18 segments (36.8% of the shoreline) were assessed as having a high (>50%) level of impact. Highly impacted areas were generally associated with areas of dense residential developments, railway and roads, or areas that had been cleared for agricultural/rural land uses.

Eighteen segments (30.6% of the shoreline) were assessed as having a medium (10-50%) level of impact. These areas were typically areas modified for agriculture or rural properties, as well as industry. Nine segments (20.3% of the shoreline), which were rural or natural areas, were assessed as having a low level of impact (<10%), and twelve segments (12.3% of the shoreline) were assessed as having no impact.

Table 15. Summary of impact score rating for each segment.

Level of Impact	Shoreline Length (m)	Shoreline %	Segments
High >50%	26,133	36.8	2, 5, 7, 15, 19, 22, 25, 26, 28, 29, 34, 38, 40, 41, 16, 49, 48A, 48B
Medium 10-50%	17,321	30.6	1, 3, 4, 6, 8, 10, 13, 17, 23, 30, 33, 35, 39, 42, 43, 44, 45A, 47,
Low <10%	18,766	20.3	9, 11, 12, 21, 31, 32, 45B, 51, 52
None	8,707	12.3	14, 16, 18, 20, 24, 27, 36, 37, 50, 53, 54, 55

4.2.11 Comparison of 2011 FIM and 2023 re-FIM Data

The shoreline was divided into 55 segments in 2011, and 57 segments in 2023, with the subdivision of Segments 45 and 48. The main differences observed between the surveys are discussed below.

4.2.11.1 Natural vs. Disturbed Shoreline

The total length of disturbed shoreline has increased from 19,513 m to 24,475 m since the 2011 survey, representing an increase of disturbed shoreline of 4,961 m (~7.0%) of the lake total shoreline over a 12-year period. However, it is noted that some of this difference is attributed to discrepancies in surveyor interpretation (see further discussion below and Table 21). When using an adjusted estimate of disturbance to only include segments where obvious changes in disturbance levels are evident between years, the percent difference is closer to 1,859 m (~2.6% of the shoreline; Figure 8). The overall rate of change corresponds with an estimated rate of change of 155 m (or 0.2% of the shoreline) per year.

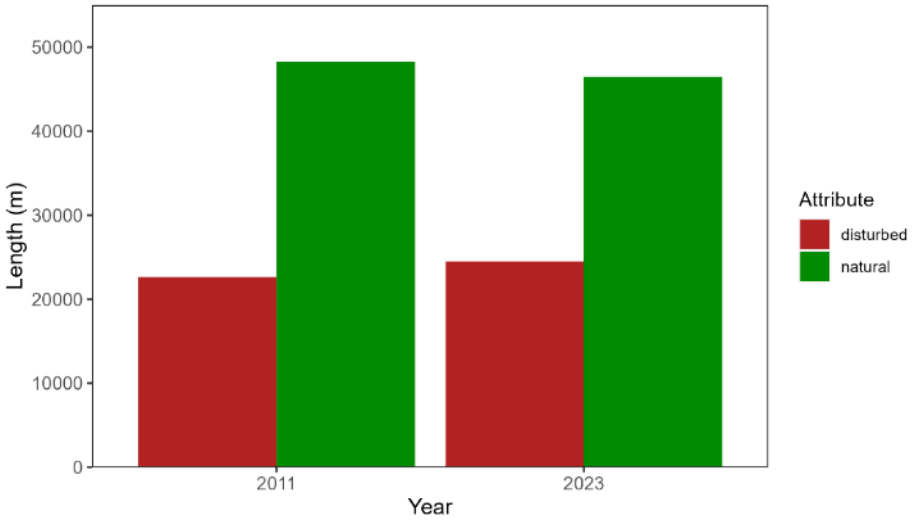

Figure 8. Comparison of the amount of natural and disturbed shoreline between 2011 and 2023 surveys.

Thirty of the fifty-seven segments showed increased disturbance from 2023 compared to 2011, with the greatest and most notable changes observed in Segments 6, 23, 13, 25, 28, 29 38, 11 and 19 (in order of greatest change to lower). These differences are described below:

- Segment 6: This segment is an area of private property at the west end of Fraser Lake, influenced by the presence of a float plane hangar, private campers, and clearing for roads within the riparian area. Comparison of historic and 2023 imagery shows new use of partially cleared foreshore area by campers (potentially temporary), as well as recent clearing for the lower portion of a private road (Photo 36 and Photo 37). Overall, the level of disturbance increased by 20% (from 25% to 45%), representing ~ 165 m of recently disturbed shoreline.

Photo 36. Google Imagery (2012) showing extent of Segment 6.

Photo 37. Aerial imagery from 2023 showing several private campers and a section of cleared vegetation for a new private road.

- Segment 23: This segment is an area of rural properties immediately west of Ormond Creek. Comparison of historic and 2023 imagery shows that since 2011, several campers and trailers have been established on the shoreline, and that additional riparian vegetation clearing has been undertaken around these features as well as for an access road built behind the structures (Photo 38 and Photo 39). Overall, the level of disturbance increased by 19% (from 1% to 20%), representing ~ 98 m of recently disturbed shoreline.

Photo 38. Google Imagery (2012) showing extent of Segment 23.

Photo 39. Google imagery (2022) showing additional riparian disturbance around structures and private road.

- Segment 13: This is a section of rural properties in a small bay at the west end of the lake. Comparison of survey data and imagery shows that 10 new shoreline modifications (a mix of docks, a boat launch, swim floats, buildings and sitting areas) have been installed along the shoreline since the 2011 survey (Photo 40 and Photo 41). Additionally, small sections of riparian vegetation have been further cleared in front of residential houses and for a new access road at the north end of the segment. Overall, the level of disturbance increased by 10% (from 40% to 50%), representing ~ 124 m of recently disturbed shoreline.

Photo 40. Google Imagery (2012) showing extent of Segment 13.

Photo 41. Representative photo of residential areas in Segment 13, with additional shoreline modifications compared to those counted in 2011.

- Segment 25: This a section of densely developed single-family residential properties along the north shore of Fraser Lake at Peterson Road, east of Ormond Creek. Comparison of survey data and imagery show that 43 new shoreline modifications (mostly retaining walls, docks, swim floats and buildings/sheds) have been established along this section of shoreline (Photo 42 and Photo 43). Overall, the level of disturbance increased by 10% (from 70% to 80%), representing ~220 m of recently disturbed shoreline.

Photo 42. Google Imagery (2012) showing extent of Segment 25.

Photo 43. Representative photo of densely developed properties along Segment 25

- Segments 28 and 29: This is a section of single-family residential properties along the north shore of Fraser Lake. Comparison of imagery shows a similar number of houses between 2011 and 2023, however data indicates that 19 new shoreline modifications (mostly retaining walls, docks, stairs and small buildings/sheds) have been established along this section of shoreline (Photo 44 and Photo 45). It was noted that several of the houses within these segments were built within 15 m of the shoreline. Overall, the level of disturbance in these segments increased by 10% (from 70% to 80%), representing ~293 m of recently disturbed shoreline.

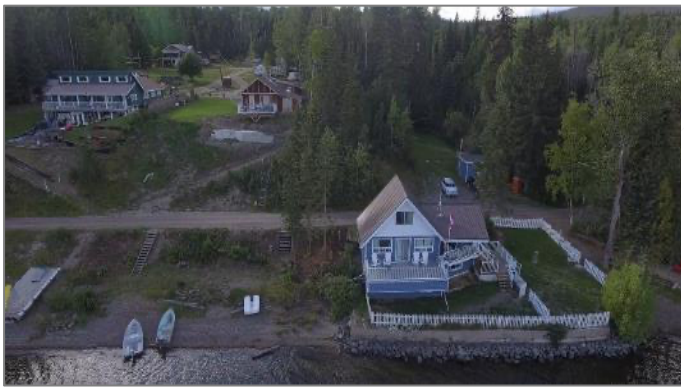

Photo 44. Representative photo of several shoreline modifications along Segment 28.

Photo 45. Representative photo of several houses and buildings close to the shoreline in Segment 29.

- Segment 38: This is a section of single-family residential properties on the Nautley Reserve. Comparison of imagery shows a similar number of houses between 2011 and 2023, however survey data indicates that 35 new shoreline modifications (mostly stairs, retaining walls, small buildings/sheds, fences and boat launches) have been established along this section of shoreline (Photo 46). It was noted that several of the houses within these segments were built within 15 m of the shoreline. Overall, the level of disturbance in these segments increased by 10% (from 50% to 60%), representing ~293 m of recently disturbed shoreline.

Photo 46. Representative photo of several shoreline modifications along Segment 38.

- Segment 11: This is a segment of rural properties off Mund Road at the west end of the lake. Clearing of vegetation appeared to have been recently undertaken on a property near the north end of the segment (Photo 47), resulting in an increase in disturbance for the segment of 6% (from 1% to 7%), representing ~195 m of recently disturbed shoreline.

Photo 47. Recent disturbance on a rural property along Segment 11.

- Segment 19: This is a segment of moderately dense single-family residential properties on the north shore of the lake. Comparison of survey data and imagery notes a small increase in the number of shoreline modifications along the lake, with a notable change on the property at the west end of the segment where a tract of vegetation along the shoreline of one property has recently been cleared of vegetation. A boat basin, which extended into the water, had also been recently constructed (Photo 48). The overall segment saw an increase in disturbance of 5% (from 70% to 75%, representing ~94 m of shoreline).

Photo 48. Recent disturbance on a rural property along Segment 19, including riparian clearing and new boat basin.

Several segments saw an increased level of disturbance that, based on review of historic imagery, were attributed to discrepancies in surveyor interpretation rather than actual changes on the landscape. These differences were typically due to the previous survey not considering disturbance associated with roads, railways, and agricultural fields, and are described briefly below.

Table 16. Differences in assessed level of disturbance attributed to discrepancies in surveyor interpretation.

Segment	Diff. in Level of Disturbance (%)	Comments
1	20 (from 30 to 50)	Section of shoreline on the south shore of Fraser Lake between White Swan Park and the municipal water treatment plant. Previous survey appears to have considered disturbance associated with residential properties (has not changed appreciably since 2011), but did not appear to consider disturbance associated with Park Drive and the railway tracks.
2	45 (from 10 to 55)	Section of shoreline immediately southeast of the outlet of Stellako River into Fraser lake. Previous survey did not appear to consider disturbance associated with agricultural field and railway tracks.
3	10 (from 15 to 25)	Outlet of Stellako River into Fraser Lake. Previous survey did not appear to consider disturbance associated with the agricultural field on the east side of the mouth.
4	16 (from 4 to 20)	Section of shoreline within the Stellaquo reserve at the west end of Fraser Lake. Previous survey did not appear to consider disturbance associated with riparian clearing for the agricultural field at the south end of the segment.
5	45 (from 25 to 70)	Previous survey did not appear to consider disturbance associated with Stella Road, which runs along entire length of segment.
17	10 (from 0 to 10)	Bay north of Stern Creek. Previous survey did not appear to consider disturbance associated with the agricultural field along the southern portion of the segment.
26	10 (from 50 to 60)	Peterson's Beach. Previous survey did not appear to adequately capture disturbance associated with the campground and boat launch.
33	10 (from 0 to 10)	Section of shoreline near the mouth of Nautley River at the east end of Fraser Lake. Previous survey did not appear to consider disturbance associated with the agricultural area at the north end of the segment.
35	15 (from 15 to 30)	Outlet of Fraser Lake into Nautley River. Previous survey did not appear to consider disturbance associated with an urban park on the south side of the bridge.
42	13 (from 2 to 15)	Section of shoreline on the south shore of the lake, immediately east of the Fraser Lake Sawmill. Previous survey did not appear to consider disturbance associated with railway tracks along much of the segment.
43	30 (from 10 to 40)	Section of shoreline on the south shore of the lake, north of the Fraser Lake Sawmills. Previous survey did not appear to consider disturbance associated with railway tracks along much of the segment.
44	19 (from 1 to 20)	Section of shoreline on the south shore of Fraser Lake immediately west of Fraser Lake Sawmills. Minor riparian clearing has been undertaken for a new road just west of the spit, however the previous survey did not appear to consider the removal of riparian vegetation associated with a fallow field that overlaps with the 50 m riparian area for much of the segment length.
45A, 45B	16 (from 2 to 18)	Section of shoreline on south shore of Fraser Lake, west of Fraser Lake Sawmills. Previous survey did not appear to consider disturbance associated with railway tracks along Segment 45A.

4.2.11.2 Land Use

In general, land use around the shoreline of Fraser Lake remained similar since the 2011 survey. Some minor reclassifications occurred in segments in consideration of the updated definitions provided in current methods (Schleppe et al. 2020) and differences in interpretation of the land use categories between surveys (Table 17). The predominant land use of segments generally remained the same between surveys.

Table 17. Summary of proportional land uses on Fraser Lake shoreline in 2011 and 2023 surveys.

Land Use Classification	2011 (%)	2023 (%)	% Change	Comment
Agricultural	2.6	5.2	2.6	Hay and livestock fields in Segments 2, 3, 7, 17, and 33 not considered in 2011.
Commercial	0.0	0.2	0.2	Piper's Glen Resort (Segment 40) not considered in 2011.
Conservation	0.4	0.4	0.0	-
Industrial	1.2	1.8	0.6	Included for the float plane hangar (Segment 6), eastern portion of Fraser Lake Saw Mills (Segment 42) and the industrial work camp at Lejac (Segment 45).
Natural Area	23.1	11.8	-11.8	Several areas previously identified as Natural Area were reassigned as Rural or Agricultural to be consistent with current method definitions.
Park	2.7	2.7	0.0	-
Recreation	0.2	0.0	-0.2	Piper's Glen Resort (Segment 40) reclassified from Recreation to Commercial.
Rural	32.8	43.1	10.2	Several areas classified previously classified as Natural Area were reassigned as Rural transportation to be consistent with current method definitions.
Single Family	14.6	14.2	-0.4	Single Family was slightly adjusted for Segment 1 and 13 based on adjustments for Urban Park, Transportation and Rural land use.
Transportation	21.7	19.8	-1.9	Adjusted to only capture areas where road and railway were within 5 m of HWM.
Urban Park	0.7	1.3	0.6	Included for the portion of Whiteswan Park in Segment 1, as well as the community park in Segment 35.

The following ten segments were reclassified for land use and were updated based on interpretation of descriptions provided in current methods (Schleppe et al. 2020).

- Segments 3 and 4 – This segment was reclassified from natural area to rural based on the rural land use within Stellaquo reserve on the eastern portion of the segment.
- Segment 5 – This segment was reclassified from rural to transportation based on the presence of Stella Road immediately adjacent to the shoreline along most of the segment length.
- Segments 24, 32, 33, 35, 36, 44, and 47 – This segment was reclassified from natural area to rural to be consistent with current method definitions.

4.2.11.3 Aquatic Vegetation

The total length of shoreline with aquatic vegetation was higher in 2023 (~31,285 m, ~35.5 % of the shoreline), compared to 2011 (25,203 m, ~44.1 % of the shoreline). While the amounts of emergent and floating aquatic vegetation were comparable between the two surveys, the main difference is attributed to a much higher occurrence of submergent vegetation along the shoreline (28.5% in 2023 vs 0.1% in 2011; Table 18). This may be due to differences in submergent vegetation cover from year to year, as occasional algae blooms and aquatic plant infestations have been reported to occur in Fraser lake (Jacklin and Carmichael 2002). The discrepancy may also be due to observation error in 2011; data from 2023 should be used for comparison in further studies.

Table 18. Summary of aquatic vegetation observed in 2011 and 2023 surveys.

Year	Aquatic (Total m; %)	Submergent (Total m; %)	Emergent (Total m; %)	Floating (Total m; %)
2011	25,203 m; 35.5%	51m; 0.1%	24,826 m; 35.0 %	1,269 m; 1.8%
2023	31,285m; 44.1%	20,209m; 28.5%	19,114 m; 26.9%	1,935 m; 2.7%

4.2.11.4 Level of Impact

The categories for defining level of impact for 2011 and 2023 surveys were slightly different (i.e., in 2011 “Medium” was classified as 10-40%, whereas in 2023 “Medium” was 10-50%). To account for this, an “equilibrated level of impact” was assigned to 2011 data to ensure that all data was being grouped into similar categories. When comparing the equilibrated level of impact for both years, eleven segments were reclassified at a higher level of impact between the 2011 and 2023 surveys. Eight of these instances (Segments 2, 4, 5, 17, 33, 42, 41, 44) were assessed at a higher level of impact based on discrepancies in surveyor interpretation between surveys (see Table 16). The remaining three are discussed below:

- Segment 23 was reclassified from a low to medium level of impact with an increase in disturbance from 1% to 20%. This was due to several campers and trailers that have been established on the shoreline and clearing of riparian vegetation around these features for an access road built behind the structures (Photo 36 and 37 above).
- Segment 30 was reclassified from a low to medium level of impact with an increase in disturbance from 6% to 10%. This is a segment of rural properties on the northeast shore of the lake, and disturbance was generally associated with an increase in shoreline modifications that had been constructed recently (e.g., 1 new dock, 4 new boat launches).
- Segment 38 was reclassified from a medium to high level of impact, with an increase in disturbance from 50% to 60%. This was mainly due to the large increase (n=35) in shoreline modifications observed during the 2023 survey (Photo 44 above).

4.2.11.5 Shoreline Modifications

Due to changes in methodology, not all of the shoreline modifications that were counted in 2023 were considered during the 2011 survey. Changes in the 6 shoreline modification types that were considered in both surveys are described below and shown in Figure 9:

- The number of boat launches increased by 19, from 9 to 28. One of these was the addition of a public boat launch at White Swan Park (Segment 49), but the remainder were associated with private lands in residential or rural properties (Segment 19 (n=1), Segment 25 (n=3), Segment 28 (n=2), Segment 29 (n=1), Segment 30 (n=3), Segment 38 (n=2), and Segments 39 (n=1), Segment 40 (n=1), Segment 44 (n=1)).
- The number of retaining walls increased by 15, from 36 to 51. This corresponds with a linear increase of ~403 m, or 0.6% of the shoreline.
- The number of docks increased by 13, from 115 to 128. These were typically associated with residential and rural properties, with more docks typically seen in denser areas (e.g., 12 new docks in Segment 25). A few segments actually had fewer docks counted in 2023, though several abandoned docks were also counted along the shoreline (categorized as other) in 2023.
- The number of groynes increased by 1, from 17 to 18. Additionally, 4 dock groynes were also counted in 2023.
- One (1) land boat house was counted in both years in Segment 25.
- One (1) marine rail that was observed in Segment 7 in 2011 was not present in 2023.

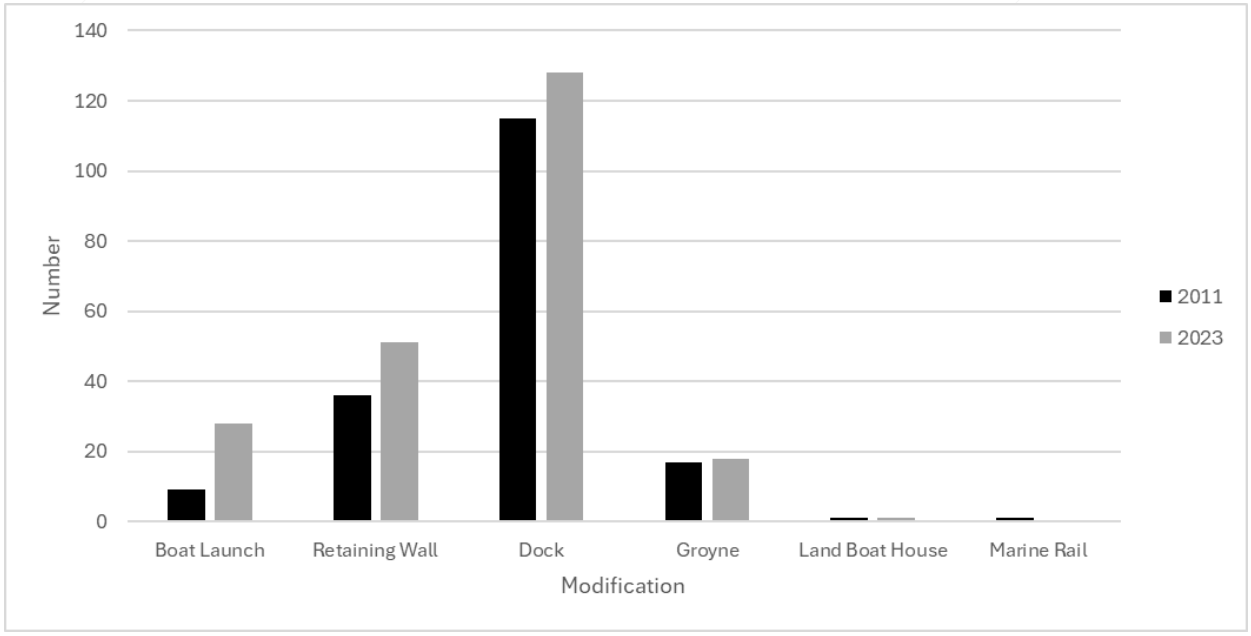

Figure 9. Comparison of the number of shoreline modifications counted on the foreshore of Fraser Lake in 2011 and 2023.

4.3 Foreshore Habitat Sensitivity Index

4.3.1 Summary of FHSI Values

A summary of FHSI scoring is provided in Table 19, and in Figure 10. A detailed table of the FHSI data and calculations is provided in Appendix 5. Individual segments were assigned an ecological rank of Very Low, Low, Medium, High, and Very High, based on their FHSI score. The highest percentage of the ecological ranking along the shoreline was Very High (26.9%), followed by High (24.6%), Medium (21.6%), Very Low (15.5 %), and Low (11.4 %). A map showing the shoreline rankings is provided in Appendix 1.

A Very High ecological rank was generally assigned to areas with extensive wetlands, including the following areas:

- The mouth of the Stellako River into Fraser Lake (Segments 2, 3, and 4), and the outlet of Fraser Lake into Nautley River (Segments 33, 35, 36, 37, and 55). These areas are high value rearing, staging, and migration habitat for fish, particularly for salmon. The presence of wetlands and abundant aquatic vegetation are important for fish and wildlife, including waterfowl.
- The mouth of Ormond Creek (Segment 24). This area is also considered to be important habitat for fish in terms of staging and migration. The current undisturbed nature of the riparian area, as well as presence of ecosystems at risk, also drove the high score of this segment.
- Two bays with abundant wetland/floodplain habitat on the north shore of the lake (Segment 10, and Simon Bay (Segments 16, 17, and 18)). The high scores for these segments were driven primarily by the presence of wetlands, high value fish habitat, and the presence of relatively undisturbed mature forest for the latter three segments.
- Two areas of relatively undisturbed shoreline along the south shore at Beaumont Provincial Park (Segment 39) and further east (Segment 42). The high scores for these segments were driven primarily by the presence of relatively undisturbed mature forest and wetlands along the foreshore, as well as the presence of four ecosystems at risk within each segment.
- Huntly Island (Segment 50). Huntly Island was a relatively unique island on Fraser Lake in that it was completely undisturbed and had mature coniferous forest present (including several veteran trees and snags, as well as two eagle nests). The blue-listed Douglas-fir - lodgepole pine / clad lichens ecosystem is also present here. The shoreline is also reportedly used by congregating waterfowl.

A High ecological rank was assigned to areas of relatively undisturbed private and crown properties near Simon Bay (Segments 11, 12, 14, and 15) and the north shoreline (Segments 20, 23 and 27 31 and 32), as well as Segments 40, 44 and 45B on the south shoreline of the lake.

Conversely, segments that were assigned a Very Low ecological rank were areas that had been heavily disturbed for densely developed single-family residential areas (Segments 19, 22, 25, 28 and 29) or transportation (Segments 46 and 48A), as well as White Swan Park (Segment 49).

Table 19. Summary of shoreline length, shoreline percentage and segments with the FHSI rankings.

Rating	Range	Shoreline Length (m)	Shoreline %	Segments
Very High	>66	19,105	26.9	2, 3, 4, 10, 16, 17, 18, 24, 33, 35, 36, 37, 39, 42, 50, 55
High	58 - 66	17,427	24.6	11, 12, 14, 15, 20, 23, 27, 31, 32, 40, 44, 45B
Medium	50 - 58	15,321	21.6	1, 6, 7, 8, 9, 13, 30, 38, 41, 51, 54
Low	42 - 50	8,068	11.4	5, 21, 26, 34, 43, 45A, 47, 48B, 52, 53
Very Low	<42	11,006	15.5	19, 22, 25, 28, 29, 46, 48A, 49

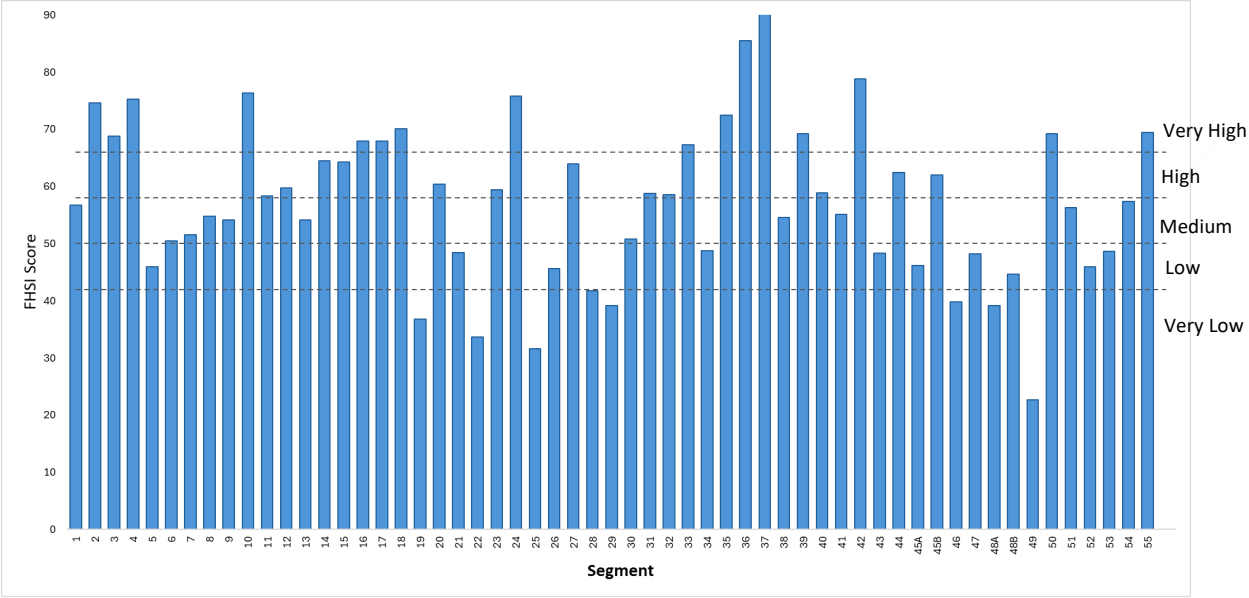

Figure 10. Plot of FHSI scores for each segment based on the criteria used in Table 3.

4.3.2 Zones of Sensitivity

Zones of Sensitivity (ZOS) are defined as specific areas that are identified as important habitats for either species or general ecosystem function (Schleppe et al. 2020). Five ZOS were identified during the FIM surveys and background review and are described below:

- **Stream Mouths** - Stream mouths provide a source of nutrients to the lake and can be key staging areas for both adult spawners and emergent fry/juveniles. The Stellako River is the main inlet of Fraser Lake and is an important migratory corridor for Sockeye and Chinook Salmon. The mouth of the Stellako River (Segment 3) has also been identified as important habitat for White Sturgeon. The Nautley River, which is the outlet of the lake, is also an important staging and rearing area for

fish, especially for Salmon. Ormond Creek historically supported spawning sockeye and chinook salmon, though these have not been observed here for many years. Possibilities to reestablish a salmon run in Ormond Creek is being explored (W. Salewski, pers. comm.). The riparian zones around streams also provide high value wildlife habitat. A 200 m radius was used for polygons at the lake inlet and outlet (i.e., Stellako and Nautley Rivers) and Ormond Creek). A 100 m radius was used for smaller tributary streams with known fish presence upstream, and 30 m buffers were applied to small stream outlets (typically culverted under roads or railway) that may provide some habitat and nutrient input into Fraser Lake. The buffer around Ormond Creek also captures the blue-listed mountain alder / common horsetail floodplain ecosystem present within the riparian area. For all stream mouths, the ZOS includes a 30 m setback from the stream within the 50 m foreshore assessment area.

- **Wetlands** - Wetlands are areas of high productivity, provide key habitat for fish, birds and other wildlife, and protect the shoreline from wind/wave erosion. Six wetland ecosystems were identified around the shoreline of Fraser Lake, including four of which are blue-listed by the province. An umbrella "wetland" ZOS that captures these features has been delineated and is present along several bays and shoreline sections.
- **Shallow/Wide Littoral Zones:** Shallow/wide littoral zones typically have abundant aquatic vegetation, which contributes to primary productivity and provides important habitat for fish, and typically encompass areas used by congregating waterfowl. These areas are often adjacent to populated areas around the lake and are sensitive to disturbance from foreshore development (e.g., dock and groyne construction) and boat action. This zone of sensitivity was delineated around much of the shoreline based on field data and orthoimagery.
- **Douglas-fir lodgepole pine / clad lichens ecosystem (SBSdw3/102):** This provincially blue-listed ecosystem includes areas of both valuable old-growth forest and grassland ecosystems, which are unique around the lake, and are sensitive to development. This ZOS was mapped within the 50 m riparian area of the lake where it was found on warm aspects with shallow slopes. This is included in Segments 21, 31-33, and 50.
- **Black cottonwood - hybrid white spruce / red-osier dogwood ecosystem (FM02):** This is a provincially blue-listed ecosystem. In addition to being an ecosystem at risk, these areas also support a large variety of plant and wildlife species. Because cottonwoods grow quickly and die relatively young, these sites often include many large trees and snags, which are valuable habitat features. This ZOS was mapped within the 50 m riparian area of the lake or up to distinct linear boundaries (e.g., railway or large roads) where it was found in patches on sand- or gravel-dominated shorelines (Segments 23-24, 29-30, 36-42, 44-46).

4.3.3 Potential Conservations Zones

Fraser Lake is considered an Important Bird Area by Bird Life International due to its importance for migrating waterfowl and wintering Trumpeter Swans and also provides critical habitat to salmon species and the Nechako White Sturgeon population. As such, several areas around Fraser Lake have been proposed for consideration as Conservation Zones. Currently, the only section of shoreline designated as a conservation area is Ellis Island (Segment 23), representing 309 m (0.4%) of shoreline, which is quite low. Although this island ranked relatively low within the FHSI scoring framework, we recommend that Ellis Island continue to be designated for conservation given its unique value for gull nesting colonies.

In addition to Ellis Island, several highly ranking shoreline segments were identified during this survey that would be suitable candidates for conservation zones. These are discussed below.

The mouth of the Stellako River into Fraser Lake (Segments 2, 3, and 4), and the outlet of Fraser Lake into Nautley River (Segments 35, 36, 37, 54, and 55) are high value rearing, staging, and migration habitat for fish. In a sense, these areas act as migration “pinch points” for fish moving in and out of Fraser Lake, most notably for salmon during spawning and outmigration periods. Additionally, the cold-water input from the Stellako River into Fraser Lake likely provides thermal refugia for fish in the west basin of the lake during summer months. In consideration of climate change, these areas may become increasingly important during hot summers. The presence of wetlands and abundant aquatic vegetation in these areas are important for fish and wildlife, including waterfowl. As these areas generally remain free of ice during the winter, they both provide particularly important habitat for wintering Trumpeter Swans. Negative impacts to aquatic or riparian habitat in these areas could disproportionately compromise habitat connectivity between Fraser Lake and upstream/downstream aquatic habitat, because alternative migration routes are unavailable. Currently, the Stellako River Wildlife Management Area provides partial protection of the connectivity corridor between Fraser and François Lakes. Continued preservation of the Stellako River shoreline and associated riparian area within the Stellaquo Reserve is important to ensure a continuous corridor. Similarly, preservation of aquatic and riparian habitat associated with the Fraser Lake outlet and Nautley River is highly important to maintain a properly functioning corridor between this habitat and the downstream Nechako River.

The mouth of Ormond Creek (Segment 24; Photo 51) is a unique feature on Fraser Lake. It has an ecologically sensitive mature cottonwood floodplain, as well as the blue-listed mountain alder / common horsetail floodplain ecosystem. Ormond Creek has had historic returns of Sockeye and Chinook salmon, and there is consideration by locals to reestablish a salmon run here (W. Salewski, pers. comm.). This area was undeveloped at the time of the 2023 survey but posted as for sale. Potential development threatens

this sensitive area, as well as the important ecological values it provides. Additionally, any development here would be on the alluvial fan of Ormond Creek and could be vulnerable to potential risk of flooding.

Huntly Island (Segment 50; Photo 52) is another high value feature on Fraser Lake. This relatively undisturbed, privately owned island had several sensitive features including old growth forest, the blue-listed Douglas-fir lodgepole pine / clad lichens ecosystem, wetlands, two raptor nests, and is reportedly used by congregating waterfowl.

The mouth of Stern Creek and the associated wetland area at the west end of Simon Bay (Segments 16 and 17) is another high value area on Fraser Lake. The privately owned land is relatively undisturbed, with the exception of a small agricultural field which approaches the shoreline in the central portion of the property. The large tract of undisturbed wetland provides high value habitat to a variety of wildlife, and this section of shoreline also contains high value fish habitat and relatively undisturbed mature forest. Habitat within this area is continuous with a natural area associated with the lot of crown provincial land to the northeast (Segments 17 and 18).

These features should be considered designation as conservation zones and could be in the form of conservation covenants. These areas could also be of interest to conservation groups such as Nature Trust of BC and Nature Conservancy of Canada in property acquisition. This would require a concerted and collaborative approach by the property owners, RDBN, conservation organizations, First Nations, and any interested stakeholders.

Photo 49. Representative photo of the outlet of Stellako River and associated wetlands (Segments 2, 3, and 4).

Photo 50. Representative photo of Fraser Lake outlet into Nautley River (Segments 35, 36, 37, 54 and 55).

Photo 51. Representative photo of the mouth of Ormond Creek (Segment 24).

Photo 52. Representative photo of the south shore of Huntly Island (Segment 52).

Photo 53. Representative photo of the mouth of Stern Creek at the west end of Simon Bay (Segment 24).

4.3.4 Culturally Sensitive Areas

Several areas of cultural sensitivity are present along the shoreline of the lake. These areas continue to be of importance to local First Nations and need to be appropriately preserved and protected during foreshore development. Culturally sensitive areas identified by Stellat'en and Nadleh Whut'en First Nations have been delineated with a suitable buffer on the Fraser Lake Foreshore Inventory Maps (Appendix 1)[4]. In some cases, these areas are of a sensitive nature, and the exact locations have been requested to be kept confidential. Development in these areas should proceed with appropriate consultation and considerations for archaeological potential of the area.

[4] Note that the culturally sensitive areas shown on the maps are not exhaustive, and additional culturally sensitive areas may be present around Nadleh Bun.

4.3.5 Comparison of 2011 and 2023 FHSI Results

The FHSI framework that was developed for this survey was also applied to the data collected in 2011, as this step was not previously completed with the 2011 data. To compare the FHSI values between years, we ran both sets of data using the 2023 index. Table 20 summarizes the amount of shoreline area designated as Very High, High, Medium, Low and Very Low habitat index rankings using data collected in 2011 and in 2023. Thirteen segments had a different shoreline ranking between the surveys, however ten of these changes were mainly attributed to differences in interpretation of categories for vegetation bands B1 and B2 between surveys, which generally resulted in a higher calculated FHSI value in 2023. Three segments were reclassified to a lower FHSI value based mainly on differences attributable to recent development activities, and driven by an increase in shoreline modifications counted in 2023 compared to 2011:

- Segment 6, which experienced a 20% increase in disturbance due to the construction of a new road and new trailers parked along the shoreline, was reclassified from Medium to Low.
- Segment 11, which experienced a 6% increase in disturbance due to the clearing of vegetation recently undertaken for a new rural development, was reclassified from High to Medium.
- Segment 28, which experienced a 10% increase in disturbance and had several new shoreline modifications, was reclassified from Low to Very Low.

Table 20. Summary of shoreline length, shoreline percentage and segments with the 2011 and 2023 FHSI rankings.

	2011			2023		
Rating	**Shoreline Length (m)**	**Shoreline %**	**Segments**	**Shoreline Length (m)**	**Shoreline %**	**Segments**
Very High	19,105	26.9%	16	16,241	22.9%	13
High	17,427	24.6%	12	8,950	12.6%	11
Medium	15,321	21.6%	11	28,266	39.9%	16
Low	8,068	11.4%	10	8,815	12.4%	8
Very Low	11,006	15.5%	8	8,655	12.2%	7

5 DISCUSSION

The foreshore of Fraser Lake has experienced substantial changes since the initial FIM in 2011. The total length of shoreline assessed as disturbed in 2023 is 35% with an increase of ~2.6% (~1,859 m) since 2011 (see Section 4.2.12.1). This represents an overall rate of change of 155 m (or 0.2% of the shoreline) per year. This rate of change is higher than most re-FIM surveys undertaken by Living Lakes Canada (Table 21). Increased disturbance was most prominent in rural and residential areas (Segments 6, 11, 13, 19, 25, 28, 29 and 38) with vegetation clearing, construction of new roads and residential developments, and increases in shoreline modifications including retaining walls, docks, swim floats, boat launches and buildings/sheds. The south shore of Fraser Lake remains impacted by the presence of the CN railway line

along most of the south shoreline, with historic removal of riparian vegetation and placement of ballast rocks directly into the lake along some of the sections. The railway corridor may disrupt animal movement to and from the lake, however, it may also provide benefits by limiting the amount of residential expansion into this area.

Table 21. Comparison of rate of change from natural to disturbed shorelines from recent re-FIM surveys.

Lake	Initial Survey	Re-FIM Survey	Lake perimeter (m)	Loss of Natural Shoreline			
				Total (m)	Total (%)	Per Year (m)	Per Year (%)
Slocan	2010	2021	88,566	80	0.1	7.3	0.01
Columbia	2009	2021	39,563	75	0.2	6.8	0.02
Windermere	2006	2020	37,400	369	1	26	0.07
Moyie	2008	2020	37,638	471	1.2	38	0.1
Kootenay	2012	2021	406,811	4,525	1.1	488	0.12
St. Mary	2010	2022	10,450	560*	5.4*	62	0.59
Okanagan	2009	2016	290,073	4,116	1.4	588	0.2
Fraser Lake	2011	2023	70,928	1,859	2.6*	155	0.2

Notes: *St. Mary Lake and Fraser Lake values used an adjusted level of % disturbance to reflect a more accurate estimate for previous surveys.

Many rural areas in the province have seen an influx of residents in the last few years attributed in part to the increasing possibilities of working remotely that have been prompted by the COVID-19 pandemic, as well as retirees from the baby boomer generation seeking an affordable rural lifestyle (e.g., The Orca 2020, The Tyhee 2023). Anecdotally, many local residents have commented that the pulse of non-resident workers associated with the Coastal Gas Link pipeline exposed Fraser Lake and the surrounding area to many people. Although Fraser Lake has seen a decrease in population over the last decades (Fraser Lake 2018), the town is a likely candidate for future population increase with its relatively low housing costs, abundant recreational opportunities, and intrinsic natural beauty. The area has already seen a shift from seasonal to year-round living (RBDN 2009), and it is possible that new properties will be bought and developed. Several undeveloped shoreline properties on the north shore of the lake are currently zoned for residential use (e.g., Segments 13, 14, 15, 21, 24, 28), and it is likely that these areas could come under development pressure in the future.

With the existing land uses and potential for population increase around the lake, Fraser Lake will continue to face development pressure and impacts to the natural resources associated with the lake. Currently, the main pressures include development impacts from single-family and rural properties, problems with the Village's aging sewage treatment system, algal blooms and aquatic plant infestations attributed to phosphorus and sediment loading, and temperature increases. The key non-point sources of phosphorus and sediment have been identified as septic systems and grey water, stormwater runoff from lawns and

agricultural areas, tree removal and inputs from the upstream Stellako-Endako system (Jacklin and Carmicheal, 2002).

The effects of climate change will likely further stress the shoreline and riparian areas of Fraser Lake in the years to come. Forest fires are becoming more common in the area, and the 2018 Shovel Lake Fire was a reminder of how vulnerable the surrounding communities are to wildfire activities (e.g. Sharp and Krebs 2018). Water levels in Fraser Lake during the 2023 survey were anecdotally reported to be the lowest they had been at that time of year in years (W. Salewski, pers. comm). Additional impacts of climate change include altered hydrological patterns, increasing water temperatures, and changes to the natural vegetation communities.

One of the key mechanisms for protecting the Fraser Lake foreshore is through the regulated management of foreshore development. Section 4.2 of the RDBN OCP provides recommendations for the protection of the Natural Environment and recognizes the provincial government as having the primary responsibility in managing this resource. The OCP encourages private property owners and property developers to follow best management practices to protect environmental sensitive habitats and unique features. The RDBN does not currently have Development Permit Areas specific to developments along the foreshore of Fraser Lake. Under a previous bylaw (RDBN Zoning Bylaw No. 700), a 7.5 m building setback was prescribed for all buildings and structures except for a fence from the natural boundary of lakes such as Fraser Lake. The current RDBN Zoning Bylaw (Zoning Bylaw No. 1800, Section 3.0.8) now prescribes a 15 m setbacks for Fraser Lake ,except where a property is smaller than 2,025m^2 and the setback is 7.5m. Stellako and Nautley Rivers have a 30 m setback (RDBN 2020). The RDBN Floodplain Management Bylaw No. 1878 (2020) also affects the siting of buildings and structures on waterfront properties. This Bylaw specifies an elevation of 671.80 m and 7.5 m setback requirements for Fraser Lake. Currently, development proposals along Fraser Lake within the RDBN jurisdiction require approval through the rezoning process, which are considered with respect to their impact on the community and natural environment. The Village of Fraser Lake does not have a Development Permit Area that applies to waterfront areas but recognizes that the Village-owned waterfront lands are a significant public asset, and a prime location for public recreation and amenity development (Fraser Lake 2018). Development in Waterfront areas should occur in accordance with a development plan approved by Council following public consultation.

It is evident from this survey that recent shoreline development, both within and beyond the current setback areas stipulated by the RDBN, and sometimes even extending below the lake high water mark, is impacting sensitive ecosystems and lowering the habitat value of riparian areas along the Fraser Lake shoreline. This was most evident in residential and rural areas. It is not known whether these

developments were reviewed and approved by the appropriate regulatory bodies prior to occurring. A more stringent review process, through the implementation of a formal Waterfront Development Permit Area, as well as enforcement of policies are recommended.

6 RECOMMENDATIONS

The following recommendations should be considered for the protection of sensitive habitats around Fraser Lake:

1. **Protection of zones of sensitivity (ZOS):** Zones of sensitivity include stream mouths that provide staging and rearing habitat for salmonids and White Sturgeon, wetlands, shallow littoral zones with submergent vegetation, the blue-listed Douglas-fir lodgepole pine / clad lichens and black cottonwood - hybrid white spruce / red-osier dogwood ecosystems.
2. **Designation of conservation areas:** Consider designation of conservation areas. Areas recommended for consideration include the outlet of Stellako River into Fraser Lake (Segments 2-4), the lake outlet into Nautley River (Segments 35, 36, 37, and 54), the mouth of Ormond Creek (Segment 24), Huntly Island (Segment 50), and the mouth of Stern Creek and the associated wetland area at the west end of Simon Bay (Segments 16 and 17). Landowner acceptance would be required for these areas as they lie within privately owned property. These areas could also be of interest to conservation groups such as Nature Trust of BC and Nature Conservancy of Canada in property acquisition.
3. **Update the RDBN and Village of Fraser Lake OCPs with the results of the FIMP:** The current OCPs do not include information regarding the Ecological Rankings associated with the shoreline. Specific requirements for foreshore development, as outlined in the Foreshore Development Guide, would be required based on shoreline Ecological Shoreline Rankings.
4. **Establish a Waterfront Development Permit Area under the RDBN and Village of Fraser Lake OCPs, and any Land Planning Processes within Stellat'en and Nadleh Whut'en Reserves:** A Waterfront Development Permit Area (WDP) is recommended for Fraser Lake, extending from the natural boundary of the lake upland. We suggest that this WDP area be established around the entire Fraser Lake shoreline, including islands, regardless of the foreshore ecological ranking designation. Additionally, we recommend that this WDP Area be established around all other watercourses, including streams and wetlands. A 15 m setback has been identified by the RDBN, however we recommend that the setback be 30 m to align with provincial standards. A WDP does not preclude development within these areas, however, landowners would be required to obtain a Development Permit prior to proceeding with any projects including any construction (such as addition or alteration of a building or other structure) or alteration of land (such removal of riparian or aquatic vegetation, site grading, deposition of fill, beach creation, or dredging), and would

require an Environmental Impact Assessment report prepared by a QEP. During redevelopment of properties that currently have structures within the proposed WDP area, property owners should be encouraged to construct new buildings further from the natural boundary where feasible.

5. **Implement a collaborative permitting process for the WDPs:** At the time of this report, local first Nations are not involved or consulted for shoreline development projects permitted at the municipal or regional levels. Given the social, cultural, and spiritual values associated with Nadleh Bun, it is strongly recommended that the issuance of WDPs through the Village of Fraser Lake and the RDNB be done as a collaborative permitting process that meaningfully involves both Stellat'en and Nadleh Whut'en First Nations.
6. **Conduct a formalized archaeological assessment and develop a local Chance Find Procedures document:** Given the prevalence and importance of culturally sensitive areas around the lake, it is critical to ensure that these areas are protected during foreshore development. Per discussions with Stellat'en and Nadleh Whut'en First Nations, it is recommended that a formalized archaeological assessment be completed around Nadleh Bun to identify sensitive areas, particularly around Lejac and the Stellaquo and Nadleh Reserves. A local Chance Find Procedures for Archaeological Material should be developed which provides information on how developers and contractors can manage for potential archaeological material discoveries during construction and maintenance activities. This should be made readily available to developers, contractors, property owners and the public (e.g., posted on the RDBN website and issued with Development Permits).
7. **Implement a co-governed compliance and enforcement committee:** In conjunction with the recommendations for a WDP area and collaborative permitting process, a compliance and enforcement committee that integrates local governments and Stellat'en and Nadleh Whut'en First Nations is also recommended in order to promote the effectiveness of the WDP Area requirements.
8. **Consider climate change during foreshore planning:** Foreshore planning should be done to help mitigate climate-related impacts including wildfire, changes to water temperature and quality, and hydrological changes. Sensitive features and habitats should be properly considered to properly protect these areas and the resilience they provide.
9. **Educate landowners regarding waterfront property protection, permitting processes, and stewardship:** Owning waterfront property comes with an inherent responsibility for the stewardship of the shoreline and associated habitat. Education programs should be implemented regarding best management practices and requirements that go along with waterfront properties, including wastewater and stormwater management, and permitting requirements at all levels of government. These programs could be implemented by a combination of by the RDBN, Village of

Fraser Lake, Fraser Basin Council, Nechako Watershed Roundtable and Nechako Environment and Water Stewardship Society.

10. **Post signage around the lake encouraging responsible boat use:** Consider posting signage at and near public boat launches encouraging boat users to exercise appropriate care to avoid disturbance to sensitive areas and habitat. Suggestions for information to be posted include:
    - Recommend a no motorized boat zone and/or restricted speed zones around the mouth of Stellako and Nautley Rivers during salmon spawning periods.
    - Encourage boat users to exercise caution within shallow littoral areas to minimize disturbance to substrates and aquatic vegetation.
    - Encourage boat users to exercise caution in areas where water birds congregate and avoid areas where nesting birds may be present during the nesting season (i.e., particularly around wetland areas).
11. **Encourage communal boat launches and shared docks:** Future development in residential areas should consider the use of communal boat launches, and property owners should be encouraged to use these rather than constructing private boat launches wherever possible. It may be worth considering offering incentives for removal/restoration of existing private boat launches where communal boat launches are available nearby. Property owners in densely populated areas should also be encouraged, where possible, to share features such as docks or swim floats with neighbours, rather than having several of these features on adjoining lots.
12. **Prohibit the placement of mooring buoys and docks in wetland and stream mouth ZOS:** Some instances of private docks and mooring buoys within sensitive areas such as wetlands were observed during the 2023 survey of Fraser Lake. These features can result in harmful scouring of substrates and disturbance of aquatic vegetation (e.g., Columbia Lake FIMP, Wood 2021). While Fraser Lake is not currently subject to heavy private moorage, it is recommended that a proactive approach be taken to manage the impacts of these features. It is recommended that non-tenured mooring buoys and docks be removed from wetland and stream mouth ZOS, and that future permitting does not allow for the placement of these structures within these sensitive habitat areas.
13. **Manage livestock access to waterfront properties:** Education for agricultural landowners around best management practices for livestock access to the waterfront is recommended. This can include practices such as fencing portions of the shoreline to limit access to fewer areas, placing feed and salt away from watercourses, cleaning up manure from sloped access, and directing surface runoff away from the shore.
14. **Encourage riparian restoration efforts in disturbed areas:** In conjunction with the above recommendation, riparian restoration should be encouraged for both proposed developments, as well as existing disturbances to riparian areas. Existing disturbances that are good candidates for

riparian restoration include recent developments with extensive areas of exposed soils (e.g., such as those seen in Segments 11, 12, and 19), as well as areas where planting could be done along the waterfront edge of agricultural fields (e.g., Segments 2, 7, 17, and 34). Additional areas that may be considered for restoration include disturbed shorelines associated with roads and railways, however these efforts would need to be properly planned to ensure that they do not interfere with regular maintenance of the associated rights-of-way.

15. **Protection of freshwater mussels:** Western/Oregon Floater mussels were found to be widespread throughout Fraser Lake. Adult freshwater mussels have a limited ability to disperse and are sensitive to changes in the foreshore and littoral zones. At the very least any development impacting littoral areas should include a mussel survey for permitting.
16. **Lake wide Mussel Survey:** A lake wide mussel survey should also be conducted to determine the extent and distribution of mussels throughout the lake. Consider completing the survey over multiple years to capture and consider annual variances.

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APPENDIX 1. FRASER LAKE FORESHORE INVENTORY MAPS

APPENDIX 2. FRASER LAKE SEGMENT SUMMARIES

APPENDIX 3. SPECIES LIST

APPENDIX 4. SPECIES AT RISK

Appendix 4. Species at risk confirmed to occur in Fraser Lake and surrounding area.

Scientific Name	Common Name	Provincial Status	BC List[1]	COSEWIC[2]	SARA[2]	Comment/Reference[3]
Amphibians						
Anaxyrus boreas	Western Toad	S4	Yellow	SC	1-SC	Along Ormond Creek above Stella Rd. (GBIF 2023)
Birds						
Accipiter gentilis atricapillus	Northern Goshawk, atricapillus subspecies	S3S4	Blue	NAR		Segment 3 (tentative ID - bird seen from distance; MEC 2023)
Aechmophorus occidentalis	Western Grebe	S1S2B,S2N	Red	SC	1-SC	Segments 1, 4, 7, 10 (MEC 2023); multiple occurrences for Fraser Lake (GBIF 2023)
Ardea herodias herodias	Great Blue Heron, herodias subspecies	S3?	Blue	0	0	Stellako River outlet; Stellako Bridge, Yellowhead Highway; Nautley River; Francois Dr, Settling Ponds & Fraser Lk
Botaurus lentiginosus	American Bittern	S3B,SNRN	Blue			Fraser Lake West (GBIF 2023)
Buteo lagopus	Rough-legged Hawk	S3N	Blue	NAR		Fraser Lake (GBIF 2023)
Charadrius vociferus	Killdeer	S3S5B	Blue			Yellowhead Highway bridge on Stellako River; N. Fraser Lake (General Area); Beamont Provincial Park Campground; Drywilliam Lake Rest Area (GBIF 2023)
Chlidonias niger	Black Tern	S2S4B	Blue	NAR		Segments 10, 11, 34 (MEC 2023); Fort Fraser--Settling Pond (GBIF 2023)
Chordeiles minor	Common Nighthawk	S3S5B	Blue	SC	1-SC	Segment 19 (calling); Fort Fraser--Settling Pond (GBIF 2023)
Clangula hyemalis	Long-tailed Duck	S2S3B,S4N	Blue			Stella Rd - 54.0649x-124.8986 - Nov 5, 2016, 1:48 PM (GBIF 2023)
Coccothraustes vespertinus	Evening Grosbeak	S5	Yellow	SC	1-SC	182 Nadina Cres; Fraser Lake CA-BC 54.05796, -124.85823 (GBIF 2023)
Contopus cooperi	Olive-sided Flycatcher	S4B	Yellow	SC	1-SC	Stellako Bridge, Yellowhead Highway, N. Fraser Lake (General Area), Fraser Lake (GBIF 2023)
Cygnus columbianus	Tundra Swan	S3N	Blue			Fraser Lake (GBIF 2023)
Euphagus carolinus	Rusty Blackbird	S3S4B	Blue	SC	1-SC	N. Fraser Lake (General Area) (GBIF 2023)
Falco peregrinus	Peregrine Falcon	S3	Red	SC	1-SC	Segment 19 (MEC 2023); Fraser Lake Sewage Ponds (GBIF 2023)
Hirundo rustica	Barn Swallow	S4B	Yellow	SC	1-SC	Segment 31 (MEC 2023); BC--Hwy 16--near Fraser Lake; Stellako Bridge, Yellowhead Highway; Drywilliam Lake Rest Area; CA-BC-LeJack field; Stella Road, Fraser Lake; Piper's Glen Resort (GBIF 2023)
Hydroprogne caspia	Caspian Tern	S3B	Blue	NAR		Beamont Provincial Park Campground (GBIF 2023)
Larus californicus	California Gull	S1B,SNRN	Red			Dry William Lake rest spot; Beamont Provincial Park Campground; Stellako River mouth (GBIF 2023)
Melanitta perspicillata	Surf Scoter	S3B,S4N	Blue			Beamont Provincial Park Campground; Peterson's Beach Rec Site (GBIF 2023)

Scientific Name	Common Name	Provincial Status	BC List[1]	COSEWIC[2]	SARA[2]	Comment/Reference[3]
Nannopterum auritum	Double-crested Cormorant	S3S4	Blue	NAR		White Swan Park, Fraser Lake (GBIF 2023)
Numenius americanus	Long-billed Curlew	S4B	Yellow	SC	1-SC	Fraser Lake West (GBIF 2023)
Pelecanus erythrorhynchos	American White Pelican	S1B	Red	NAR		Beamont Provincial Park Campground (GBIF 2023)
Podiceps auritus	Horned Grebe	S4B,SNRN	Yellow	SC	1-SC	Fraser Lake; Yellowhead Hwy; CA-BC-4750-5428 Stella Rd - 54.0649x-124.8986 - Nov 5, 2016, 1:48 PM (GBIF 2023)
Fish						
Acipenser transmontanus pop. 5	White Sturgeon (Upper Fraser River Population)	S2	Red	E	1-E	BC Conservation Data Centre mapped element occurrence for Fraser Lake (BC CDC 2023)
Oncorhynchus nerka DU7 (Francois-Fraser-S)	Sockeye Salmon	SNR		SC		Designatable Unit (DU)7: Francois-Fraser-Summer. "This anadromous species faces a number of threats in both freshwater and marine areas, which are causing habitat quality to decline. However, the number of mature individuals increased considerably during the period 1970-2000 and the most recent numbers have been among the highest on record. However, there has been a decline over the last three generations, and this fish may become Threatened if the factors contributing to this decline are not effectively managed." (COSEWIC 2018).
Oncorhynchus nerka DU28 (Fraser-ES)	Sockeye Salmon	SNR		E		Designatable Unit (DU)28: Fraser-Early Summer (Endako River and Ormond Creek) "Mature fish in this population returned to spawn in Endako River and Ormond Creek that flow into the Fraser Lake, British Columbia. This population is upstream from the 1913 Hell's Gate landslide and the 2018 Big Bar landslide. Sockeye have not been seen in Ormond Creek since 1976, nor in Endako River since 1991, despite two surveys in 1992 and 2000, and Chinook Salmon surveys in late summer from 2001 to the present. Sockeye returning during these surveys would likely have been seen if they were present. Although likely extinct, fewer than 50 years have passed since the last credible record, and so the wildlife species is still considered Endangered." (COSEWIC 2021)

Scientific Name	Common Name	Provincial Status	BC List[1]	COSEWIC[2]	SARA[2]	Comment/Reference[3]
Oncorhynchus tshawytscha DU 9 and DU10 (Middle Fraser Rive Spring and Summer)	Chinook Salmon	SNR		T		Both DUs are stream-type (i.e., spend one or more years in freshwater before migrating to the ocean) populations. Among many tributaries to the Middle Fraser River, these populations are known to spawn in Endako River and previously spawned in Ormond Creek, though they have not been observed here since the 1980s (GOC 2024). There is no documentation of rearing within Fraser Lake. These populations have been subject to recent declines, and were both assessed by COSEWIC as Threatened in 2018. (COSEWIC 2019).
Salvelinus confluentus pop. 26	Bull Trout - Pacific Populations	S3S4	Blue	NAR		Pacific populations unit covers a broad area with a relatively stable population, however threats are high and there are a number of unknowns around population totals and number of occurrences (BC CDC 2023; COSEWIC 2012).
Insects						
Bombus bohemicus	Gypsy Cuckoo Bumble Bee	S1S2	Red	E	1-E	BC Conservation Data Centre mapped element occurrence at west end of lake (BC CDC 2023).
Plants						
Schistidium tenerum	Slender Bloom Moss	S3	Blue			Fraser Lake, Simon Bay Area (GBIF 2023)

[1]Red: Species that is at risk of being lost (extirpated, endangered, or threatened) within British Columbia. Blue: Species considered to be of special concern within British Columbia. [2](E) Endangered: Facing imminent extirpation or extinction. (T) Threatened: Likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction. (SC) Special concern: May become a threatened or an endangered species because of a combination of biological characteristics and identified threats. (NAR) Not at Risk: A species that has been evaluated and found to be not at risk federally. (SNR) Status not reviewed. [3]British Columbia Conservation Data Centre (BC CDC).2023; Global Biodiversity Information Facility (GBIF) 2023; Masse Environmental Consultants (MEC) 2023. Fraser Lake Foreshore Inventory field data.

APPENDIX 5. FORESHORE HABITAT SENSITIVITY INDEX DATA AND CALCULATIONS

APPENDIX 6. LAND USE DESIGNATIONS

APPENDIX 7. FRASER LAKE FORESHORE DEVELOPMENT GUIDE