Kootenay Lake
Foreshore Integrated Management Planning

Prepared For:
Living Lakes Canada and Project Partners

Prepared By:
Ecoscape Environmental Consultants Ltd. and
Lotic Environmental Ltd.

FINAL REPORT - March 2022

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The results contained in this report are based upon data collected during a single season inventory. Biological and lake systems respond differently both in space and time. For this reason, the assumptions contained within the text are based upon field results, previously published material on the subject, and air photo interpretation. The material in this report attempts to account for some of the variability between years and in space by using safe assumptions and a conservative approach. Data in this assessment was not analyzed statistically and no inferences about statistical significance are made if the word significant is used. Use of or reliance upon biological conclusions made in this report are the responsibility of the party using the information. Neither the authors of this report (Ecoscape Environmental Consultants Ltd. or Lotic Environmental Ltd.) or Living Lakes Canada (or project partners) are liable for accidental mistakes, omissions, or errors made in preparation of this report because best attempts were made to verify the accuracy and completeness of data collected, analyzed, and presented.

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EXECUTIVE SUMMARY

The desire to live and recreate in the Kootenay Region of British Columbia (BC), combined with the generally positive economic climate, has resulted in rapid population growth and urban development. Lake foreshore (or shoreline) residential development pressures (both permanent and seasonal) have especially increased. Kootenay Lake, with its approximate 400 km of shoreline, has seen a pronounced amount of this growth. This development inevitably impacts the natural foreshore environment. Unfortunately, these impacts can diminish the natural values that draw people to live and recreate along the foreshore in the first place. Living Lakes Canada (LLC) has funded this shoreline mapping project through Fisheries and Oceans Canada (DFO) Nature Fund for Aquatic Species at Risk (SAR) Program, to aid long-term lakeshore planning to protect high value fish and wildlife habitat values.

In addition to development pressure from settlement and regional growth, Kootenay Lake has experienced several other impacts. These include but are not limited to hydro-electric power generation and dams, logging, mining, flood protection, and agriculture. The introduction of mysid shrimp in 1949, and effluent discharge from the Cominco phosphate fertilizer plant between 1952 and 1975 are other noteworthy historic impacts (Fish and Wildlife Compensation Program [FWCP] 2019). The study does not specifically address these cumulative impacts. Rather, it recognizes that maintaining a healthy shoreline is an important foundation to the protection of fish and wildlife who reside amongst many pressures.

Foreshore Integrated Management Planning (FIMP) is a framework intended to help governments, landowners, and nonprofit organizations understand lake foreshore habitat values and the potential ecological risks from proposed shore altering activities. The resulting information is used to help make decisions regarding foreshore development and conservation. The methods used are standardized to provide a consistent framework for assessing proposed shoreline development. One of the many benefits of the standardized process is that if data from previous surveys are available, the rate of loss of natural shoreline can be determined. The rate of loss information can be used to help identify improvements necessary to better manage natural foreshore values into the future. The FIMP methods have been developed to provide a habitat overview for all stakeholders, recognizing that the budgets available are finite. These data are primarily intended to aid land use planning. Detailed assessments and planning are an integral part of the urban development process and must be incorporated at later phases of project planning, as necessitated by any existing legislation or permitting processes required.

The key objective of this study was to update the original FIMP that was conducted in 2012 on Kootenay Lake (Schleppe and Cormano 2016), and to document changes that have occurred over the nine-year period since the last survey. The following three standard FIMP steps were completed during this study (Schleppe et al. 2020):

1. Foreshore Inventory and Mapping (FIM) was first conducted and involved the collection of standardized field data from a boat viewing the shoreline. These data were supplemented with other available ecological datasets originating

from a variety of sources (e.g., Species at Risk Management Plans, BC Conservation Data Center, Official Community Plans, etc.). The foreshore was defined as the area from the deeper edge of the littoral region of the lake (i.e., where the start of pelagic region begins) to an area up to 50 m past the high-water mark (HWM) into the upland/riparian zone. Within this area, the following was counted, catalogued, and described: land use (e.g., residential development), modifications (e.g., retaining walls, docks, marinas), and biophysical attributes (e.g., shoreline vegetation cover, substrates, large woody debris, and aquatic vegetation).

2. Shoreline habitat sensitivities were then determined using a ranking index called the Foreshore Habitat Sensitivity Index (FHSI). The index used FIM and other data to rank shoreline habitat value for fish, wildlife and ecosystems. The index was intended to "flag" areas of the greatest ecological sensitivity to change from urbanization. As part of the FHSI, the most sensitive habitats were identified as Zones of Sensitivity (ZOS).
3. The Foreshore Development Guide (FDG) was prepared to identify risks posed by different shore altering activities, to inform land use decisions. The FDG was intended to help mitigate or reduce the potential for negative effects to sensitive habitats owing to urban developments and identify areas for conservation (e.g., ZOS). The Foreshore Development Guide has not been provided in this report because it is pending Kootenay Lake Partnership review (see Appendix C).

Overall, 63% (256,106 m) of the shoreline was in a natural condition, while the remaining 37% (150,705 m) was considered disturbed (i.e., areas that had any sign of being altered). Since 2012, there has been an approximate loss of 4,525 m of natural shoreline. This means there is a loss of 0.12% per year or approximately ~488 m of natural shoreline per year. Losses were scattered around the lake on Rocky (2,868 m) and Gravel Beach (1,583 m) shorelines where gradients were typically less, and access was easier. Losses were primarily evident on existing urbanized lots or occurred on more recently created lots that were just building out.

These disturbances occurred primarily as improvements/upgrades to previously existing urbanized areas. However, disturbance was also observed in previously undeveloped areas, which contained many new lots that had initiated construction since the previous FIM (e.g., south past Riondel to Pilot Bay Provincial Park, east past Proctor). Observed losses were almost always greatest in areas that had limited or no previous development, when compared to more urbanized areas. Differences were observed throughout the West Arm, around Gray Creek and Kaslo, south past Riondel to Pilot Bay Provincial Park, east past Proctor, sporadically in the North Arm, and north of Lockhart Beach Provincial Park. While these changes individually may not seem significant on a lake of this size, continued losses add up over time, with the potential to result in landscape-level changes to the surrounding ecosystem if not managed for conservation. Further, some of the individual losses on one or two lots were extensive and highlight the need for appropriate management of shoreline areas because single events, albeit on only a few lots, cumulatively add up to the impacts observed on a lake wide scale.

The FHSI identified numerous high value habitats around Kootenay Lake for SAR, provincially and regionally sensitive species, and for maintaining general biodiversity. All criteria from the original study were considered and included: biophysical data, wildlife ZOS data (heron rookery, Conservation Data Centre red, and blue listings, raptor nests, bat sites, and amphibian sites), fisheries ZOS data (critical White Sturgeon habitat, Kokanee shore spawning, juvenile rearing, migration (e.g., Bull Trout), and spawning). New ZOS were identified, and these were habitats supporting: fish (native mussels, Burbot spawning/rearing) and wildlife (e.g., Caribou; SAR accounts not in the CDC database, including bat species, and additional Painted Turtle habitat; and Wildlife Habitat Areas). Concerted effort went into updating the original data with new species and habitat accounts. This involved reaching out to the network of local biologists and organizations for unpublished data. The environmental values of the habitats were also described thoroughly (e.g., such as what made the critical White Sturgeon habitat important). This rationale was provided to help users understand why specific areas required protection.

The FHSI identified that 11.1% of shoreline had a Very High Ecological Rank, and 32.3% of the shoreline had a High Rank, which translates to approximately 45,355 and 131,183 m of shoreline, respectively. These areas were represented predominantly by wetlands along the shore, stream confluences, and locations where important habitat features such as spawning or wildlife were identified.

Moderate accounted for 42.3% of the shoreline or 172,065 m. These areas occurred in locations that had fewer overlapping ZOS or were areas with important ZOS that were impacted by development. These areas were represented by all land use types and were common along all shore types except stream mouths and wetlands.

Areas of Low and Very Low Ecological Rank occurred along 14.3% or along 58,208 m of shoreline. These areas occurred predominantly in areas of increased development intensity, such as industrial or commercial areas. This was expected, as areas with more intense development often lose many of the habitat values that were originally present, highlighting the importance of protection of natural areas in any development process.

Recommendations have been presented to help all levels of government utilize these findings and move towards more sustainable urban development practices. Recommendations were categorized by type, and include measures to address cumulative impacts, restoration, and other planning related needs.

The FDG is presented under a separate cover and presents recommendations and tools to aid in identification and planning so high value environments and ZOS are conserved during development (see Appendix C).

ACRONYMS

Post 2020 FIMP Methods Update	Pre 2020 FIMP Methods Update (only if changed)	Meaning
CDC		Conservation Data Center
DFO		Fisheries and Oceans Canada
CMN		Community Mapping Network
EKILMP		East Kootenay Integrated Lake Management Partnership
FDG	SMG	Foreshore Development Guide / Shoreline Management Guidelines Documents
FHSI	AHI	Foreshore Habitat Sensitivity Index / Aquatic Habitat Index
FHSI Category		Foreshore Habitat Sensitivity Index Category
FHSI Criteria or Criterion		Foreshore Habitat Sensitivity Index Criteria
FHSI Ecological Rank		Foreshore Habitat Sensitivity Index Ecological Rank or output
FIM		Foreshore Inventory and Mapping
FIMP	SHIM	Foreshore Integrated Management Planning / Sensitive Habitat Inventory and Mapping
FNLRORD		Provincial Ministry of Forests, Lands, Natural Resource Operations and Rural Development'
GIS		Geographic Information Systems
GPS		Geographic Positioning System
HWM		High Water Mark
LLC		Living Lakes Canada
TEK		Traditional Ecological Knowledge
ZOS		Zone of Sensitivity

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1.0 INTRODUCTION

Living Lakes Canada (LLC) is part of a global network of over 120 non-governmental organizations that facilitates collaboration in education, monitoring, restoration and policy development initiatives for the long-term protection of Canada's lakes, rivers, wetlands and watersheds. LLC has a mandate to help Canadians understand, adapt, and mitigate the impacts of climate change on water quality and quantity, biodiversity and healthy human communities through grassroots water stewardship activities. LLC helps bridge the gap between science and action to foster and normalize citizen-based water stewardship. Declines in lakeshore conditions are occurring globally, and LLC funded this shoreline mapping project through DFO's Canada Nature Fund for Aquatic Species at Risk (CNFASAR) Program to help aid better long-term lakeshore planning and protect aquatic Species At Risk (SAR) in the Kootenay Region of British Columbia (BC).

LLC has contracted the team of Ecoscape Environmental Consultants Ltd (Ecoscape) and Lotic Environmental Ltd (Lotic Environmental) to complete Foreshore Integrated Management Planning (FIMP) on Kootenay Lake (the Project). The Project will involve updating previous mapping completed in 2012 (Schleppe and Cormano 2016, and Kootenay Lake Partnership [KLP] 2019) and determining the amount of change with time. The Project involved using the recently revised FIMP methods (Schleppe et al. 2020).

1.1 Study Area

Kootenay Lake is located in the southern interior of BC, in the West Kootenay Region. The town of Nelson is the largest community on the lake, with numerous smaller villages also present (e.g., Ainsworth, Kaslo, Balfour, Gray Creek, Lardeau, Argenta, Boswell). The lake is situated between the Purcell and Selkirk Mountain ranges and is divided into the North and South Arms (or main lake) and the West Arm (Figure 1). The lake is fed by two main rivers, which together supply 75% of the flow - Duncan River flows in at the north end, and Kootenay River flows in at the south end (Carmack and Grey 1981). There are several other smaller tributaries feeding the lake, many of which are fish bearing. The lake outlet is in the West Arm, where flows enter the Kootenay River and subsequently join the Columbia River system. The shoreline perimeter is approximately 403 km long (Schleppe and Cormano 2016).

The main lake is 107 km long, and is widest at its south end, where it is 6 km across. The main lake basin is steep-sided and U-shaped with a maximum depth of 154 m and mean depth of 94 m (Daley et al. 1981). The main lake generally supports little littoral vegetation due to its steep sides and limited areas where lakebed substrates and light conditions are appropriate to support growth (Crozier and Duncan 1984). The West Arm is physically and limnologically different from the main lake. It is approximately 40 km long with a mean depth of only 13 m (Irvine et al. 2012). It is comprised of a series of shallow basins interconnected by narrow riverine sections (Irvine et al. 2012). The flushing rate for the main lake is 1.5 years (Carmack and Gray 1981), whereas it is about 5-6 days for the West Arm (Perrin 1987; Martin and Northcote 1991).

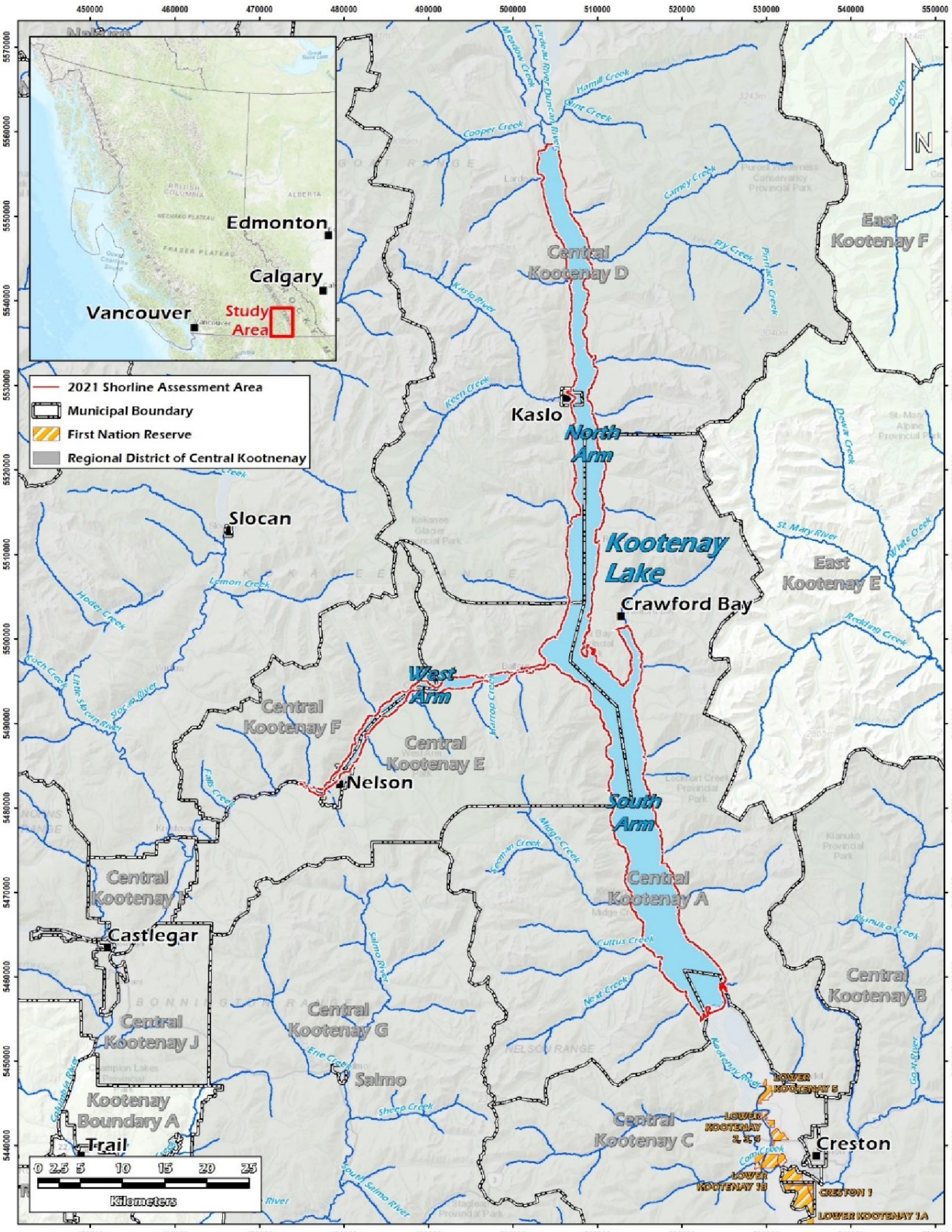


Figure 1. Kootenay Lake Study Area

1.2 Foreshore Significance and Development Pressures

The desire to live and recreate in the Kootenay Region of BC, combined with the generally positive economic climate in BC and Alberta, has resulted in rapid population growth and development. This growth has increased the value of all property, and in particular waterfront property for recreational or permanent residences. As a result, commercial and residential development pressures have increased along lake foreshores (or shorelines). On Kootenay Lake specifically, there has been a high demand for secondary recreational and investment properties, often in the form of single-family homes. Typically, the size and magnitude of these new homes are much greater than the historical lakefront cabins of the past. These developments inevitably impact the natural foreshore environment through removal of riparian and aquatic vegetation, and installation of modifications such as marinas, groynes, retaining walls and docks. Unfortunately, these impacts can diminish the natural values that draw people to live and recreate along the foreshore in the first place. Ultimately, the goal should be to maintain a balance between anthropogenic and natural values to the benefit of all residents and species that rely upon the lake.

The foreshore is ecologically significant because it is the transitional community between aquatic and terrestrial habitats. This area provides a high diversity of habitat types for fish and wildlife such as aquatic vegetation, deep and shallow lake edges, stream mouths, wetlands, riparian vegetation, and grasslands. The foreshore also provides many beneficial ecological functions including but not limited to forage, nesting and rearing areas for aquatic and terrestrial fauna; buffering the watercourse from contaminants; and maintaining bank stability (e.g., Department of Fisheries and Oceans [DFO] 1992). Even though there are several legislative mechanisms in place to help protect the foreshore (e.g., Federal *Fisheries Act*, BC Water Sustainability Act, Local Government Official Community Plans, etc.), anthropogenic pressures often result in incremental losses leading to habitat fragmentation and degradation. These impacts can reduce the ability of a lake to provide habitat necessary to sustain healthy populations of fish, wildlife, and ecosystems.

As a result of ongoing urban development pressures and evidence of degradation, Foreshore Inventory and Mapping (FIM) was implemented in BC, starting in 2004 by the Community Mapping Network and Regional District Central Okanagan (see Schleppe et al. (2019) for summary of methodological development). In 2020, the methods were updated, and the assessment framework was renamed Foreshore Integrated Management Planning or "FIMP". Although the name has changed, the primary objective of the FIMP process remains to identify environmental values of importance and provide land-use planning guidelines to reduce impacts on high value areas. The science-based methods were developed with input from all levels of government (federal, provincial, regional, and municipal), First Nations, lake stewardship groups and professional consultants. The outputs including those specific to Kootenay Lake have received support from these groups and have been relied upon during development planning.

1.3 Other impacts on fish and fish habitat

Although outside of the scope of this study, in addition to pressure from foreshore development, Kootenay Lake has also experienced impacts related to a host of other industrial activities, including hydroelectric/dams, logging, mining, and agriculture. Further, the lake is not sheltered from climate change impacts, which have only been considered in this report in a broad sense. There is a long and complex history of significant effort to understand and manage the impacts of these activities to meet a balance and maintain the very high valued fishery in the lake.

1.3.1 Dam/hydro electric pressures on fish and fish habitat

Dams, both for hydro-electric power generation and flood control, are noteworthy since they are prolific in this section of the Kootenay-Columbia watershed and have a long history of influence on Kootenay Lake. Kootenay Lake inflows and outflows are primarily driven by the terms of the Columbia River Treaty (CRT), a joint agreement under negotiation between the United States and Canada to optimize hydro-electric generation and limit flooding on both sides of the border (FWCP 2019. Duncan Dam (est. 1967) is present approximately 10 km upstream of the northern lake inlet, and Libby Dam (est. 1973) in the United States is approximately 175 km upstream of the southern inlet. Corra Linn dam (est. 1939) is present 10 km downstream of the outlet, with five additional dams within 30 km of the lake outlet (Upper and Lower Bonnington, Kootenay Canal, South Slocan, and Brilliant Dam. The Upper and Lower Bonnington and South Slocan dams were built on natural waterfalls and thus did not fragment the fish populations (Northcote 1973).

The dams have influenced Kootenay Lake in several ways. Upstream impoundments reduced nutrient inputs and suspended solids, and thus have reduced productivity in Kootenay Lake (Daley et al. 1981, and Fish and Wildlife Compensation Program [FWCP] 2019). Lake water levels and the hydrograph have also been altered, resulting in lower high-water levels during the spring and summer and slightly higher low-water levels during the winter (Moody et al. 2007; Figure 2). Hydrograph regulation historically dewatered littoral areas in the West Arm, subsequently impairing the shore spawning Kokanee stocks through dewatering of redds, which are prepared mainly in water depths of 0.5-2.0 m at the time of spawn (Andrusak 2016, Andrusak and Andrusak 2014, Irvine et al. 2012). Fish have also likely been indirectly impacted through loss of littoral habitat food production, also associated with regulation of the hydrograph (Martin 1980, and Andrusak and Northcote 1989). Damming of tributaries has also affected the availability of spawning and rearing habitat and fish migration routes (FWCP 2019).

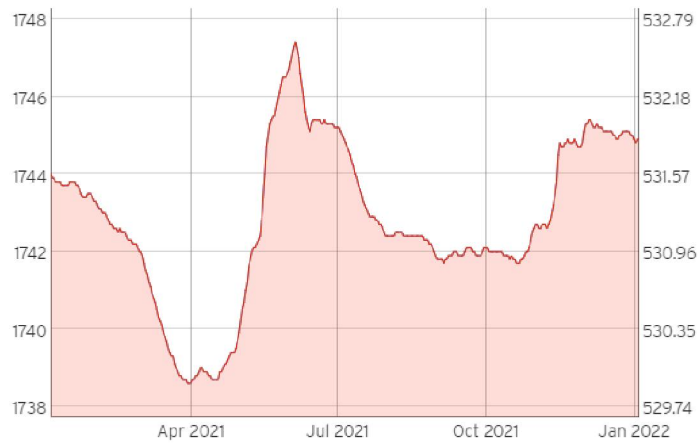


Figure 2. Kootenay Lake water levels in 2021 (Fortis BC 2021).

The upper Kootenay River population of White Sturgeon (*Acipenser transmontanus)* is an endangered species both Federally (under the Species at Risk Act [SARA; Schedule 1[1]] and Committee on the Status of Endangered Wildlife in Canada [COSEWIC]) and provincially. This population extends from Kootenai Falls, Montana, located 50 km downstream of Libby Dam (Idaho), downstream through Kootenay Lake to Corra Linn Dam on the lower West Arm of Kootenay Lake (DFO 2014). The spawning habitat is located in the U.S., whereas much of the adult and juvenile rearing habitat is located in Kootenay Lake and the Canadian portion of Kootenay River (DFO 2014). This population has been greatly impacted by hydroelectric development. The following impact summary was obtained from the White Sturgeon Federal Recovery Strategy (DFO 2014) and the BC Conservation Data Center species report (BC CDC 2014):

> *The upper Kootenay River population of White Sturgeon remains in decline, with very little recruitment since the mid 1970's. The 2011 population was estimated at 980 wild naturally produced fish (95% Confidence Interval 733 – 1375), with many additional juvenile hatchery releases that are >40 cm (Beamesderfer et al. 2011). The recruitment survival bottleneck is at the egg/larva stage (Rust et al. 2004). The installation of Libby Dam has had a great impact, although other dams and alterations have also influenced the habitat conditions for this species. Changes to the natural hydrograph have altered spawning, egg incubation, and rearing habitats; and reduced overall biological productivity (U.S. Fish and Wildlife Service [USFWS] 1999). Notably, lower freshet flows at Libby Dam and the lower spring maximum elevation of Kootenay Lake likely contributed to the decline by affecting depths at their spawning locations and by causing fish to spawn in locations with*

[1] Schedule 1 is the official federal list of wildlife species at risk, which receive legal protection under SARA.

sub-optimal conditions (USFWS 2006). Other alterations affecting this species include:

- *Nutrient retention associated with both the Libby and Duncan dams has decreased biological productivity of Kootenay Lake (Daley et al. 1981).*
- *Lack of access to prey habitats associated with the Duncan Dam (Duke et al. 1999).*
- *Altered water temperatures (e.g., warmer in winter and colder in summer (Duke et al. 1999) associated with Libby Dam operations.*
- *Alterations to floodplain habitats – for example, elimination of side-channel and slough habitats from Bonners Ferry (Idaho) to Creston (B.C.) due to dyking and bank stabilization for flood protection (Duke et al. 1999). These changes have reduced aquatic habitat diversity, altered access or flow conditions at potential spawning and nursery areas, and altered substrates in incubation and rearing habitats (Duke et al. 1999).*

The Province of BC and its partners have implemented several programs to counteract dam related impacts on fisheries, with highlights of key programs provided here:

- A White Sturgeon culture facility was established at Fort Steele, BC and in 2000 & 2002 the first release of cultured Kootenay River juveniles occurred near Bonner's Ferry, Idaho and Creston, BC, respectively (COSEWIC 2003).
- Critical habitat has been identified for White Sturgeon under the federal recovery strategy (DFO 02014). This habitat has been identified as a Zone of Sensitivity in this FIMP, and along with other SAR and sensitive species and habitats, has been further described in the Results (Section 4.0).
- Hatcheries were also used as early efforts to address Bull Trout and Kokanee spawning habitat losses. However, the hatchery program for these species was unsuccessful and has been discontinued.
- Kokanee spawning channels were constructed at Meadow Creek and continue to be operated (FWCP 2019).
- A nutrient restoration program was initiated to address concerns of decreased nutrient supply caused by the impoundments. This concern was also compounded by an upstream fertilizer plant closure in the 1970s (Binsted and Ashley 2006). It was speculated that nutrient limitations would cause the North Arm Kokanee stock to collapse, and sport fish such as Gerrard Rainbow Trout and Bull Trout to also decrease because Kokanee are their main food source (Walters et al. 1991). The nutrient restoration program was implemented in the North Arm in 1992, and the South Arm was added in 2004, with both still ongoing today (Peck et al. 2019). The ongoing Kootenay Lake Nutrient Restoration Program has been successful in partially offsetting nutrient declines and increasing biological productivity in the lake (Sebastian et al. 2010).

- In 2011, an examination of lake levels relative to known West Arm shore spawning Kokanee distributions was initiated to determine the optimal operational regime for Kokanee (Irvine et al. 2012). The most recently reported pattern of Kootenay Lake operating levels indicated a substantial improvement in incubation and recruitment success (1.5% were estimated to have potentially dewatered) (Andrusak 2016).

1.3.2 Other Main Lake fisheries issues and improvement efforts

Kootenay Lake supports one of BC's most important large lake sport fisheries. The trophy sized Gerrard Rainbow Trout (Gerrard) have been prized by anglers and are important economically and recreationally. However, since about 2014 Kootenay Lake has been experiencing serious fisheries issues. The Gerrard fishery has been in decline, with poor fish condition with few large fish (McPherson 2018). Adult Kokanee populations in the main body of Kootenay Lake (a separate stock from those in the West Arm) have been at unprecedented and sustained low numbers both for in-lake fish and fish returning to spawn (McPherson 2018). Historically the number of main lake Kokanee spawners typically ranged between 250,000 and 2 million; however, low survival rates of Kokanee reduced spawner numbers to less than 40,000 in recent years, with approximately 90,000 counted in 2020 (BC Ministry of Forests Lands and Natural Resource Operations [FLNRORD] 2021). Data indicates that a leading cause for these issues is an imbalance between predator (Gerrard and Bull Trout) and prey (Kokanee) abundance (McPherson 2018). This issue is summarized here because of the relation to lake wide productivity for fish. This is an important fisheries topic on Kootenay Lake currently and shows the complexity of the natural ecosystem amidst human related influences, for which, the FIMP process is useful. Further, it highlights the level of effort needed to better achieve a natural balance for both fish, ecosystems, and people.

The Kootenay Lake Fisheries Advisory Team was formed in 2014, with the objective of recovering populations of Kokanee and the sport fishery for Rainbow Trout and Bull Trout. The Team had initial workshops in 2015 (McPherson 2015a, McPherson 2015 b), which led to the development of the Kootenay Lake Action Plan in 2016 (Redfish Consulting Ltd 2016), and an update in 2018 (McPherson 2018).

Initial efforts to recover the Kokanee population included (FLNRORD 2018): adjusting the fishing regulations to decrease Kokanee quota and increase Gerrard Trout quota (April 2015), extending the nutrient restoration program's fall season (September 2015), supplementing Kootenay Lake with Kokanee collected from other waterbodies in B.C, and assessing other possible survival limitations (e.g., virus assessments and virus management). Eyed eggs stocking efforts in 2016 and 2017 resulted in Kokanee fall fry numbers being within the historical range; however, numbers remained very low in the subsequent age classes (0-1, 1-2 and the 1-3) (Peck et al. 2019).

Actions in 2020-21 included (FLNRORD 2021): liberal Rainbow Trout and Bull Trout fishing regulations, angler incentive program, the nutrient restoration program, and a continued robust monitoring program (data collected on predator abundance, diet, genetics, size, and age structure). In-lake hydroacoustic surveys estimated a very low spawner return in 2021 and continued poor in-lake survival of Kokanee due to high levels of predation from Rainbow and Bull Trout (FLNRORD 2021). While a decline in Gerrard Rainbow Trout spawner numbers has occurred in recent years through the above efforts, their numbers are still thought to be relatively high based on Kootenay Lake recreational fishery data (Peck et al. 2019).

The Kootenay Lake Fisheries Advisory Team has considered other possible influences on the fishery and continues to adapt their approaches using available data and science. This includes consideration of Mysid shrimp influence. Mysid shrimp were introduced into Kootenay Lake in 1949 to accelerate Gerard Rainbow Trout recovery efforts needed at that time. However, after their introduction it was determined that Mysids compete for the same food source (pelagic plankton) as young Kokanee (alevin and fry) and may thus impact their growth (McPherson 2018). During the 2018 Kootenay Lake scientific technical committee meeting it was decided that the Mysid removal feasibility study being completed by the Ktunaxa Nation Council (Ktunaxa Nation) would be reviewed once completed, with an informed decision made moving forward (McPherson 2018).

1.4 Climate change

Although also outside of the scope of this study, the effects of climate change on the health of aquatic and terrestrial habitats are also to be considered during foreshore planning. Any shoreline development that creates newly subdivided lots on natural areas will inevitably result in loss of green space such as mature forest, which will have climate related impacts. Like shoreline losses, these individual impacts are small in and of themselves, but add up cumulatively. For this reason, avoiding densification processes such as subdivision or rezoning along the shoreline are extremely important for both habitat related reasons and those associated with climate change.

1.5 Kootenay Lake Local Conservation Fund Initiative

In November 2015, the RDCK electorate from Electoral Areas A, D and E voted to establish the Kootenay Lake Local Conservation Fund (KLLCF). The intent is to provide funding for local conservation projects that are not the existing priority of Federal, Provincial or Local governments, and that address known threats to priority terrestrial and aquatic habitats and dependent species. The KLLCF Guidance Document was prepared to inform the KLLCF Terms of Reference and ensure that funded projects are strategically aligned with identified priorities and actions (Amec Foster Wheeler and Pandion Ecological Research [Amec and Pandion] 2018). The KLLCF report provides an important summary of the current values, issues and priorities in the Kootenay Lake area, which aligns with the nature and intent of this study. A summary of key outputs from the KLLCF Guidance Document are as follows:

- *Ten habitat targets were listed as key components of local ecosystem/habitat diversity in the study area and included in order of importance: hydro-riparian systems; fish habitat; at-risk aquatic and terrestrial vertebrates; wetlands; dry forest; connectivity habitats; old forest; cottonwood-dominated floodplain; brushlands/grasslands; shrub and herb-dominated floodplain; and karst (distinctive landforms that result from the dissolving action of water on soluble bedrock). The area of each habitat target on private versus Crown Land was quantified as was the area protected.*
- *Threats and sub-threats were evaluated for the habitat targets, with eight threat categories and 55 threat activities identified. The top ranked threats included habitat loss, degradation/conversion (due to dams, residential development and other factors), roads (construction, use and maintenance in multiple contexts), overall impact of changing climate, increased fire risk (frequency and severity), resource use (in particular roads on crown land), and water management regimes (river flows, flood patterns, and reservoir levels).*
- *In total, 39 broad-based conservation actions were developed that were applicable to aquatic and terrestrial habitat targets on private land. These actions were ranked (Very High; High; Moderate; or Low).*

1.6 Foreshore Integrated Management Planning Framework

FIMP is intended to help governments, landowners, and nonprofit organizations understand lake foreshore habitat values and the potential ecological risks from proposed shore altering activities (Schleppe et al. 2020). The outputs are used to help make decisions regarding foreshore development and conservation. The methods are standardized to provide a consistent framework for shoreline development reviews. One of the many benefits of the standardized process is that if data from previous surveys are available, the rate of loss of natural shoreline can be determined. Understanding rates of loss is important to better manage the shoreline. The methods have been developed to provide an overview of ecological values of the shoreline, recognizing that budgets available are usually finite. These data and analytical results are primarily intended to aid land use planning, and they may not identify site specific habitats of importance. Detailed assessments and planning are integral for individual developments planned and must be incorporated as necessitated by regulatory requirements, conservation strategies, etc.

The FIMP process follows three general steps (Schleppe et al. 2020):

1. Shoreline inventory and mapping is conducted following the FIM protocols. FIM consists of collection of standardized field data, which are supplemented with

available ecological datasets originating for a variety of sources (e.g., Species at Risk Management Plans, Official Community Plans, etc.).

2. Shoreline habitat sensitivities are determined using a ranking index called the Foreshore Habitat Sensitivity Index (FHSI). The index is a simple, cost-effective method to approximate shoreline values collected from numerous datasets and is developed using assessments, inventories, and professional opinions. The index is intended to act as a "flagging" tool to identify areas of greatest sensitivity to change from urbanization. The index was formerly called the Aquatic Habitat Index (AHI).
3. The Foreshore Development Guide (FDG) is prepared to identify risks posed by different shore altering activities, to inform land use decisions. The FDG is intended to help mitigate or reduce the potential for negative effects to sensitive habitats owing to urban developments.

Note, that the foreshore process terms have changed since the original Kootenay Lake report was completed. The Acronyms Section on page vii of this report is to be referred to for a comparison of the original terms with the above new terms.

1.7 FIMP During Regulatory Reviews

Kootenay Lake is managed by numerous federal, provincial, regional, local and First Nations agencies. Also included is the Kootenay Lake Partnership, which is a government working group consisting of local, Provincial, Federal agencies, and First Nations (Ktunaxa Nation and Yaqan Nuki). Each governing agency/regulator has certain activities that they are responsible for managing, as specified by legislation (e.g., acts, regulations, bylaws and policies; Table 1). For instance, the Federal government is responsible for managing fish and their habitats, species at risk, and navigation; the Province of BC manages all areas in and around lake (or stream) water bodies; regional and local governments review land use activities on properties within their jurisdictional areas; and First Nations review land use activities on properties within their traditional territories. The FIMP outputs (FDG maps in particular), have proven to provide reviewers with a clear, consistent, and coordinated management strategy to protect high value shoreline environmental values during the development review process. Key regulatory requirements triggered by foreshore development proposals are summarized below, while a full listing of other potential requirements is provided in the FDG. Despite regulatory requirements, there are still documented impacts resulting from shoreline urbanization, inferring the need for more stringent requirements to maintain ecological values.

Table 1. Summary of Kootenay Lake governing agencies.

Level	Agency	Applicable Legislation
Federal	Department of Fisheries and Oceans	*Federal Fisheries Act,* *Species At Risk Act,* *Navigation Protection Act*
Provincial	Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Ministry of Environment and Climate Change Strategy	*Water Sustainability Act,* *BC Park Act*
Regional	Regional District of Central Kootenay	*Local Government Act* - Official Community Plan and associated bylaws
Local	City of Nelson, Village of Kaslo.	*Local Government Act*- Official Community Plan and associated bylaws
First Nation	Ktunaxa Nation Council	Official Community Plan and associated Bylaws, provincial or federal referrals on land and resource decisions that could impact their treaty rights or aboriginal interests.

1.7.1 Federal government

For projects near fish bearing waterbodies, the Federal *Fisheries Act* requires Project Reviews to ensure works adjacent to or within watercourses do not result in the harmful alteration, disruption or destruction of fish habitat (HADD). Where a HADD may occur, an Authorization from DFO is required that clearly demonstrates that Avoidance, Mitigation and appropriate Compensation or Offsetting measures are in place.

1.7.2 Provincial government

In BC, the foreshore is generally defined as the land between the high and low water mark. This area is considered provincial Crown Land (in almost all cases, with a few rare exceptions) and includes the permanently wetted lake area (Province of BC 2021a). The public retains the right to access Crown Land even if the upland is privately owned. Provincial authorization is required for any developments (e.g., installation of docks, and retaining walls) on this Crown Land. This includes, but is not limited to, obtaining *BC Lands Act* leases/licenses to occupy the land (i.e., to install a permanent structure) and/or obtaining a BC *Water Sustainability Act* Approval or Notification for Works in and About A Stream.

The BC *Lands Act* also governs Crown Land, where upland property ownership abuts the Present Natural Boundary (PNB). The PNB is determined through a legal survey and is defined as: "The visible high-water mark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the body of water a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself."

1.7.3 Regional District

Kootenay Lake is within the jurisdiction of the Regional District of Central Kootenay (RDCK), with exception of the municipalities of Nelson and Kaslo. The RDCK jurisdictional boundary is divided into several electoral areas, with five bordering the shoreline of Kootenay Lake (Figure 1). Each area has its own land management policies as identified in Official Community Plans (OCPs) and/or bylaws. Three of the five electoral areas (Areas A, D, and E) require that a Development Permit (DP) be obtained prior to development activities in watercourses, lakes and wetlands, and their adjacent riparian areas to protect aquatic habitat in order to conserve, enhance and restore high value (Table 2; RDCK 2013a, 2013 c, 2016). Areas A and E require a DP within 15 meters of the HWM, while area D requires one within 30 m; and all three areas specify that development is to follow the Riparian Areas Regulation (RAR) as legislated elsewhere in the province (RDCK 2013a, 2013c and 2016). There are exemptions for certain activities, which are noted in the individual OCP's. It is understood that RDCK is currently working on updating much of this, and it is strongly encouraged to use the data in this report to help facilitate that process.

The FDG is used by both Qualified Environmental Professionals (QEP's) preparing shoreline and riparian assessments and staff in review of those submissions. Although the FDG is not specifically listed in any of the OCP's, the RDCK's intention is to do so in the future as part of the current project to update the DPA's around Kootenay Lake (N. Wight pers. comm.). Another example of how the FDG is used internally pertains to the Ktunaxa Nation Cultural Values assessment. Where enhanced engagement is identified, RDCK staff send a referral to the Ktunaxa through their application portal and alert the applicant (N. Wight pers. comm). Please refer to Appendix C for further information.

Table 2. Summary of governing agencies for Kootenay Lake shoreline.

Jurisdiction	Electoral Area and Bylaw	Environmental development permit (DP)	Summary of DP requirements
RDCK	Electoral Area A - Wynndel/East Shore Kootenay Lake Land Use Bylaw (RDCK 2013a).	Environmentally Sensitive Development Permit Area within 15 m of HWM.	All proposals will be assessed by a Qualified Environmental Practitioner (QEP) or Registered Professional Biologist (RP Bio) in accordance with the Riparian Areas Regulation (RAR) established by the Provincial and/or Federal governments as used elsewhere in the Province.
RDCK	Electoral Area C - West Creston Land Use Bylaw (RDCK 2013b).	No Environmental Development Permit.	-
RDCK	Electoral Area D - North Kootenay Lake Land Use Bylaw (RDCK 2016).	Watercourse Development Permit Area within 30 m of HWM.	All proposals will be assessed by a QEP in accordance with RAR as outlined above (see Area A). Valuable Fish Habitat is also mapped, which is assumed will aid in the QEP assessment.
RDCK	Electoral Area E - Official Community Plan Bylaw (covers most of the south side West Arm) (RDCK 2013c).	Watercourse Development Permit Area within 15 m of HWM	All proposals will be assessed by a QEP or RP Bio in accordance with RAR as outlined above (see Area A).
RDCK	Electoral Area F – Electoral Area 'F' Official Community Plan Bylaw (covers most of the north side of the West Arm) (RDCK 2011).	No Environmental Development Permit.	-
Corporation of the City of Nelson (City of Nelson)	Official Community Plan Bylaw No. 3247 (City of Nelson 2013).	Development Permit Area #3 – Natural Environment and Hazardous Lands. DP required within 15 metres of HWM of all watercourses, wetlands, or Kootenay Lake; or riparian area.	Proposals will require a detailed assessment by a R.P. Bio, or other qualified professional. Development within or along the shores of Kootenay Lake will require a detailed assessment for Species at Risk, including specifically White Sturgeon (known along Kootenay River), and Nuttall's waterweed (known along the southern shore of Kootenay River).

Jurisdiction	Electoral Area and Bylaw	Environmental development permit (DP)	Summary of DP requirements
Village of Kaslo	Official Community Plan, Bylaw 1098 (Village of Kaslo 2011).	The Village of Kaslo has three environmental DP Areas: Lakefront Protection Area, Lakefront Development Area, and Stream Protection Area.	These DP areas were designated for the following reasons: ● Lakefront Protection Area – to protect the natural beauty, natural resource, and water source. ● Lakefront Development Area – to ensure tourism activities are developed with the character of the village and do not negatively impact the functioning of the lake front, lake, and foreshore ecosystems. ● Stream Protection Area – to protect the Kaslo River riparian ecosystem. An Environmental Impact Assessment is required for development in the associated mapped areas.

1.7.4 Municipalities

The municipalities of Nelson and Kaslo are also situated along the Kootenay Lake shoreline. Like the RDCK, these municipalities have enacted their own policies (OCPs), outlining measures including DP Areas to protect shoreline values (Table 2). The City of Nelson requires a DP within 15 meters of the HWM of all watercourses, wetlands, or Kootenay Lake; or riparian area (City of Nelson 2013). The Village of Kaslo, requires a DP for designated lakefront areas as well as the Kaslo River (Village of Kaslo 2011). The OCPs provide many specific details. For example, all development along the Kaslo River is to have a 25 m setback (Village of Kaslo 2011). Kaslo is currently updating their OCP and the RDCK are in contact with their Chief Administrative Officer regarding their project to update the Kootenay Lake DPA's (N. Wight pers. comm.). Similarly, all municipalities are encouraged to use and integrate data in this report into their OCP or relevant bylaws.

1.7.5 First Nations

First Nations have occupied and used Kootenay Lake since time immemorial. The Ktunaxa Nation, Syilx Okanagan Nation, Shuswap Band and Sinixt Nation all used some of the areas on or around the lake for hunting, fishing, foraging and/or traditional ceremonies (KLP 2021). The Ktunaxa Nation through the KLP has collected data on cultural or archeological zones around Kootenay Lake (KLP 2019).

First Nation referrals are part of the environmental application review process, for the Federal government (e.g., *Fisheries Act* Authorizations), the Provincial government (e.g., *Water Sustainability Act* Section 11 Approvals), and local government (through the Foreshore Development Guide for instance).

1.7.6 Kootenay Lake Partnership

The Kootenay Lake Partnership was formed in 2010 in response to the increasing development and recreation pressures on Kootenay Lake. These pressures resulted in many issues including: cumulative foreshore impacts, degraded habitat, recreational use conflicts, water use issues, and water quality concerns (Schleppe and Cormano 2016). The Kootenay Lake Partnership brings together federal, provincial, local First Nations, and local governments to collaborate on how to best address these multi stakeholder issues (KLP 2021).

The Kootenay Lake Partnership supports management approaches that sustain Kootenay Lake's environmental, community, recreational, aboriginal cultural, traditional, and aesthetic values (KLP 2021). The partnership includes DFO, the RDCK, the Lower Kootenay Band (Yaqan Nukiy), the Ktunaxa Nation, , FLNRORD, Ministry of Transportation and Infrastructure (MOTI), Interior Health Authority (IHA), and the City of Nelson (KLP 2021). The partnership works cooperatively to ensure that land use decision making processes are consistent between the different levels of government. To help achieve this, the KLP obtained funding and oversaw the completion of the original Kootenay Lake FIM and AHI (now called the FHSI) (Schleppe and Cormano, 2016), and Shoreline Guidance Document (KLP 2019). In addition, the partnership conducts research, develops innovative ways to improve decision making and provides clarity and understanding to lake users (KLP 2021). In the past, DP applications were forwarded to the KLP. However, this was discontinued, recognizing the duplication in that the applications are also reviewed by the referral agencies who sit on the KLP (N. Wight pers comm.).

1.7.7 Stewardship Groups

Stewardship groups play an important role on Kootenay Lake, by engaging citizens in monitoring lake health, public outreach and education etc. The Friends of Kootenay Lake Stewardship Society (FOKLSS) is the main group involved on the lake as a whole. However, more localized groups are also present, including:

- Central Kootenay Invasive Species Society (aquatic invasive species management)
- Creston Valley Rod and Gun Club
- Columbia Basin Watershed Network
- Duhamel Water Society
- Eastshore Freshwater Habitat Society.
- Friends of the Lardeau River
- Harrop-Procter Watershed Protection Society
- Kokanee Creek Nature Centre
- Kootenay-Columbia Discovery Centre
- Kootenay Conservation Program
- Kootenay Lake Sustainable Boating Society
- Kootenay Native Plant Society
- Nelson and District Rod and Gun Club
- West Arm Outdoors Club
- West Kootenay EcoSociety
- West Kootenay Naturalists
- West Arm Recreation Society
- Wildsight
- Friends of Kootenay Lake Stewardship Society

Friends of Kootenay Lake Stewardship Society (FOKLSS) was formed in 2012 and is dedicated to sustaining a healthy Kootenay Lake for future generations (FOKLSS 2021).

FOLKSS provides a central location for lakeside communities to share information, collaborate, and learn about Kootenay Lake. Additional highlights of this stewardship group are as follows (FOKLSS 2021):

> The vision is for "*a productive ecosystem supporting abundant fish and wildlife.* This vision includes *residents, First Nations, and other stakeholders, so they have a strong sense of place and engage actively in lake stewardship and governance. The FOKLSS mission is to improve the health and stewardship of Kootenay Lake through monitoring, habitat restoration, capacity building, and the empowerment of local communities, First Nations, and stakeholders.*
>
> *FOKLSS has a comprehensive online resource library, with the following folders of information: Animal Facts, Biomonitoring Resources, Fish & Wildlife, Homeowner Resources, Impact Studies, Kootenay Lake, Lake Planning, Osprey Nest Monitoring, Resources for Kids, Water, and Wetlands.*

FOKLSS also helps residents participate in planning initiatives to improve lake management. This includes use of the FDG to protect shoreline resources. *FOKLSS plans to work with the KLP and lake-side communities to develop a lake management plan to harmonize regulation, coordinate enforcement, and improve protection of the lake* (FOKLSS 2021).

1.8 Original Kootenay Lake Foreshore Assessment

The following are key findings from the original shoreline study (*in italics*) completed on Kootenay Lake in 2012 (Schleppe and Cormano 2016):

> *Field data for the FIM was collected from September 24 - October 4, 2012. The 403 km of shoreline was assessed as 254 individual segments. The predominant land use was natural areas (25.6%), followed by rural residential areas (21.8%). The predominant shore types were gravel beach (38.4%) and rocky shore (34.1%). Aquatic vegetation was present along 36% of the shoreline and was identified to be an important habitat feature for juvenile salmonids. Of this, emergent vegetation was the most common (33.6%). In terms of counts, groynes were the most common modification (1,776), followed by docks (738 count), retaining walls (709 count), concrete boat launches (114), marine rails (107), marinas (35). Many retaining walls were present below the HWM, and construction practices were not compliant with Best Management Practices. Of the modifications measured as length (or percentage) of shoreline, substrate modification (i.e., groyne construction, importing sand, removal of emergent floodplain vegetation, and road or railway ballast fill) had the greatest impact (34%). Roads and railroads accounted for 5% and 6% of the shoreline length modified, respectively.*

In addition to collecting the standard FIM data, the following information was mapped during the 2012 field surveys: extent of aquatic vegetation (emergent, floating and submergent), areas of good overhanging vegetation, significant breaks or changes in substrates, small stream confluences and seepage areas, boat launches, retaining walls, intact riparian areas, and erosion areas.

The original AHI parameters and logic table included the standard biophysical, shoreline vegetation and modification parameters. Several wildlife and fish parameters were added that were specific to the lake (collectively termed Zones of Sensitivity (ZOS)) under current methods. Wildlife ZOS were: Heron rookery; Conservation Data Centre (CDC) masked, Red listed and blue listed species; raptor nest, bat site, and amphibian site. Fish ZOS were: high value Kokanee area, Critical White Sturgeon Area, juvenile rearing habitat, migration corridor, and staging area. The AHI ranked the Ecological Value of the shoreline as follows: 12.7% Very High, 41.2% High, 14.8% Moderate, 6.8% Low, and 0.6% Very Low.

The Archaeological and Ktunaxa Cultural Values were also evaluated in the original study. The FHSI and these First Nations ranks were mapped individually and presented in the FDG (KLP 2019). The FDG also provided an Activity Risk Matrix for each of Ecological, Cultural and Archaeological values. Finally, steps to be followed before works could commence were identified in the Design, Assessment and Review Process Flow Charts. Four flow charts were prepared: 1) development that may impact fish habitat, cultural or archaeological values; 2) lakeshore erosion control; 3) new private moorage; and 4) commercial and strata moorage. Overall, the intent of the FDG was to direct shoreline development (such as docks, retaining walls, or dredging activities) to protect high value habitats.

1.9 Objectives

The key objective of this study was to update the original FIM and AHI that was based on data collected in 2012. An important component of the grant funding for this project was to update SAR information. This information was used to identify changes that have occurred over the nine-year period, and to identify any trends that might need consideration into the future. It is hoped that these updates will be incorporated into local, regional, provincial, and federal policy and guidelines, where appropriate, as tools to continue to improve land use and planning decisions and ultimately protect high value areas.

In completing the above, the objectives of the original FIMP were also to be met (Schleppe and Cormano 2016):

1. Compile existing map base resource information for Kootenay Lake and the associated watersheds.
2. Foster collaboration between DFO, the Province, the RDCK, municipalities, and the Ktunaxa Nation; and utilize available expertise, where possible.
3. Provide an overview of lake foreshore habitat condition.
4. Inventory foreshore morphology, land use, riparian condition and anthropogenic alterations.
5. Obtain spatially accurate digital video of the shoreline.
6. Provide access to the video and Geographic Information Systems (GIS) geo-database through the Community Mapping Network (www.cmnbc.ca).
7. Collect information that will aid in prioritizing critical areas for conservation and protection and suitable areas for lakeshore development.
8. Make the information available to planners, politicians and other key referring agencies that review applications for land development approval.
9. Make recommendations to help protect sensitive foreshore areas, and to integrate information with upland development planning so management planning is watershed based.

2.0 METHODS

For this Project, Kootenay Lake was re-assessed using the recently revised FIMP methods FIMP (Schleppe et al. 2020). The FIMP involved completing the three components: FIM, FHSI, and FDG. Since the lake was previously assessed, past results were included to provide an understanding of any changes that have occurred over the 9-year period since the last assessment. To align the original data set with the new standards with as much accuracy as possible, important and detailed quality assurance/quality control (QA/QC) procedures were completed, such as photo comparisons between the original survey and this survey wherever feasible. This process is described below.

The Ecoscape/Lotic Environmental Project Team was carefully selected to include professionals with direct experience conducting FIM, FHSI, and FDG on other similar projects in the province (all team members), as well as on Kootenay Lake (Jason Schleppe). The team was comprised of:

Ecoscape

- Jason Schleppe as Lead Biologist (MSc, RPBio)
- Tina Deenik as a Project Biologist (MSc student)
- Dan Austin, M.GIS, GISP as the GIS Specialist (BSc)
- Fabian Cid Yanez as a Data and GIS Analyst

Lotic Environmental

- Sherri McPherson as Lead Biologist (BSc, RPBio)
- Tegan Arnett as Project Biologist (BSc, RPBio)

2.1 Foreshore Inventory and Mapping (FIM) Methods

Foreshore Inventory and Mapping methods were used to delineate, inventory and map foreshore habitats. The foreshore was defined as the area from the deeper edge of the littoral region of the lake (i.e., where the start of pelagic region begins) to an area up to 50 m beyond the HWM into the upland/riparian zone. Within this area, through completion of the FIM, field technicians counted, catalogued and described the following: land use (e.g., residential development), modifications (e.g., retaining walls, docks, marinas), and biophysical attributes (e.g., shoreline vegetation cover, substrates, large woody debris and aquatic vegetation). The FIM was completed in a four-step process, as identified below.

2.1.1 Step 1 Pre-Field Assessment

The FIM field database was prepared by first converting the original database into the revised database available in the new FIMP methods (Schleppe et al. 2020). This involved merging data fields collected using similar methods. Attribute data requiring additional field consideration to ensure consistency between the former and current data collection were identified.

The original FIM geographical information system (GIS) dataset was converted using GIS 'R' software to script a "rule set". The following rules were applied:

1. Data fields attributes in the 2012 FIM database were matched with the most similar field in the 2020 FIM database. The matched fields were then updated to the most common nomenclature.
2. Fields that were not sampled during the original event were left as either NA's or were estimated using photos, aerial imagery, or other methods.
3. Field data notes in the original database were left in the comments field and/or GIS meta-data, to allow users to understand what fields were added in the second FIM and which fields were completed using estimation or other tools. This field database was used for field inventory.

Other background information was mapped, including the following data layers:

1. The Provincial and Federal GIS registries were searched for Species and Ecological Communities at Risk and Critical Habitat data. A review was conducted for other high value habitats potentially present (i.e., grasslands and wildlife habitat areas). Mapped occurrences were loaded on to the field maps.
2. Local government data was obtained, including zoning, cadastral (including government and non-government organization [NGO] conservation areas), and recent aerial imagery. These data were used to help understand the key land use designations, and inform the field surveys (e.g., segment brakes) and conservation recommendations. From this office exercise, there were no significant land use changes evident, inferring that there were no preliminary segment break changes required.
3. Finally, all pertinent data above were loaded onto the most recent aerial imagery, and these were loaded onto iPads for field use. This included but was not limited to GIS mapping layers from the original FIM database (e.g., aquatic vegetation polygons, marinas, boat basins, stick nests). These data were used to help pinpoint and identify if there were changes necessary during the 2021 field work (e.g., to determine if the polygon size changed).

Associated field data mapping protocols were also developed and field forms specific to the Kootenay Lake FIMP process were developed using a series of fillable forms, and pre field information necessary (e.g., for FHSI and ZOS).

2.1.2 Step 2 Field Assessment

The FIM field assessment was conducted by boat on August 13 – 22, 2021 using a commercially registered 18-foot aluminum hulled vessel. A crew of four was aboard the boat throughout the assessment: Jason Schleppe and Tina Deenik (Ecoscape); and Sherri McPherson and Tegan Arnett (Lotic Environmental). Georgia Peck (LLC) also joined on August 14 to both observe the field methods employed and to assist with field data collection.

The updated database was used for field collection of FIM data. During this step, field data were collected as follows:

1. Using a laptop computer, data were entered electronically into the MS Excel FIM database field forms. The field forms contained the original FIM data to allow review and evaluation of both years simultaneously.
2. Biophysical and habitat attribute data were collected in accordance with the FIMP methods. (Schleppe et al. 2020). All mandatory data were collected, as well as other important but non-mandatory data (e.g., overhanging vegetation, large woody debris, and modifications).

3. During the original FIM, spatial mapping of modifications consisted of mostly marinas and boat basins; and other modifications were just counted. In 2021, modification mapping was expanded to improve accuracy both for the current report and for any future comparisons that may be made. In 2021, iPads were used to spatially mark collected data using ArcGIS collector as follows:
   - Lines: retaining walls and erosion control (riprap).
   - Points: docks, groynes, boat launches, marinas, boat houses and boat basins.

   **Note, the accuracy of the above spatial attributes has not been confirmed because field time did not allow for field measurements. User interpretation of this data is important and must acknowledge that the data was collected from a boat.*

4. Fish, wildlife and ecological habitat observations were conducted. The following observations were mapped on iPads (some of which were simply checked against the original study and updated as necessary):

   Polygons:
   - Aquatic vegetation -submergent, floating, emergent, overhanging.
   - Riparian - riparian areas of significance.
   - Aquatic life - mussel beds, and areas where fish were visibly rearing.

   Points: stick nests, and significant wildlife trees, small stream confluences, and seepage areas.

   Lines: overhanging vegetation, erosion control.

   From the above list, all but mussel beds, fish rearing areas, and erosion control were originally mapped.

   *Note, the a*ccuracy of these spatial attributes has not been confirmed because field time did not allow for field specific measurements. User interpretation of these data is important and must acknowledge these data were collected from a boat and may not include identification of all mapped instances or locations.*

5. All iPad GIS mapping were downloaded to the Ecoscape Server and “Cloud” daily to protect from data loss.

The original FIM segment breaks were confirmed, with no changes identified to be necessary.

Geo-referenced still photographs were taken to characterize each shoreline segment and its attributes. These photos, where possible, were spatially referenced with the previous photos from 2012, and were used extensively to QA/QC the 2012 data to ensure rates of change calculated were as accurate as possible against 2021 data. Where possible, photo comparisons of change were noted for future reference.

2.1.3 Step 3 Video Documentation

Video documentation was conducted to assist in classifying land use and features, and to detect change over time. A shoreline video was collected from November 2 - 4, 2021, from a boat by a crew of two (Scott McGill and Cole Rithaler). An 18 ft. commercial boat was used. The weather conditions during the survey were generally dry, clear, and calm, which aided data collection. However, some days or times within days were not as favorable.

The video was recorded within 50 m from the shoreline. The video was filmed using an iPad and was merged with a file for the "path taken" using GPS. Features of the camera were: a lens shroud to protect from direct sunlight, a polarized lens, a tripod, and hard drive storage media.

Video processing involved running the video through an image stabilizer and applying text to identify the segment number. The time, boat speed, geo-reference (latitude and longitude coordinates), and compass direction (boat's travel direction) were also shown on the video. The output was provided in MP4 format, to work with any standard viewing software.

The following is a stepwise summary of the video collection methods:

1. Created georeferenced maps showing segments, orthophoto, and landmarks to allow the video field crew to determine location of segment breaks.
2. Created a video for each segment to reduce file size, and to make finding a location of interest easier (instead of scanning one large video).
3. Georeferenced maps were uploaded into iPads to allow the video field crew to see their location on the map.
4. GPS tracks were recorded in sync with the video recording so the start/stop of GPS track was recorded synonymous with the video start/stop.
5. All video and GPS tracks were downloaded post field work, and these were processed on a computer at the office as follows:
    a. Video editing software was used to stabilize the video due to wave action/boat movement.
    b. Metrics were derived from the GPS track data including date, time, speed, direction, and GPS coordinates.
    c. The metrics were synchronized with the videos.
    d. Metrics were graphically displayed on the exported video.

2.1.4 Step 4 Reporting and Data Analysis

The FIM database was first reviewed and corrected for QA/QC purposes. This involved:

1. Verifying that both the original and new FIM databases were copied over properly. This step was done to ensure the estimates of change between the assessments were accurate as possible.

2. In 2021, select data were collected differently from the original SHIM. These differences and respective QA/QC measures completed to make the databases comparable, so the change analysis could be conducted accurately, were as follows:

    a. Retaining walls: In 2012 retaining walls were not mapped using GIS and were only counted. In 2021, they were counted and mapped. To ensure accuracy and account for user biases, retaining walls were reviewed in the office as part of QA/QC. This involved using the 2012 and 2021 photos to confirm counts and improve the estimate of the approximate linear extent (%) for each segment. The 2012 and 2021 databases were adjusted accordingly to allow for a comparison between years that was as accurate as possible.

    b. Boat launches: The original FIM only counted the public boat launch sites. In 2021 all boat launches, including private gravel launches leading out of boathouses were counted. In 2021, these launches were split into two categories based on whether they were gravel or concrete and mapped. To account for the differences, the office QA/QC involved reviewing 2012 photos to confirm counts using the 2021 methods. The 2012 database was adjusted accordingly to allow for a comparison.

    c. Boat rack/lifts: In 2021, when two jet skis were connected and lifted as one entity, they were counted as one rack/lift. We mention this because it was not specified in the methods. No change was made to the 2012 database since the values were found to be relatively comparable between the years, noting that counts in 2012 were sporadic and should not be considered accurate for comparative purposes with 2021.

    d. Groynes: In 2012 groynes were only counted, noting some very large ones were possibly delineated spatially. In 2021, they were mapped using the iPads. In both years, as per the methods, any collection of rocks running perpendicular to the shore that could impact sediment drift were counted. Similar to retaining walls, photos were checked to confirm that there was consistency with the counts, with only some segment totals adjusted in either 2012 or 2021.

    e. Floating boat houses: In 2021 floating boat houses included hard roofed (metal or wood) structures to park boats in, with or without three walls. Boat covers were other soft roofed structures to park boats in. In 2012, floating boat houses were similarly counted.

    f. Marinas: In 2012 there was only one marina category, while 2021 had a small and large marina category. The 2012 database was updated accordingly. Within a marina, each dock connection to the land was also separately counted as a dock in both years.

g. Pile supported docks: In 2021, pile supported docks included both docks with piles driven into the substrate, as well as docks that had metal framework connected to the shore, albeit with a much smaller structure that could sometimes be moved as water dropped. However, rectifying this was not critical since total combined docks (pile supported and floating) were used for the analysis and differences were only accounted for using the iPad GIS data mapping.

h. Sheds: In 2021, sheds included any structure that would not require a building permit. Sheds thus included outhouses, small outbuildings/sheds, large gazebos, etc. These were not counted in 2012.

3. Percentages disturbed and natural were key attributes contributing to the extent of change analysis. These values were proofed between the years by looking for disturbance (i.e., development and riparian removal) in the 2021 photos that was not evident in 2012 photos.

4. Erosion Index - At the request of the KLP, Ecoscape completed erosion mapping along the lakeshore in the 2012 study. The mapped results were simply carried over in the GIS dataset, so the information was not lost, with no updates completed since the original study. Mapping was based on a variation or modification of the methodology outlined in the document Lakeshore Erosion Hazard Mapping (Guthrie and Law 2005). Field mapping of erosion potential included recording information for a number of parameters including wind exposure, soil composition and backshore soil exposure. In addition to these parameters Ecoscape recorded the size of material being mobilized off site, the size of material being rolled around but remaining on site and the size of stable material. Ecoscape quantified the erosive conditions present at the site and compared this information to the potential risk from wind exposure to determine an erosion hazard rating for the site.

Results of the FIM survey were then analyzed using R Programing Software (R Core Team 2021) and were presented in a series of tables and graphs to describe the overall shoreline condition. Rates of change in key metrics, such as the quantity of natural and disturbed shoreline, were compared at a lake wide scale.

2.2 Foreshore Habitat Sensitivity Index (FHSI)

Foreshore Habitat Sensitivity Index methods were used to rank approximate relative shoreline values based on the data available from the FIM (including biophysical and modification criteria), ZOS determination (using other inventories), and professional judgement. Ultimately, the FHSI identified areas of greatest sensitivity to change from foreshore development or areas where risks to important ZOS or habitat features may occur if development proceeded.

To develop the FHSI, an additional detailed literature review was conducted to further describe foreshore values identified during the FIM office and field activities. This information was specifically used to confirm the applicable Kootenay Lake ZOS. The results of this review were used to support criterion and weightings used in the FHSI, as well as support and strengthen the FDG recommendations.

2.2.1 Step 1 Preliminary Review of Original 2012 FHSI

The 2012 FHSI categories and criterion and their weightings were reviewed to determine if they could be carried over and used as-is with the new 2021 data (i.e., to identify if they were still accurate and relevant). As a first step, to confirm that weightings and start points were similar to 2012, the original FIM weightings were scaled to the new methods, and the FHSI was run to ensure a similar end outcome could be derived (i.e., the FHSI Ranks were reproduced). During the review, it was determined that although the original data were relevant, the FHSI (including ZOS) should be updated using the new methods and to allow incorporation of new data collected or identified as relevant during the FIM. Further, this would also allow for the inclusion of First Nations Traditional Ecological Knowledge (TEK) data, if provided.

2.2.2 Step 2 FHSI Criteria and ZOS development

The FHSI involved first deciding which FIM attributes, ZOS and modifications to consider as criteria and then the weightings to apply in the FHSI. Care was taken to include criteria that both supported a broad range of important habitats, while avoiding duplication of a habitat value. For instance, the overlapping values of juvenile rearing, fish migration and staging were all considered, in conjunction with the biophysical values from the FIM. This step was important to ensure the influence of any given criterion was estimated correctly and did not overly leverage the resultant FHSI rank.

Zones of Sensitivity were determined using the original ZOS, FIM office and field findings, and subsequent literature review/data search. A key step was to contact fish, wildlife and habitat professionals from various organizations, (including FLNRORD, Ktunaxa Nation, consultants, and stewardship groups) and request current spatial data for high value / sensitive species and their habitats. Inventory data was specifically sought which was not already on the provincial databases (Conservation Data Centre (CDC) and iMap). For example, recent Kokanee shore spawning data was sought from the FLNRORD, and freshwater mussel data was sought from Ktunaxa Nation. These ZOS are, at minimum, a flagging tool to help call attention to areas of particularly high importance for fish and wildlife. If more detailed data becomes available, the ZOS spatial boundaries can be amended to improve spatial accuracy.

In accordance with the methods, when developing the FHSI, each selected criterion was categorized by habitat. Each criterion was weighted to assess the influence of each category. Data from the original FIMP were used to help determine the initial weightings of criteria within a category. This step was done to help ensure consistency with the original index. For consistency with previous mapping, only two categories were considered: Fish, and Wildlife (which include Ecosystems).

Criteria in the FHSI need to be carefully considered. To be part of the FHSI, data used for each criterion preferably had GIS data for the entire lake because without complete surveys the results of the FHSI could be skewed. Similarly, an applicable criterion was not to have data that was uniformly or equally distributed across all FIM lakeshore segments because this would not have any effect on the FHSI. An example of this was the Upper Kootenay River White Sturgeon occurrence data, which mapped this species as being present throughout the entire lake. Instead of using this data, only the critical habitat for this species was selected as a criterion. In summary, data used in the FHSI needed to present for the entire lake and have some type of variation in density such as high, moderate, low *or* present / absent.

To determine which data were "considered" in the FHSI for a segment, polygons covering the entire lake were created using the spatial extents of FIM segments to crate the polygon. For each segment, a polygon from 500 m buffer away from the HWM to the center of the lake was created using orthogonal offsets. The lake wide polygons created were manually adjusted for some segments where the scripted GIS offsets created unnecessary segment polygon overlap or failed to capture represented data that should be considered part of the segment because of how the scripted orthogonal offset was created. The polygons created for each segment of the lake were then used to consider data used for criterion in the FHSI as present (Yes), or absent (No) if there was overlapping spatial values (i.e., SARA Critical Habitat for White Sturgeon overlapped with the orthogonally created segment polygons). During the FHSI, if scripted polygons captured by the spatial mesh were deemed not highly relevant because of low overlap for example (i.e., long segment with less than 10% overlap for stream feature, when segment type was a rocky, steep cliff /bluff shoreline), they were removed from the analysis manually during calibration.

2.2.3 Step 3 FHSI Calibration

Calibration of the FHSI involved an iterative process of reviewing the Ecological Rank results that were determined for shoreline segments considering the assigned weightings. The calibration considered the influence of weighting for all habitat categories and individual criterion both within the category and compared to all criteria in the FHSI. The objective was to assign weightings that were representative of observed habitat values and reflective of the shoreline ecological values present for each FIM segment, considering all fish and wildlife data available and ways they may overlap or influence each other. The purpose of these iterations was to determine the sensitivity of each category and criterion on the FHSI analysis outcome. While these results were visualized on maps to help quickly assess results and influence of the criteria in the FHSI, each iteration was not presented in this report.

The FHSI was calibrated by preparing a suite of R scripts. For the first iteration of the index, each habitat category was weighted using the 2012 Kootenay Lake data. To be consistent with the new FIMP methods, the original data for each criterion were scaled to range from 0 to 1 because the original FHSI used an arbitrary scale. This analysis had a high level of agreement, noting that this step identified some data errors in the original 2012 data that had been corrected (e.g., a few cases where Band 2 vegetation was included, but a specific bandwidth was not identified, affecting the FHSI slightly).

For each iteration, histograms of shoreline FHSI scores were prepared. If the results clumped into discrete groups, it meant that shoreline segments were similar and that values overlapped. With each iteration of the index, several small database QA/QC corrections were made as required (e.g., sometimes riparian or substrate parameters were revisited and confirmed). Manual manipulations of spatial buffers used to identify the FHSI criteria were considered to ensure that the presence/absence data used in the FHSI did not overestimate shoreline value in longer lake segments. The final determination of the "break" used to differentiate segments (e.g., rank score between Very High and High) considered the location on the lake, length of segment, field observations, professional opinion, reference literature, and the values within the identified ZOS.

Results were evaluated spatially and in a series of figures. Throughout the FHSI calibration process, QA/QC occurred to ensure that the final deliverable was as accurate as possible. For example, the criteria that applied to a segment using the spatial mesh were evaluated, and in some cases the criteria were manually adjusted to ensure they were neither over or under representing habitat values found in a segment.

The last phase of FHSI calibration involved scrutiny of the categories, criteria, and weightings by other professionals. The FHSI analysis was refined once a consensus was reached (i.e., the Ecological Ranks assigned to different shoreline segments were appropriate).

2.2.4 Step 3 Reporting, Data Analysis and map production

Results were analyzed and presented in a series of graphs, tables, and figures to describe the overall shoreline condition. The maps summarized the FIM inventory data, and included categories and criteria used in the development of the FHSI. A map set depicting the FHSI Ecological Ranks, including spatial habitat data, was provided to portray the FHSI results. These map sets and associated mapping deliverables are available in GIS and can be integrated into any planning or permit process easily. These outputs provide a framework for considering the variety of different values around the lake.

2.3 Foreshore Development Guide (FDG)

The FDG report was prepared in accordance with the FIMP methods and the FDG template (Schleppe et al. 2020). The FDG was prepared according to the following stepwise process:

STEP 1: The FDG map was prepared using the FHSI outputs. The map depicted the pertinent fish and wildlife information needed to guide development planning. This included: a) The FHSI Ecological Ranking for each segment (ranging from very high to very low) as colour zones; and, b) the ZOS.

STEP 2: For each colour zone and ZOS, a summary and general recommendations were provided. Information on habitat sensitivity, anthropogenic disturbance risks, acceptable activities, and conservation recommendations were included.

STEP 3: The Activity Risk Matrix (ARM) identifies the level of risk of typical activities for each colour zone and ZOS. The ARM and associated recommendations from the FDG template were updated, as necessary.

STEP 4: The table outlining the typical regulatory requirements for each activity listed in the ARM was reviewed and updated, as necessary. Additional tools provided in the FDG template were also reviewed and updated as necessary, including the list of federal, provincial and local environmental legislation, and the Best Management Practices (BMP) list.

STEP 5: All GIS, habitat, and fisheries data were finalized into appropriate databases and provided as a final deliverable. The ARC GIS files for linking data to the database were also provided. This step ensured that the colour palettes used, and links for integration into GIS platforms was consistent.

2.4 Traditional Ecological Knowledge (TEK)

First Nations Traditional Ecological Knowledge (TEK) can contribute to a broader understanding of existing ecological values. The FIMP framework was updated with a proposed process for obtaining and including First Nations TEK into FIMP Projects (Schleppe et al. 2020).

Our project team reached out to local First Nations and requested TEK data. The Ktunaxa Nation, Yaqan Nukiy (Lower Kootenay Band), Shuswap Indian Band, Syilx Okanagan Nation, and Sinixt Nation were contacted in late July, 2021. The Ktunaxa Nation provided freshwater mussel data that was input directly into the FHSI as a ZOS. There was no other mussel data available for the lake (the provincial Habitat Wizard and EcoCat databases were searched) making this information particularly valuable to updating the FIMP. No other information was provided by the report publication deadline.

The 2012 Kootenay Lake FIM survey considered First Nations provided data to a greater extent. It is suspected that the data in this (and the previous) FIM inventory will overlap with known or newly acquired TEK, cultural, and fisheries data as it is collected. Ongoing collaboration and connection of these data with the FIM data are important.

3.0 FORESHORE INVENTORY AND MAPPING RESULTS

The Kootenay Lake FIM assessment was conducted from August 13 – 22. During this time, the lake water level was 531.08 masl (Fortis BC 2021). The water level during the previous assessment (Sept 24-Oct 4, 2012) was similar at 530.9 masl (Schleppe and Cormano 2016). During the video collection, which occurred from November 2 – 4, the water level was 531. 14 - 531.17 masl (Fortis BC 2021).

The total length of the Kootenay Lake shoreline was determined to be 406,811 m (406 km). This estimate varied slightly from the estimate used in the 2012 FIM survey (403 km). Differences between length estimates between years could be attributed to a variety of possibilities, such as slight alterations to the mapped HWM, altering projection differences between years in GIS, etc. These changes amounted to less than 1% of the shore length between years. To conduct the rate of change analyses, the 2012 shore length and other associated values were corrected to match with the 2021 length, during the QA/QC process.

The foreshore was divided into 254 contiguous segments. The number of segments was also consistent with the original study. The FIM database with all data collected by segment is best viewed electronically and has not been provided because it is hard to interpret in tabular format. FIM maps showing segment location and key segment information are provided in Appendix A.

3.1 Summary of Shoreline Disturbance

Overall, 63% (256,106 m) of the shoreline was in a Natural condition, while the remaining 37% (150,705 m) was considered Disturbed (i.e., areas that had any sign of being altered) (Figure 3). This represented a loss of 4,525 m of Natural shore over the 9-year period, or approximately -0.12% per year (~488 m/year). The Natural areas were mostly present along lesser developed rural lands or in already protected areas of the lake. New disturbances since 2012 were spread around the lake and were focused in lower gradient areas (see shore type summary below), where there was road access and existing subdivisions continued to build out (e.g., during the first FIM, the lots may have existed, but buildout had not started yet). These disturbances occurred primarily as improvements/upgrades to previously existing urbanized areas. However, disturbance was also observed in previously undeveloped areas, which contained many new lots that had initiated construction since the previous FIM (e.g., south past Riondel to Pilot Bay Provincial Park, east past Proctor). Observed losses were almost always greatest in areas that had limited or no previous development, when compared to more urbanized areas. Differences were observed throughout the West Arm, around Gray Creek and Kaslo, south past Riondel to Pilot Bay Provincial Park, east past Proctor, sporadically in the North Arm, and north of Lockhart Beach Provincial Park.

The highest percentage loss of natural shoreline at a lake wide scale between 2012 and 2021 on Kootenay Lake are found in Figure 3. These areas represent the shore segments where the largest percentage losses were observed between years of the study. To better relate the losses to length of shoreline and consider the magnitude of intensity of loss, the rates of loss were scaled to the shoreline segment length. Figure 4 presents the scaled results, which show that the scale or magnitude of impacts is similar across the lake. Further, these figures show that impacts are widespread and in many areas.

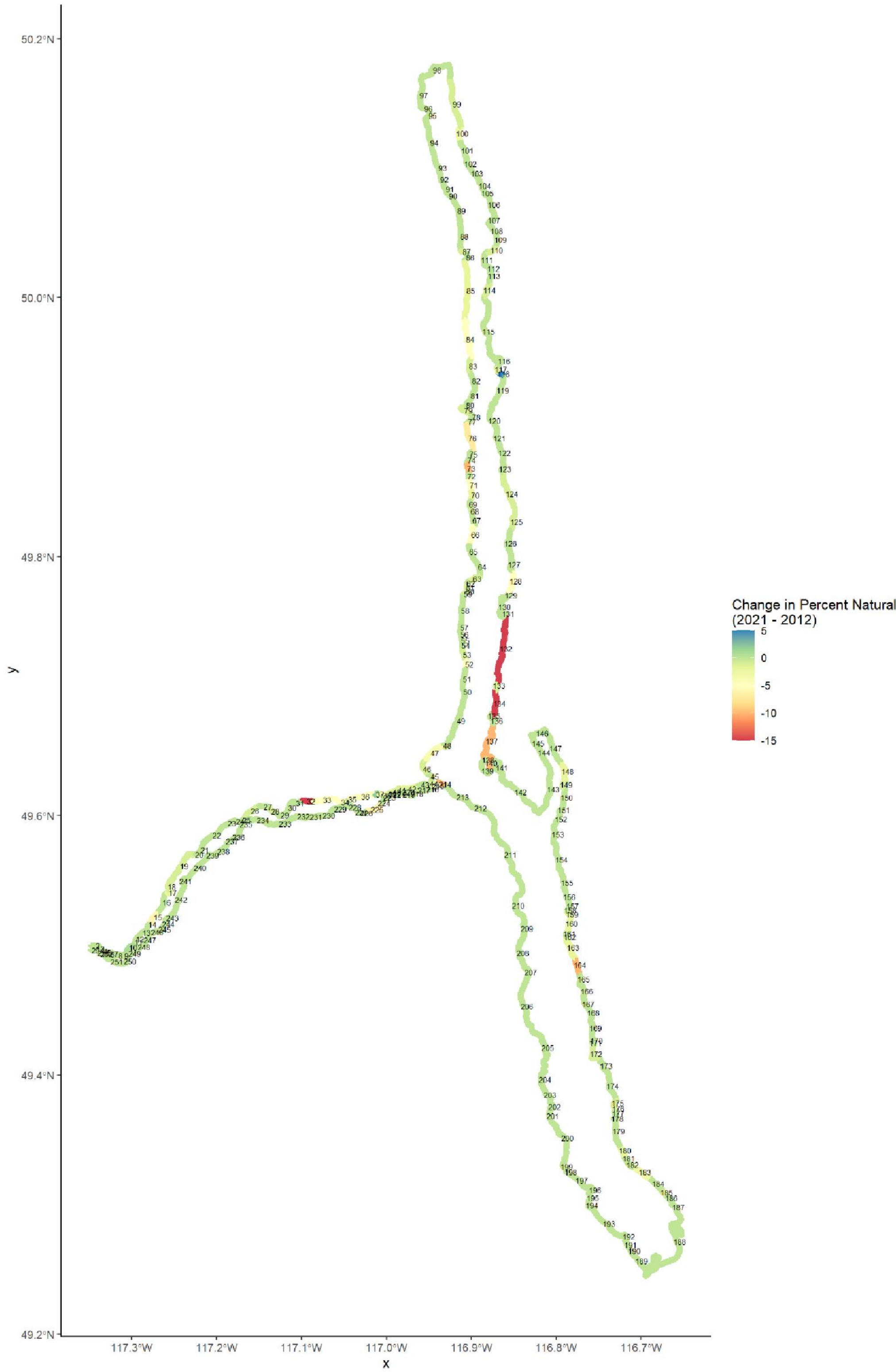


Figure 3. **The areas of biggest loss of natural lake shoreline (%) between 2012 and 2021 on Kootenay Lake**

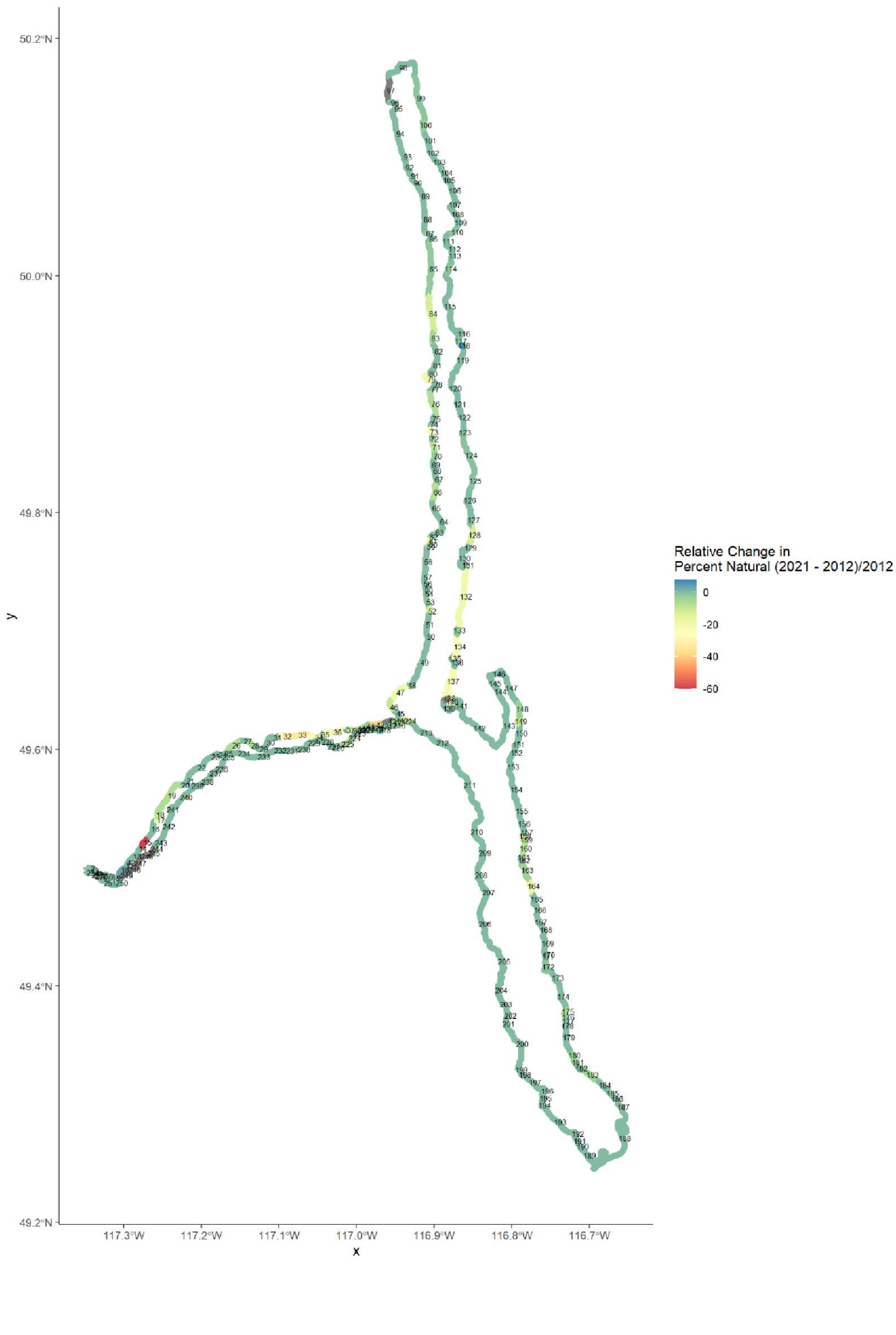


Figure 4. Summary of lake wide shoreline disturbance (%) scaled to the length of shoreline segment.

Existing natural areas occur in thirteen Provincial Park areas located at Drewry Point Park, Grohman Narrows Park, Lockhart Creek Park, Kootenay Lake Park – Campbell Bay Site, Purcell Wilderness Conservancy Park, Pilot Bay Park, Lockhart Beach Park, Kokanee Creek Park, West Arm Park, Kootenay Lake Park – Coffee Creek Site, Kootenay Lake Park – Lost Ledge Site, Kootenay Lake Park – Davis Creek Site, Kootenay Lake Park – Midge Creek Site. Other natural reserves (of varying types) include: Kokanee, Marsden Face, Redfish Creek, Duncan Flats, Midge Creek Wildlife Management Area (WMA), Creston Valley WMA, Queen's Bay, Redfish Creek, Darkwoods, Darkwoods (X2), Marsden Face - Grohman Creek, Marsden Face - Grohman Creek and Redfish Creek.

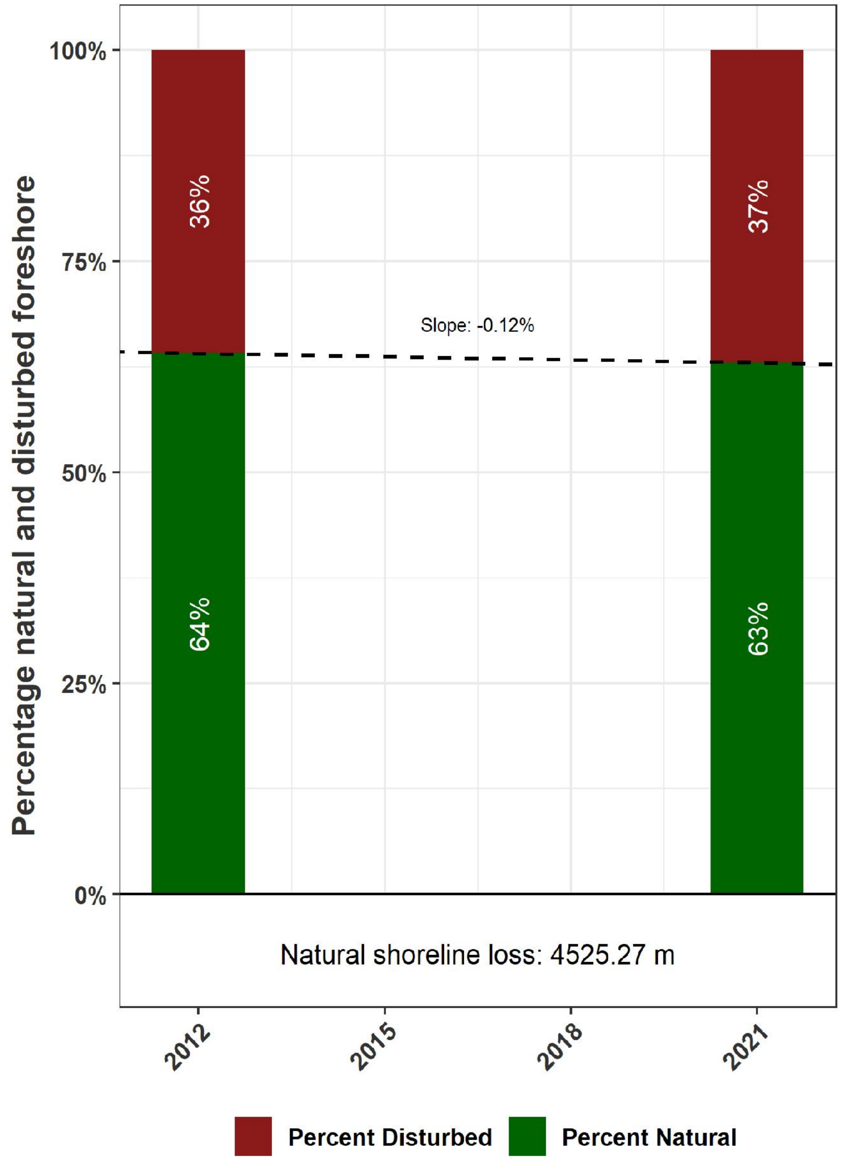


Figure 5. Summary of lake wide shoreline disturbance

The observed changes occurred through incremental losses at a small scale, often associated with clearing of small natural areas on private property. While these changes individually may not seem significant, continued losses have added up over time. During the field work, many examples of the shoreline being impacted from recent and ongoing new development were observed, with many from subdivisions that had recently been approved or were approved a few years prior to the 2012 survey. These sites showed signs of decline from recent disturbance as they continued to buildout. As these developments continue to be developed and used, further shoreline impacts are expected. At the current rate of change, the potential exists for lake ecosystem changes to occur. It is hard to identify the point where the ecosystem would reach an undesirable tipping point or a point when populations of important species may be significantly impacted.

3.2 Summary of Land Use Disturbances

Land use types were summarized in order of prevalence in Table 3. The extent of natural and disturbed habitat was consistent for most land uses between 2012 and 2021. The exceptions were Single-family and Rural residential land uses, which both exhibited increased disturbance between the two study years.

Table 3. Foreshore land uses and percent natural in 2012 and 2021.

Land use	Total length (m)	% Natural	
		2012	2021
Rural Residential	102,730.5	77.4%	75.4%
Natural Area	101,556.6	93.0%	92.8%
Single Family	78,092.9	27.6%	25.0%
Transportation	73,449.7	44.6%	44.2%
Park	31,228.5	88.9%	88.9%
Commercial	7,093.9	7.2%	6.7%
Urban Park	6,063.4	28.4%	28.4%
Industrial	5,430.8	37.1%	37.1%
Forestry	1,165.1	30.0%	30.0%

Rural Residential development was the most prevalent land use, extending along 25% of the foreshore. Rural areas were approximately 75% natural, with 77,482 m in a natural condition in 2021 (Figure 4). Since 2012, this land use had approximately 2,068 m of shoreline change from natural to disturbed, representing a rate of loss of 0.22% per year. This rate of loss was commensurate with the Single-family land use, suggesting that disturbance occurs similarly between these land uses. However, the impacts were greater when land use density increased.

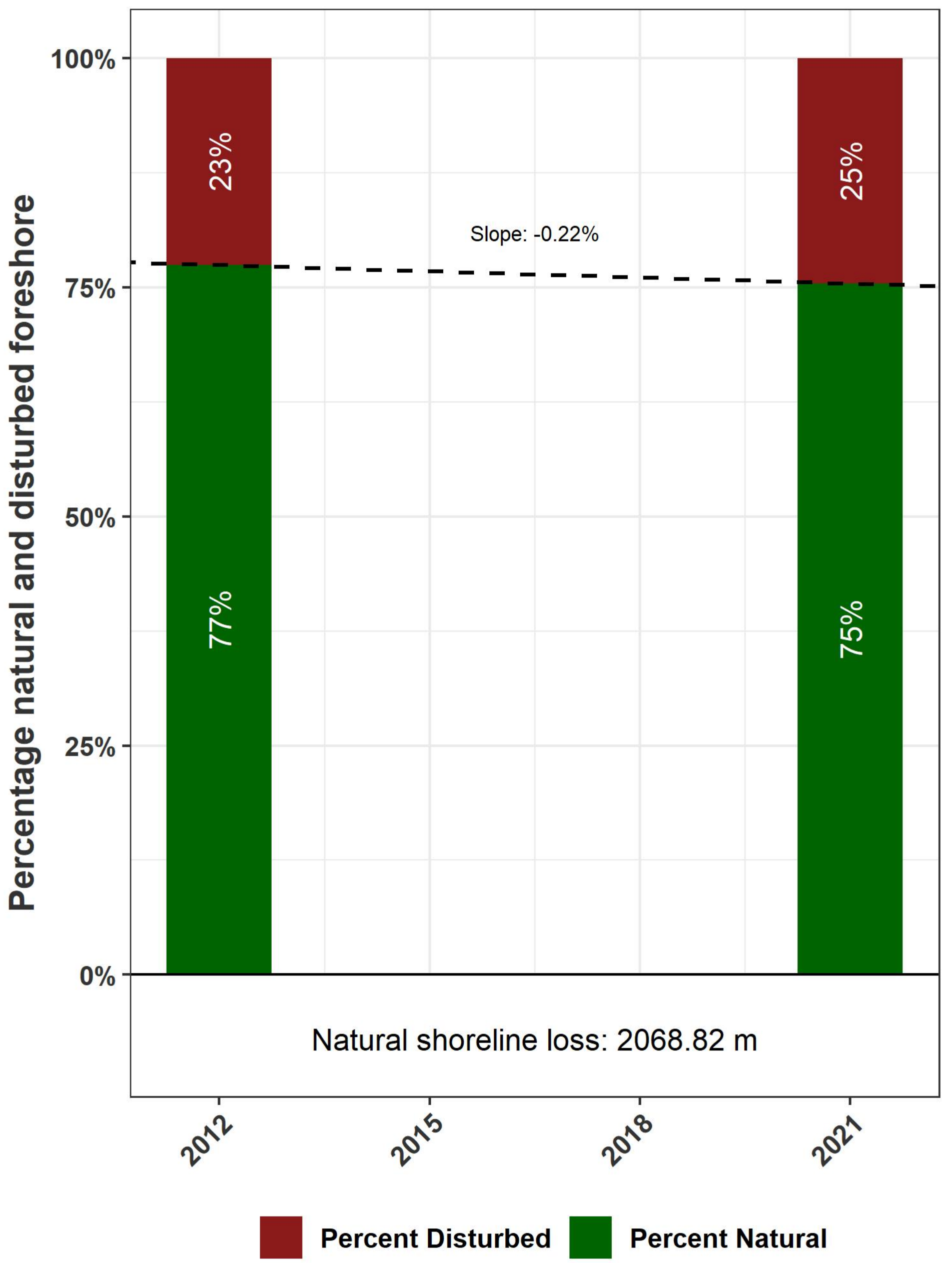


Figure 6. Shoreline disturbance in areas of Rural Residential land use.

The Single-family land use occurred along 19% of the foreshore and was the third most predominant land use type observed. This was primarily lakefront homes concentrated in various areas around the lake. Many of these residences were recreational properties. Shorelines in areas of Single-family land use were 72% disturbed in 2012 and were 75% in 2021 (Figure 5). This level of disturbance in Single-family areas is typical of other lakes in the region and across BC (Schleppe et al. 2019, Schleppe and McPherson 2021). The Single-family land use had a natural habitat loss of 2.6% or 2,025 m over the 9-year period. The changes appeared to be from small incremental losses, usually in the form of removal of patches of riparian vegetation. Although there were no big losses in natural areas, the losses were indicative that the Best Management Practices were not being followed. This can be improved in the future through improved engagement with landowners through stewardship and enforcement.

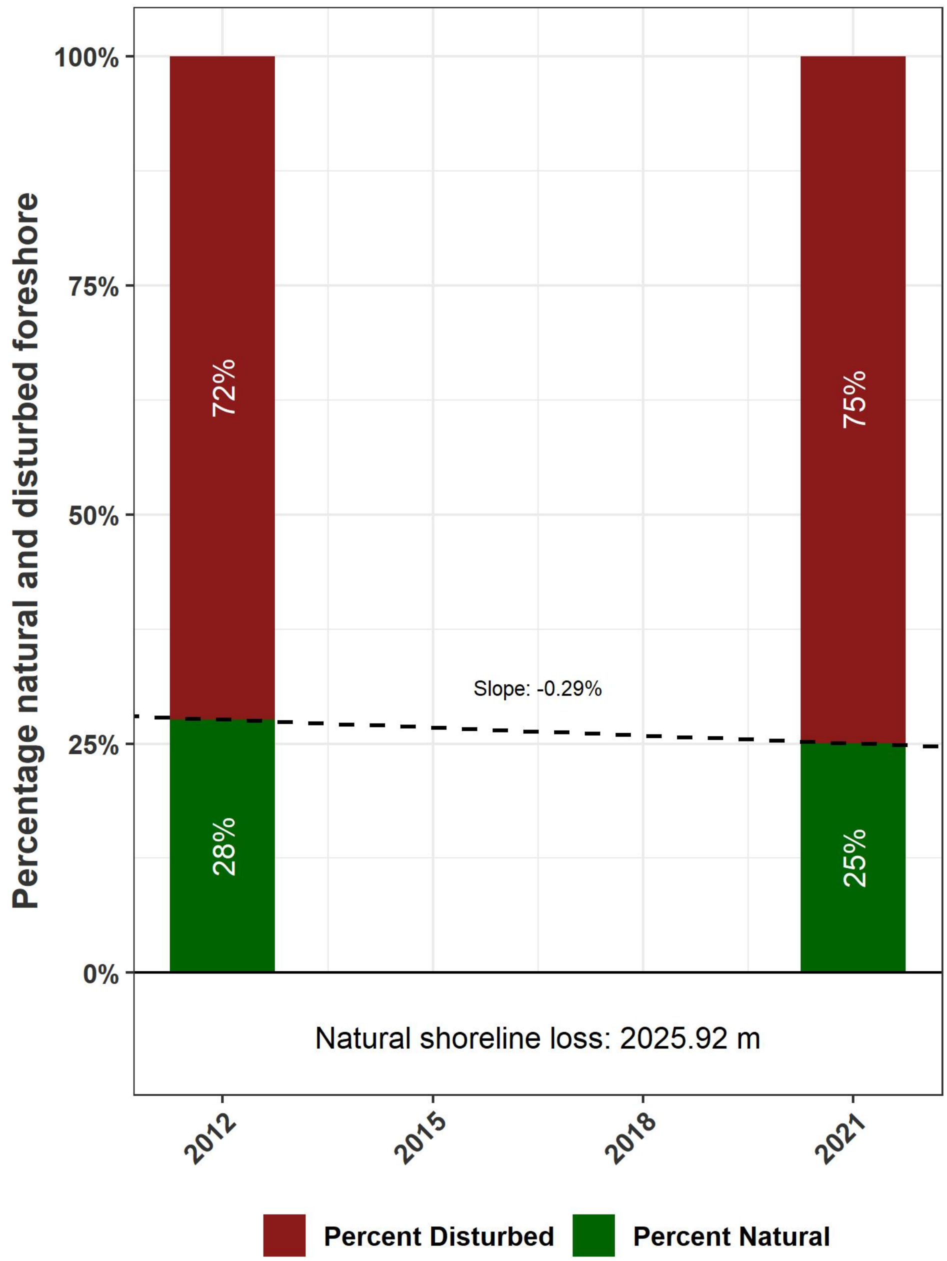


Figure 7. Shoreline disturbance in areas of Single-family land use.

The greatest disturbances to shoreline areas usually occur in processes of shoreline densification. This occurs, for example, where land use changes from Rural or Natural area (or similar) to a more urban land use like Single-family development, or when large areas of land are cleared for agriculture as on Okanagan Lake (Schleppe and Plewes 2016). On Kootenay Lake, many of these disturbances occurred on subdivisions that were approved around the previous FIM survey but had not been built out until more recent years. The small incremental changes to the Single-family land use seen on Kootenay Lake resulted in a rate of loss of 0.29% on a lake wide scale, or approximately 225 m annually. This rate was similar to Okanagan Lake, which experienced a 0.20% loss per year (Schleppe and Plewes 2016) and Windermere Lake, which experienced a loss of 0.18% within this land use (Schleppe and McPherson 2021). These similarities highlight that loss rates are most likely associated with land use, given that each of these lakes occur within a different jurisdiction with different policies to protect habitat.

While few new subdivisions were observed, there were several lakefront homes that had been recently constructed, re-built, or substantially renovated (Figure 6). On these more urban lots, there was very little shoreline restoration observed as part of a reconstruction process. The incremental, slow losses of riparian habitat can only be balanced with appropriate commitment to incremental shoreline restoration, otherwise, ongoing losses will occur and only a few remnant patches will remain over time on these urbanized lots.

Figure 8. Examples of new construction where little riparian enhancement is possible or where works were occurring below the HWM.

The Natural Area land use comprised 25% of the foreshore. These areas were approximately 93% natural and showed little change since 2012.

The remaining land uses combined accounted for 30% of the foreshore. Within these areas, changes were less apparent. For instance, in Urban Parks, Parks (natural area parklands) and Industrial areas, no change occurred. While in Commercial areas, a loss of 31 m of shore was observed. However, based on our review of other lakes, the potential for impacts in these areas remain. For example, Urban Parks can see loss of riparian and aquatic vegetation as parks build out and/or recreation intensifies. This was evident at Windermere Lake, as loss of emergent vegetation through unauthorized moorage (Schleppe and McPherson 2021). Mechanisms to monitor and abate these slow and incremental losses should be in effect for all land uses.

3.3 Summary of Disturbance along Different Shore Types

The extent of disturbance was consistent for most shore types between the two years of study (Table 4). The exceptions were Rocky Shore, Gravel and Sand beaches, which exhibited habitat losses between 2012 and 2021. Losses in gravel beach and rocky shore areas were expected to have a particularly high level of habitat related impact because these areas often occur in the highest value areas for fish and wildlife along the shoreline.

Table 4. Shore type and percent natural in 2012 and 2021.

Shore Type	Total length (m)	% Natural	
		2012	2021
Cliff/Bluff	48832.8	91.7%	91.7%
Stream Mouth	33339.2	88.3%	88.3%
Wetland	7470.6	76.4%	76.4%
Rocky Shore	169448.4	67.6%	65.9%
Gravel	140442.7	46.0%	44.9%
Sand	6420.5	23.3%	22.6%
Other	857.4	0.0%	0.0%

Rocky shorelines occurred along 41.7% of the shoreline and were 67.6% and 65.9% disturbed in 2012 and 2021, respectively (Figure 7). This means that since 2012, an additional 1.7% (2,868 m) of this shore type has been disturbed. This was a loss of 0.19% per year. This loss was greater than that calculated for Okanagan Lake, which had a loss of 0.10% per year (Schleppe and Plewes 2017). On Kootenay Lake, Rocky Shores often had high levels of disturbance because they were associated with moderately steep areas that needed to be substantially altered for easy access, both for land development and recreation purposes. Several recent subdivisions were evidenced to have changed land use from a rural nature to a Single-family nature (or Rural with more homes), and buildout was evident to be impacting the shoreline. Disturbances were attributed to incremental losses of small patches of native riparian (e.g., large coniferous trees such as Interior Douglas Fir) and emergent vegetation, and foreshore substrate alteration. These losses occurred both where land was developed for new construction or where existing residences were reconstructed.

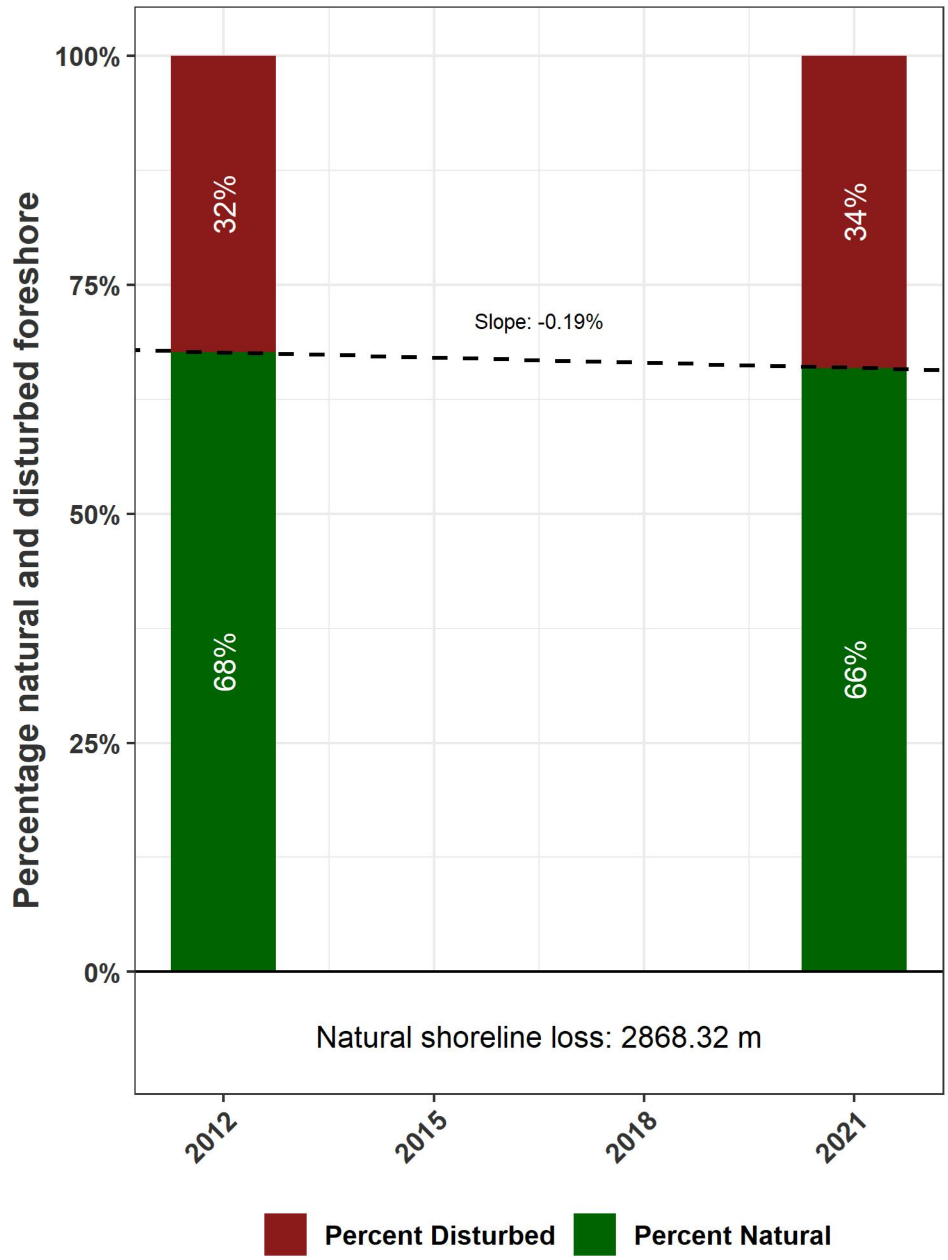


Figure 9. Shoreline disturbance in areas of Rocky shore type.

Gravel shorelines occurred along 34.5% of the shoreline and were 54.0% and 55.1% disturbed in 2012 and 2021 respectively (Figure 8). Since 2012, an additional 1.1% (1,583 m) of this shore type has been disturbed, resulting in a loss of 0.13% per year. This rate of loss was comparable to Okanagan Lake which had a loss of 0.11% per year for this shore type (Schleppe and Plewes 2017). Gravel beaches often have high levels of disturbance because they are associated with lower gradient areas that are easily accessible for land development and are often locations for transportation corridor. Disturbances were attributed to incremental losses of small patches of native riparian (e.g., large coniferous trees such as Interior Douglas Fir) and emergent vegetation, as well as foreshore substrate alteration. Disturbances often occurred where land was developed for new construction or where existing residences were reconstructed.

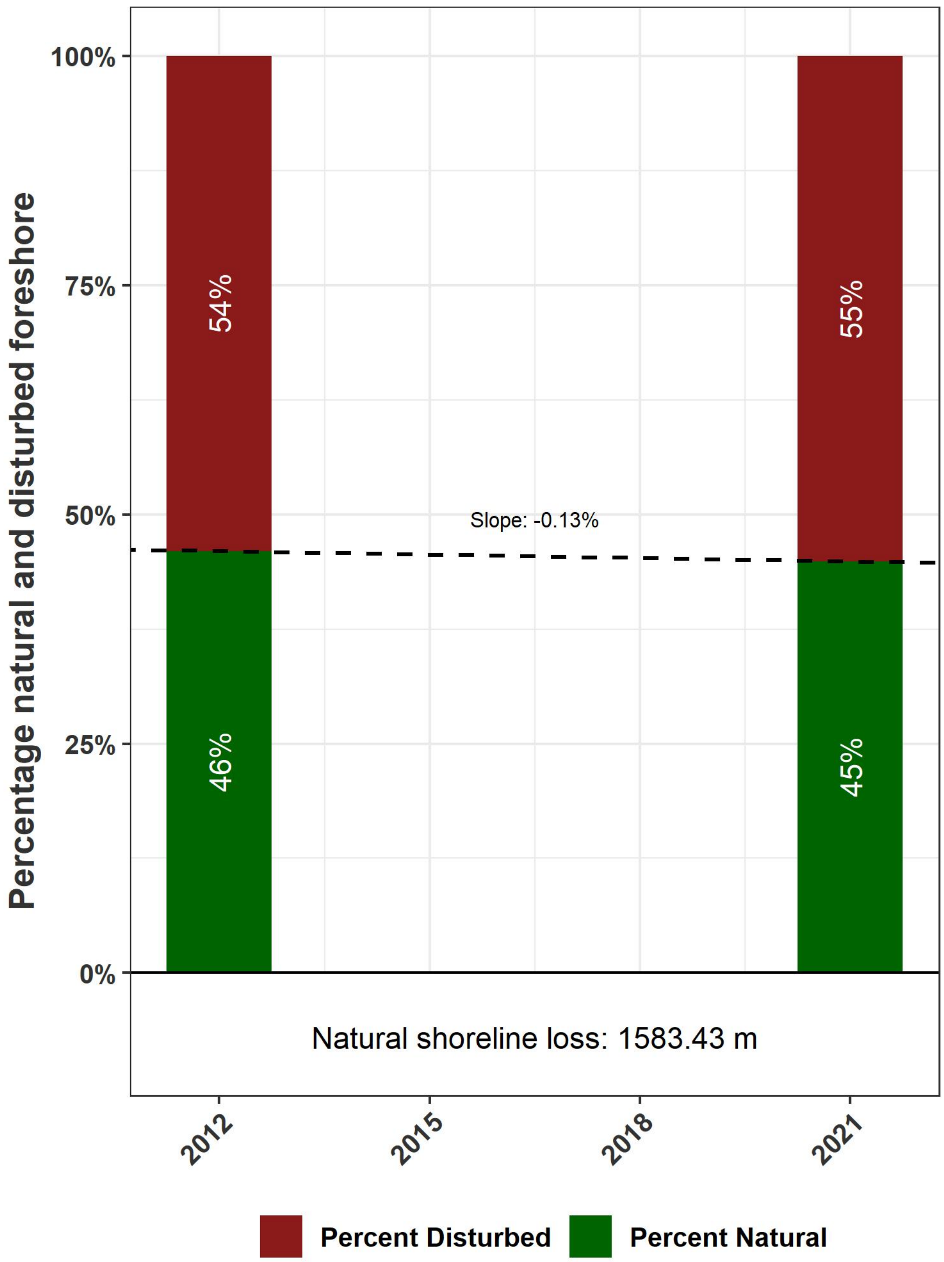


Figure 10. Shoreline disturbance in areas of Gravel Beach shore type.

Cliff/Bluff shoreline comprised 12% of the foreshore. These shorelines had the lowest amount of disturbance (8.3%), with no additional disturbance noted since 2012. This shore type typically has less disturbance because of the challenges with construction in a steep environment.

Wetland shores comprised 1.8% of the shoreline. A large extent (23.6%) of these habitats remained in a natural condition, with no additional disturbance evident since 2012. These are high value fish and wildlife habitats, and their continued preservation is considered important. The only observable impacts were mostly associated with mooring buoys placed impacting emergent vegetation.

Sand Beach shore type was present along 1.6% of the lake. A high percentage of this shore type (76.7%) was disturbed in 2012, which increased to 77.4% in 2021. This rate of disturbance equated to approximately 43 m of natural shore loss over the study period. Similar to the Gravel Beach shore type, the disturbances were attributed to this shore type being present in easy to develop low elevation areas.

Stream Confluences or mouths were present along 8.2% or 33,339 m of the shoreline. Approximately 11.7% of this shore type was disturbed, with no substantial losses documented since 2012.

Overall, maintaining and restoring rocky shores and gravel beach areas is considered important, both for fish and wildlife, as this is where impacts were found to be highest. Continuing to maintain wetlands and other areas of high biodiversity and habitat value such as stream confluences is also important. Further, there are often additional benefits related to flood management and protection or property and infrastructure from keeping these habitats intact and functional.

3.4 Summary of Anthropogenic Modifications

There were several types of foreshore modifications present along the Kootenay Lake shoreline (Figure 9). Since 2012, most of the modification counts increased in number. Observations attributed to modifications were:

- Groynes were the most abundant modification, with most properties having at least one. There were 1,704 groynes observed in 2021, an increase of 9% as 1,543 were counted in 2012. As above, the reconciliation of previous counts with historic ones was challenging, but it was highly probable that more were present along the shoreline than in 2012. These new groynes were typically observed on newer lots that were building out. Groyne construction typically resulted in rocky shore being transitioned to gravel beach. Groyne expansion or new construction was apparent in both newly developed areas without any previous shoreline disturbance or in areas where existing groynes were expanded upon. Groynes varied considerably in their size (length and profile), and thus in their potential to impact the environment.

- There were 1,059 retaining walls in 2021, which was a 33% increase from 2012. Although verifying this number with explicit accuracy was challenging, an increase in quantity of retaining walls was observed, corresponding with other observed small and incremental changes along the shoreline.
- In 2021, there were 671 docks, which was slightly less than the 709 observed in 2012. This result suggests that new dock construction was not likely occurring. We note that the small decrease observed may have resulted from error (i.e., the counts between years were largely similar), a count variation between years is expected, and this difference is insufficient to state with certainty that there was a decrease in docks between years. Swim float counts may also have contributed to the dock discrepancy. In accordance with the revised methods, swim floats were distinguished from docks in 2021, with 218 observed. Swim floats could have possibly been counted as docks historically (i.e., accidentally), elevating the total count. The high number of swim floats could be partially attributed to the new inflatable version on the market and found in the lake; we noted that some of these were very large. Overall, significant new dock construction did not likely occur.
- There were 254 floating and 83 land boat houses. Comparisons to 2012 are challenging, as data were only partially collected in 2012 because boat houses were not part of the standard data collection at the time. There did not appear to be extensive new boat house construction, either on land or on the water, but some newer buildings were observed. However, extensive renovations to older boat houses were observed, indicating that these older, relic structures are not likely to be dismantled (unless legislatively required due to no Crown Land tenure as an example). It is most probable that lakeside residences will continue to maintain these structures as long as allowed.
- Marine rails increased from 109 in 2012 to 129 in 2021. At least some of the marine rails observed in 2021 appeared to have been recently constructed or renovated. Most were associated with boat house structures constructed prior to 2012.
- The number of concrete boat launches also increased, with 97 counted in 2012 and 103 in 2021. The small difference suggests that a few new concrete launches may have been constructed, but there did not appear to be substantial change over the study period. A reconciliation with appropriate Crown Land licenses or tenures was not undertaken, but it was assumed that appropriate rights to space were not obtained prior to construction for some of the launches, similar to other modifications. Simple removal of concrete boat launches would easily restore lakebed disturbance in many areas. For instance, if 15 launches were removed, and each was 2 m wide and 3 m long, a total of 90 m^2 of lakebed habitat would be restored. In 2021, there were a total of 137 gravel boat launches or sites where a gravel beach was commonly used to launch a boat. These data could not be compared to 2012 because ad hoc, residential gravel boat launches were not counted in 2012.

- The number of marinas increased from 38 to 41 over the study period. It is acknowledged that some of these may have been present in 2012 and were not counted or were assumed to be one marina, when in fact, they were on adjacent lots.

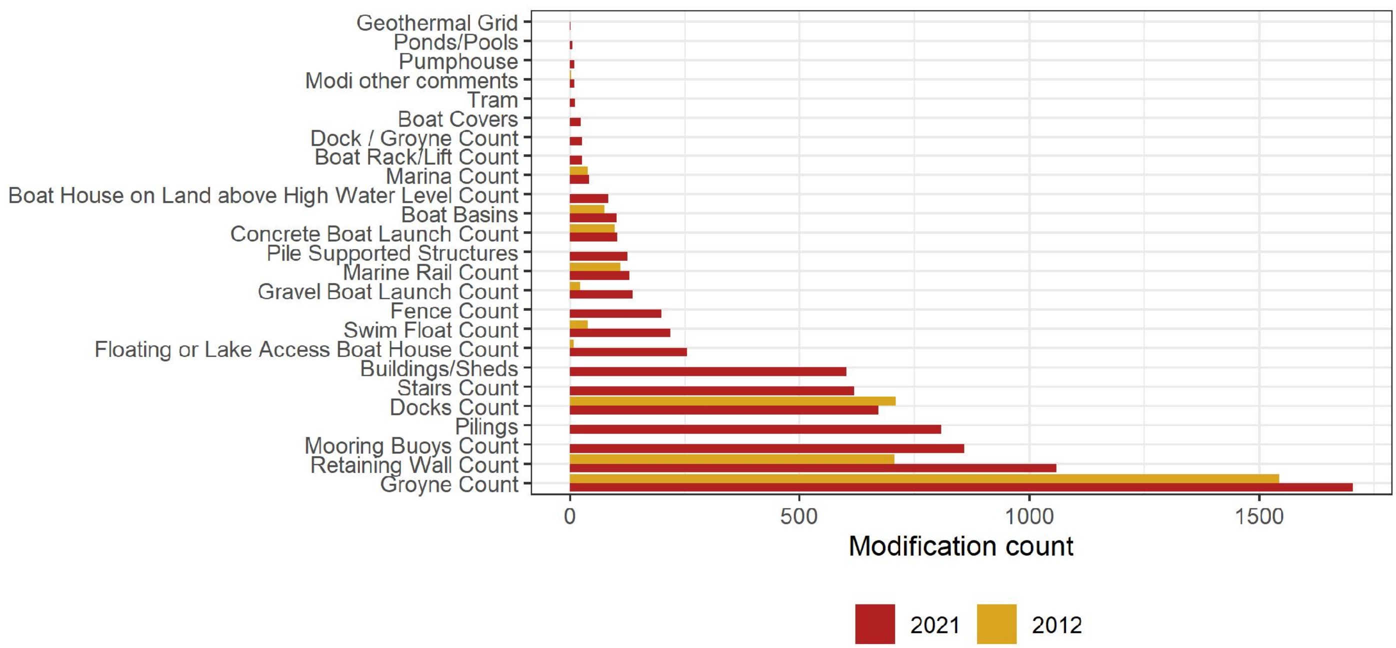


Figure 11. Total number of different shoreline modifications observed.

The extent of shoreline disturbance was reviewed for modifications that were assessed as line features (Figure 10), with the following observations:

- Substrate modification was the most apparent lakebed disturbance and was estimated to occur along 137,662 m or 34% of the shoreline. This was an increase from 133,707 m or 33% in 2012. Substrate modifications included importation of sand, significant movement of natural substrates or earthworks, and rail ballast deposition used for railroad construction.
- The estimated length of retaining walls increased from 11,769 to 17,643 m (or 3% to 4%) between the study periods. It is suspected that a portion of this difference may be the result of observer biases or inaccuracies with data reconciliation from 2012 to 2021. While estimates may not be precise, the approximate overall length of shoreline covered by retaining walls has increased. This increase seemed to be commensurate with the apparent level of effort and expenditure by landowners to harden up their shoreline to protect from erosion (e.g., using rip rap, or vertical structures). Extensive installations appeared to be a standard practice, especially at new builds or when existing features were expanded upon. Restoration and removal

of hard, vertical retaining walls for softer, bioengineered shorelines that allow natural shoreline processes to occur is recommended. In 2017, Okanagan Lake experienced significant flooding and during these events it was observed that hardened areas tended to experience more significant impacts than those with natural vegetation cover and a more natural floodplain area (Schleppe, J. personal observation from numerous Okanagan related flood restoration initiatives 2020).

- The extent of erosion protection was mapped in 2021 but was not in the original study to the same extent. Erosion protection increased from 358 m in 2012 to 6063 m in 2021, representing 0.09% and 1.5% of the shoreline, respectively. This increase was largely attributed to a change in mapping methods, and comparisons between years should not occur. Ongoing future mapping should continue to document this field to determine if change is occurring. In future years, it may also be useful to differentiate between hard erosion control and bioengineering, if at all possible.
- The railway occurred along 25,382 m or 6% of the shoreline. There were no changes evident in the railway length; however, there was some maintenance evident as erosion protection (see above). The railway ran along the near full extent of the west shore of the lake. It was assumed that there were no imminent plans to deactivate the railway, and that it would remain in place in perpetuity. The railway in some respects aided to protect the environment from urbanization. However, the railway did impact the shoreline, particularly stream mouth habitat since all crossings were culverts. The railway also isolated formerly connected backwaters and bay habitats. A detailed assessment of this habitat and identification of Improvement opportunities are recommended (see Section 5.0). Opportunities may include replacing the closed bottom culvert crossings with open bottom structures.

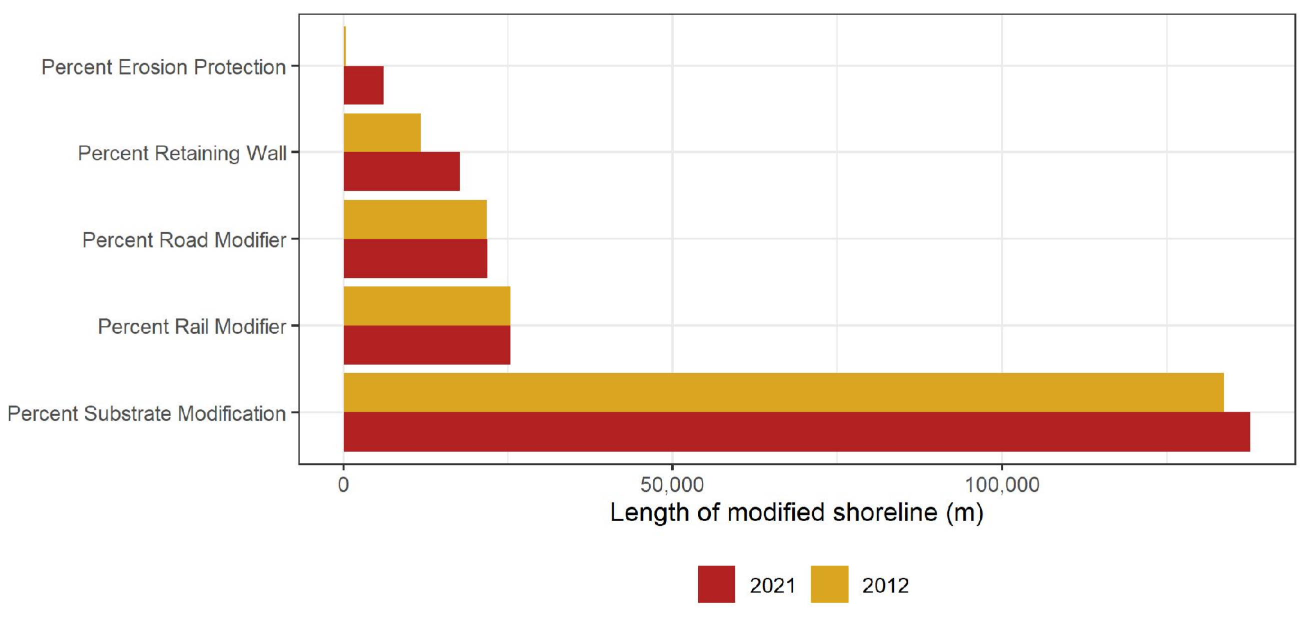


Figure 12. Foreshore length (m) of disturbance.

4.0 FORESHORE HABITAT SENSITIVITY INDEX RESULTS

4.1 FHSI Criteria Development

The FHSI analysis considered each habitat category, which include FIM, ZOS (e.g., fish, wildlife, waterfowl, ecosystem, and rare occurrence) and modifications. Within each of these categories, the respective criteria were weighted relative to the ecological values they support. These data were supported by the results of a desktop study that included a literature review, provincial database downloads, and seeking unpublished information from local professionals and organizations.

Kootenay Lake has a variety of important fish, wildlife and ecosystem species and habitats values. An overview of sensitive species and habitats is provided below. A summary of species and habitats that were identified to be ZOS is provided in Table 7, with rationale for inclusion in the FHSI and notes provided on substantial changes from the original study. The subsequent FHSI logic table where all these values were included in the evaluation towards determining the Ecological rank of a segment is provided in Table 8.

4.1.1 Fish Values

The following summary of Kootenay Lake fish and related foreshore habitat values was obtained from the original FIMP (Schleppe and Cormano 2016):

> *The Lower Kootenay River watershed contributes significantly to the overall production of fish species in the Columbia River Basin. Fish stocks here are very important to local communities, including First Nations, through their contribution to the commercial and sport fisheries, and to local eco-tourism. Fish also have significant cultural and societal importance to First Nations.*
>
> *The Kootenay Lake foreshore provides important habitats for a variety of fish species and life stages, including Kokanee spawning and White Sturgeon rearing. Kokanee and Rainbow Trout are keystone species[2] in the Lower Kootenay River watershed. Adult salmon are a critical fall food source for bears, eagles and other species; and the spawned-out carcasses of the adults provide fertilizer for terrestrial and aquatic ecosystems. Salmon also act as an indicator species[3] for the overall health of the surrounding ecosystems because they are highly sensitive to changes in habitat, such as a reduction in water quality or alterations to spawning habitats or lake productivity. The importance of these fishery resources must be*

[2] A keystone is a species that has a disproportionately large effect on its environment relative to its abundance.
[3] An indicator species is any biological species that defines a trait or characteristic of the environment.

considered during land use planning and provide the basis and rationale for completion of this foreshore inventory project.

Kootenay Lake and its tributaries support the following 18 species of native fish and 4 species of non-native fish species (BC MoE 2021):

Native fish species

- Bull Trout (*Salvelinus confluentus*)
- Burbot (*Lota lota*)
- Peamouth Chub (*Mylocheilus caurinus*)
- Westslope Cutthroat Trout (*Oncorhynchus 48erodia lewisi*)
- Kokanee (*Oncorhynchus nerka*)
- Lake Whitefish (*Coregonus clupeaformis*)
- Largescale Sucker (*Catostomus macrocheilus*)
- Longnose Dace (*Rhinichthys cataractae*)
- Longnose Sucker (*Catostomus erodiase*)
- Mountain Whitefish (*Prosopium williamsoni*)
- Northern Pikeminnow (*Ptychocheilus oregonensis*)
- Prickly Sculpin (*Cottus Asper*)
- Torrent Sculpin (*Cottus rhotheus*)
- Pygmy Whitefish (*Prosopium coulterii*)
- Rainbow Trout (*Oncorhynchus mykiss*)
- Redside Shiner (*Richardsonius balteatus*)
- Slimy Sculpin (*Cottus cognatus*)
- White Sturgeon (*Acipenser transmontanus*)

Non-native fish species:

- Brook Trout (*Salvelinus fontinalis*)
- Largemouth Bass (*Micropterus salmoides*)
- Pumpkinseed (*Lepomis gibbosus*)
- Yellow Perch (*Perca flavescens*)

Five fish species present in Kootenay Lake are considered sensitive. These are White Sturgeon, Bull Trout, Westslope Cutthroat Trout, Burbot and Kokanee (Table 5; Province of BC 2021b). The Introduction (Section 1.3) describes development and hydroelectric impacts on these species in general, and also provides specifics on White Sturgeon given its endangered status. Where inventory data were available, the known foreshore habitats of importance for these species were mapped as ZOS for this project.

Table 5. Sensitive fish species in Kootenay Lake (Province of BC 2021b).

Common Name	BC Listing	COSEWIC Status[1]	SARA Status (Schedule)[2]
White Sturgeon (Upper Kootenay River pop.)	Red – endangered	Endangered	Endangered (1)
Bull Trout (interior lineage)	Blue – special concern	Special Concern[3]	-
Westslope Cutthroat Trout (*lewisi* subspecies)	Blue – special concern	Special Concern	Special Concern (1)
Burbot (Lower Kootenay pop.)	Red – endangered	-	-
Kokanee	Regionally significant	-	-

Legend:

1. COSEWIC – Committee on the Status of Endangered Wildlife in Canada
2. SARA – Species at Risk Act – Schedule 1 is the official federal list of wildlife species at risk, which receive legal protection under SARA.
3. The Pacific population of Bull Trout are deemed Not at Risk by COSEWIC (2012).

Mussels are also considered fish under the Federal *Fisheries Act.* Freshwater mussels are experiencing population declines worldwide (due to habitat modification and introduction of non-native mussels etc.) (FLNRORD 2018b, Metcalfe-Smith and Cudmore-Vokey 2004, Lydeard et al. 2004, Perles et al. 2003, Neves 1997, and Bogan 1993). The native freshwater mussels that have been found in Kootenay Lake are California/Winged Floater *(Anodonta californiensis/nuttalliana*), Oregon Floater (*A. oregonensis)*, and Western Pearlshell (*Margaritifera falcata*). Where inventory data was available, habitats for these sensitive species were included in the FHSI as ZOS. Further details on the mussel and other fish ZOS are provided in Table 7.

4.1.2 Wildlife values

Wildlife values in this study collectively included aquatic (non-fish) and terrestrial wildlife, plant and ecosystem values. Sensitive wildlife species and habitats along the Kootenay Lake foreshore were identified to be ZOS (Table 7). The wildlife ZOS identified in the original study were carried forward, with additional data collected since 2012 sought and mapped. Nearly all the ZOS were included in the FHSI.

The BC Conservation Data Center (BC CDC 2021) Identified the presence of sensitive species of vertebrate animals, invertebrate animals, and vascular plants along the Kootenay Lake foreshore (Table 6).

Table 6. Species at Risk Occurrences for Kootenay Lake (BC CDC 2021).

Species Group	Common Name	Scientific Name	BC Listing	COSEWIC Status	SARA Status - Schedule	Occurrence details (last observation)
Vertebrate Animal	Caribou (Southern Mountain Population)	*Rangifer tarandus pop. 1*	Red	Endangered	Threatened -1	Approved Critical Habitat for this population is present throughout a 238,199 ha area that includes the shoreline along the south end of the Main Lake and south side of the West Arm.
Vertebrate Animal	Coeur d'Alene Salamander	*Plethodon idahoensis*	Yellow	Special Concern (2021)	Special Concern – 1	Near Weasel Creek (1995), and near Sanca Creek Park (1990) (Ohanjanian 1996, Orchard 1991).
Vertebrate Animal	Western Skink	Plestiodon skiltonianus	Blue	Special Concern (2014)	Special Concern – 1	Burgess Point: 1 adult and 16 exuvia (2005) & Donegal Creek: 3 skinks detected during survey (2005) (Dulisse2006).
Vertebrate Animal	Western Screech-Owl, macfarlanei subspecies	*Megascops kennicottii macfarlanei*	Blue	Threatened (2012)	Threatened – 1	Nelson area: 2 seen in the summer (1971) (BC Vertebrate Record File. 2001).
Vertebrate Animal	Western Grebe	*Aechmophorus occidentalis*	Red	Special Concern (2014)	Special Concern – 1	Duck Lake: 40 to 90 nests (1973 – 1983); a small sub-colony of 4 nests at S end of Kootenay Lake (1982); pair with brood on Leach Lake 9 (1990); 105 adults on Duck Lake (1991) (Burger 1991).

Table 6. Species at Risk Occurrences for Kootenay Lake (BC CDC 2021).

Species Group	Common Name	Scientific Name	BC Listing	COSEWIC Status	SARA Status - Schedule	Occurrence details (last observation)
Vertebrate Animal	Painted Turtle – Intermountain – Rocky Mountain Population	*Chrysemys picta pop. 2*	Blue	Special Concern (2016)	Special Concern – 1	A small population (~15 individuals) was recorded outside Grohman Narrows Provincial Park, and 30 turtles were present at Grohman Narrows Provincial Park (2006) (Clarke 2012 and Hobbs 2012).
Invertebrate Animal	Western Bumble Bee	*Bombus occidentalis*	Blue	Threatened (2014)	-	Kokanee Creek Park: One Bee was photographed (2019) (iNaturalist nd).
Vascular Plant	Monardella	*Monardella odoratissima ssp. Discolor*	Un-known	-	-	Nelson area: Collected by University of BC (1956) (University of British Columbia herbarium nd)
Vascular Plant	American sweet-flag	*Acorus americanus*	Blue	-	-	Kuskanook, south end of lake: observed (Brayshaw 1985); and 16 collected in shallow water at mouth of river (1980) (Royal British Columbia Museum Herbarium nd).
Vascular Plant	Wild licorice	*Glycyrrhiza lepidota*	Blue	-	-	Queens Bay: 1937 and 1940-Roadside (UBC and, and Royal BC Museum).

There was also one sensitive species with a masked polygon present on the south-west shore of the main lake. As described by the BC CDC (2021),

> "*Masked species have only a generalized area provided that masks the precise locations of secured occurrences of species and ecosystems at risk. The occurrences may be secured due to the species or ecosystems being susceptible to persecution or harm, or for proprietary reasons. For information or to obtain details about Masked Occurrence Records, contact the CDC at cdcdata@gov.bc.ca and provide projects details including precise location information and activities expected to occur on site or other reasons for requiring the information. Release of details of secured occurrences is subject to the signing of a Confidentiality and Non-reproduction Agreement and a demonstrated need-to-know.*"

Similarly, the BC Habitat Wizard database (BC MoE 2021) identified eight masked polygons along the shoreline designated as Wildlife Habitat Areas (WHA) under the BC Forest and Range Practices Act (FRPA). FLNRORD (SPI_Mail@gov.bc.ca) is to be contacted for these masked occurrence details, who will have similar data use requirements as outlined above by the BC CDC.

These sensitive species and habitat accounts were included as ZOS. They were separated into the three criteria: CDC/WHA Masked, CDC Red listed, and CDC Blue-listed/COSEWIC Special Concern. However, although included on our project pdf maps sensitive species/habitats were not included in the GIS database, since this data belongs to the Province, and it is expected that it will continually be updated. The QEP is to review the Provincial databases for the most current listings at the time of completing an environmental impact assessment for a proposed project.

The literature review and discussions with local biologists provided additional detail on sensitive species, habitats and ecosystems that were not identified in the Provincial databases. This resulted in additional wildlife ZOS for sensitive species and habitats for: bats, birds (heron rookeries, and raptor nests), amphibians and reptiles. There was a backlog with recent data collected not yet posted online. Our concerted effort to reach out to other biologists and organizations resulted in considerable data updates since the original study.

All information sources are provided in the rationale table for each ZOS (Table 7). There were a few sources not listed, since information was either not provided or sensitive features were confirmed to not be present. We provide these contacts to indicate the thoroughness of our search for terrestrial values:

1. Bank Swallows: Janice Arndt, consulting wildlife biologist (pers comm.) confirmed that the Kootenay Bank Swallow Survey Program had no known breeding colonies identified in the project area.

2. Northern Leopard Frogs and Painted Turtles at the south end of the lake: Leigh Anne Isaac, BC MoE (pers. comm) provided that "*The southern Kootenay Lake region, in particular regions of the Creston Valley Wildlife Management Area, are home to the only extant population of Northern Leopard Frogs in the region. Western Painted Turtles also occur in this area, and as far as I recall, we did not track any turtles into Kootenay Lake proper*". The CVWMA is outside of the project boundary, and the CDC review confirmed the absence of mapped data for these species at the south end of the lake.
3. Wildlife corridors: A local wildlife biologist who specializes in Grizzly Bears and wildlife corridors was emailed to discuss the importance and possible locations for the wildlife corridor ZOS. We did not obtain a response.
4. Amphibian surveys: The amphibian wildlife biologist from the original study was contacted to see if there were any updates, with no response.
5. Several FLNRORD habitat biologists were contacted and generally referred us to published information with no specific new information provided.

4.1.3 Other high value habitats

A source not fully explored in our review was the Provincial Species & Ecosystems Data & Information Security (SPI) GIS database. This database houses secure species and ecosystems data. Special permissions with a confidentiality and non-disclosure agreement are needed to obtain this data. It is recommended that at the time of a project review, the QEP checks if there may be any additional relevant wildlife data in SPI (SPI_Mail@gov.bc.ca) that is not otherwise reported in the BC CDC or BC Habitat Wizard.
The following vegetation mapping was carried over from the original study and was included as background FIM data on the maps, not as ZOS specifically.

1. Wetlands, classified as follows using Wetlands of BC (Mackenzie and Moran 2004):
    - Low flood benches – Tall shrub thicket on regularly flooded riparian site.
    - Mid-flood bench – Broadleaf thicket on flooded riparian site.
    - Marsh – Permanently to seasonally flooded area dominated by emergent grass.
2. Riparian corridor and Cottonwood riparian vegetation mapped in 2012 FIM.

Other high value habitat information was available that was not mapped or included as ZOS in this study. Specifically, this included the habitats mapped in the RDCK Kootenay Lake Local Conservation Fund Guidance Document (Amec and Pandion 2018). The RDCK report provides maps for the following high value habitats: connectivity corridors (both existing and proposed), obstacles and barriers to fish migration, hydroriparian buffers, wetlands, bio geoclimatic zones, old and mature forest, karst likelihood, brushland, and cottonwood ecosystems. Due to the completeness of these maps within the stand-alone document, and additional complexity that the mapping would add to our FIMP, this data was only referenced here. The RDCK is to be contacted to receive the full report and maps.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
FIM	Shore Type	Yes	Shore type describes the shoreline morphology and is related to many aspects of fish and wildlife productivity. Shore type values were determined using the initial habitat index that considered fish life stage habitat specificity (Schleppe and Arsenault 2006), and subsequent studies completed in the East Kootenay Region, including Kootenay Lake (Schleppe and Cormano 2016). These values further considered the methods review completed on all lakes, where the general ranges in former habitat rankings were summarized for all lakes where an FHSI was completed (Schleppe et al. 2019). Finally, shore type was considered based upon the specific habitats observed around Kootenay Lake. Stream mouth habitat was highly valued because it was limited on Kootenay Lake and provides important spawning, staging and forage habitat for native fish (e.g., Burbot, Bull Trout, Westslope Cutthroat Trout, and Kokanee), and food sources and connectivity from upland areas for wildlife. Wetlands were also valued high for their fish rearing and staging and avian values. The coarse substrates associated with gravel and rocky shorelines often were associated with spawning and rearing potential. Cliff/bluffs were associated with deep water offering refuge. Sand beach habitat was of the lowest value to fish and wildlife and was typically associated with more intensive development and associated recreational uses.
	Foreshore Substrate	Yes	Substrates relate directly to aquatic life productivity. Lakebed substrates provide key growth media for periphyton, which in turn support benthic invertebrate communities, and fish foraging. Gravel substrates are also important for shoreline spawning (e.g., Kokanee) and rearing, and support wildlife and avian fauna by providing a growth medium for emergent, submergent and floating aquatic vegetation. Substrates were evaluated considering Okanagan and Shuswap watershed studies (e.g., see summary in Schleppe et al. 2019), and subsequent studies in the East Kootenay Region such as Windermere Lake (Schleppe and McPherson 2021). Spawning substrates (gravel and cobble) were valued highest, followed by foraging substrates (finer substrates). Cobble and gravel substrates supported important habitats including spawning, rearing, and invertebrate production. Boulder, organic, mud, marl, and fines all supported aquatic vegetation, which in turn provided important forage and cover areas for fish, avian fauna and wildlife. Sands and bedrock had the lowest biodiversity potential.
	Percentage Natural	Yes	The length of shoreline in a natural condition was determined for an approximate depth upland of 50 m, and this was used to determine the % natural for the segment. This criterion relates to the risks of change from a natural state, where the closer to a natural state, the higher the risks to ecosystem function are likely to be. As the percentage of lake wide natural shoreline decreases, the inherent value of any remaining natural areas will increase. The % natural criteria has generally been lowered over time in FHSI because even disturbed habitat has value depending upon the level of urbanization present (Schleppe et al. 2019). It is noted that this criterion considers all categories of FIM data and has some inherent overlap with other FIM criteria.
	Aquatic Vegetation	Yes	Native aquatic vegetation provides important habitats for fish and wildlife, including nesting, forage, biomass production, and cover. The % aquatic vegetation for each segment was determined using the cover of one or all aquatic vegetation types (submerged, floating and/or emergent). Overall, this criterion was weighted relatively low in the FHSI because of overlap with other criteria such as wetland shore types.
	Overhanging Vegetation	Yes	Overhanging vegetation provides important habitat function, such as cover, nutrient additions and forage opportunities.
	Large Woody Debris	Yes	Large woody debris (LWD) provides important cover for fish and also provides a variety of wildlife functions. In Kootenay Lake, LWD was common in many areas, and this is reflected in the low weight assigned to this criterion.
	Vegetation Band 1	Yes	

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	Vegetation Band 2	Yes	Riparian vegetation provides important ecological values for both aquatic and terrestrial species. These values include food, cover, nesting areas, erosion protection etc. This study provided an estimate of vegetative quality values for the Riparian Bands 1 and 2 that were included in the FIM dataset. Band 1 was the first distinct vegetation zone along the shore, while band 2 occurred immediately upslope of it. The two bands together represented a maximum 50 m width along the segment. Vegetation Band 1 was assigned a higher weight than Vegetation Band 2 because it contributed to shoreline fish and wildlife habitat to a greater extent.
Fish Zone of Sensitivity	Critical Habitat – White Sturgeon	Yes	The Upper Kootenay River population of White Sturgeon are considered an endangered species both federally and provincially. The Federal Recovery Strategy for White Sturgeon was used to define the White Sturgeon ZOS and factor this species into the index (DFO 2014). There are three critical areas for White Sturgeon in the main lake. These areas were established based on being medium to high use areas for adults outside spawning season and are (DFO 2014): 1) Creston Delta at the south end of the lake, 2) Duncan Delta at the north end of the lake, and 3) Crawford Creek Delta on the east side. The following summary of habitat values for the Kootenay Lake Critical Habitat areas was obtained from the Recovery Strategy (DFO 2014): *The Kootenay River population of White Sturgeon extends from Kootenai Falls, Montana, located 50 km downstream of Libby Dam (Idaho, U.S.), through Kootenay Lake to Corra Linn Dam on the lower West Arm of Kootenay Lake. Spawning habitat is located in the U.S. and affected by the presence and operation of the Libby Dam, whereas much of the adult and juvenile rearing habitat is located in the Canadian portion of Kootenay River and Kootenay Lake (e.g., Kootenay delta and tributary creek mouths). Off channel wetland habitat is likely valuable for early life stages, and historically was in greater abundance than at present.* The Critical Habitat areas designated in Kootenay Lake provide juvenile and adult rearing and feeding and overwintering habitat. The features are large depositional areas, important for food availability for Sturgeon. Attributes include higher temperatures driven by significant shallow water littoral zone, providing optimum summer temperature range for all life stage growth. These areas are also a high source of benthic invertebrates and fish (i.e., Kokanee, Mountain Whitefish and Peamouth Chub). The polygons extend to a depth of 100 m, which is the transition from depositional delta to regular lake bottom). The mapped polygons were also in the original FIMP, but as a draft. In both studies they contributed to the FHSI as either presence or absence in any overlapping shore segments.
	High Value Kokanee Area (shore spawning)	Yes	FLNRORD has identified Kokanee spawning habitat as high conservation value areas in the Rocky Mountain and Kootenay Lake Forest District (M. Neufeld pers. comm. 2021, Chirico 2005). Also as described in the Introduction (Section 1.3), adult Kokanee populations in the main body of Kootenay Lake are at unprecedented and sustained low numbers (McPherson 2018). Shore spawning stocks in the West Arm are a distinct population, that along with the stream spawners have historically supported one of BC's most productive Kokanee sport fisheries. Much of the decline of this sport fishery can be traced back to hydro developments within the Columbia Basin (Hirst 1991), and as such there has been much effort directed to understanding impacts and making improvements. Shore spawning assessment data was provided by FLNRORD dating back to 1970. Despite several management efforts over the last three decades, West Arm Kokanee today are less abundant than the 1970s (Redfish Consulting 2002). There is no literature documenting Main Lake shore spawners nor surveys for them (J. Burrows pers. comm. 2022). There are no confirmed lake spawning Kokanee in the Main Lake – shore, shoal (shallow or deep), beach or otherwise; presumably this does not occur, or is rare and/or deep enough to remain unobserved (J. Burrows pers. comm. 2022).

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	High Value Kokanee Area (shore spawning), continued…	Yes	Spawning location data from 2021 was provided by FLNRORD (M. Teather and J. Burrows, pers. comm. 2021). All new sites were added to the original 2012 FIMP dataset, which was obtained from: a) 2012 spawning surveys conducted for FLNRORD (field markings left behind by consulting biologist [G. Andrusak] were mapped during the FIM); and, b) data provided by DFO. Even though GIS data were not available, other Kokanee spawning reports prepared between the two periods of study were reviewed with additional spawning sites added to the database if not already included (i.e., data from Andrusak 2016, and Andrusak and Andrusak 2014). Confirmed spawning locations were areas identified in the studies referenced above, while locations used historically or having potential based upon observed substrates (identified by DFO during field inventories in 2012 FIM) were classified as potential in the index.
	High Value Burbot Area (Spawning)	Yes	The report "2019-20 lower Kootenay Burbot summary: Moyie Lake and Kootenay Lake/River" provides the most recent comprehensive information on the Burbot population in the Lower Kootenay River (Stephenson et al. 2021): *The lower Kootenay Burbot population extends throughout the Kootenay River in Montana, Idaho and BC, and downstream into Kootenay Lake. This population was nearly extirpated by the early 2000s (Kootenai Valley Resource Initiative Burbot Committee (KVRI) 2005. Likely factors for the population decline include decreased food availability, overfishing and habitat changes (e.g., diking along the Kootenay River and the completion of Libby Dam in the early 1970s) (Partridge 1983). A multilateral agreement was signed in 2005 to guide population restoration (KVRI Burbot Committee 2005). Conservation aquaculture has been in place since 2009 and utilizes gametes from the Moyie Lake population and brood stock collected during the spawn season in Kootenay River. The 2019 and 2020 Moyie Lake Burbot gamete collection efforts were a success, with 151 and 452 Burbot caught, providing the 5 and 7 million egg targets for hatchery production, in these two years respectively. Kootenay Lake cod trapping in 2020 had the highest yield since the start of the hatchery re-introduction efforts; CPUE was 0.11 Burbot/24 hours in 2020, compared to 0.02 in 2019. However, the adult densities were still very low; with an estimated adult population of 3520 in 2019 for a density of only ~ 9 Burbot/km^2. Three years of acoustic telemetry data from hatchery releases (age 1-5 years at release) into the West Arm of Kootenay Lake revealed overall low dispersal from release locations, especially for the age 1-year old release group. Mixing to the river was lower (11% of the Burbot detected in the river) than expected from earlier work on river releases (24%; Hardy et al. 2015), but all the fish that went to the river stayed in the river.* In lakes and rivers, Burbot generally spawn in shallow depths (0 to 10 m) over a variety of substrates from silt and sand to coarse gravel and cobble (McPhail and Paragamian 2000). Studies in Columbia and Windermere Lake found juvenile Burbot to be strongly associated with interstitial spaces in the substrate (Taylor 2001 and 2002). Shorelines with gravel and cobble substrates were the preferred habitat for age 0 burbot, while older juveniles were associated with larger substrates of cobble and boulders (Taylor 2001 and 2002). Where aquatic vegetation was utilized, extensively branching species such as bushy pondweed (*Najas flexis*) was preferred (Taylor 2001). In 1998 and 1999, the province undertook extensive Burbot sampling throughout Kootenay Lake using various techniques. This provided an understanding of habitat use of the wild stocks in the lake and showed that Burbot were concentrated at the north end of the main lake and in the lower reach of the Duncan River (Spence 1999). Key related findings were as follows: *Extensive electrofishing from the north to south end of the lake captured one young of year (YOY) from a small pile of cobble and boulder in water 30 cm deep. During trapping efforts, 20 adult burbot were captured, from depths of 10 m or more. Spawning was also documented at the north end of the lake in March of both years at three locations (21 fish observed in 1998 and an incomplete count of 14 reported in 1999). The spawning habitat was estimated to be 0.5-2.0 m deep within cobble and boulder substrate. During the spawning surveys, juveniles were also observed in less than 2 m of water, amongst primarily fine substrates. The importance of the Duncan River delta to Burbot was also supported by previous research, where extensive set line work was conducted around the lake between 1994 and 1996, with 13 of the 14 Burbot captured in this area (BC Environment, data on file).*

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

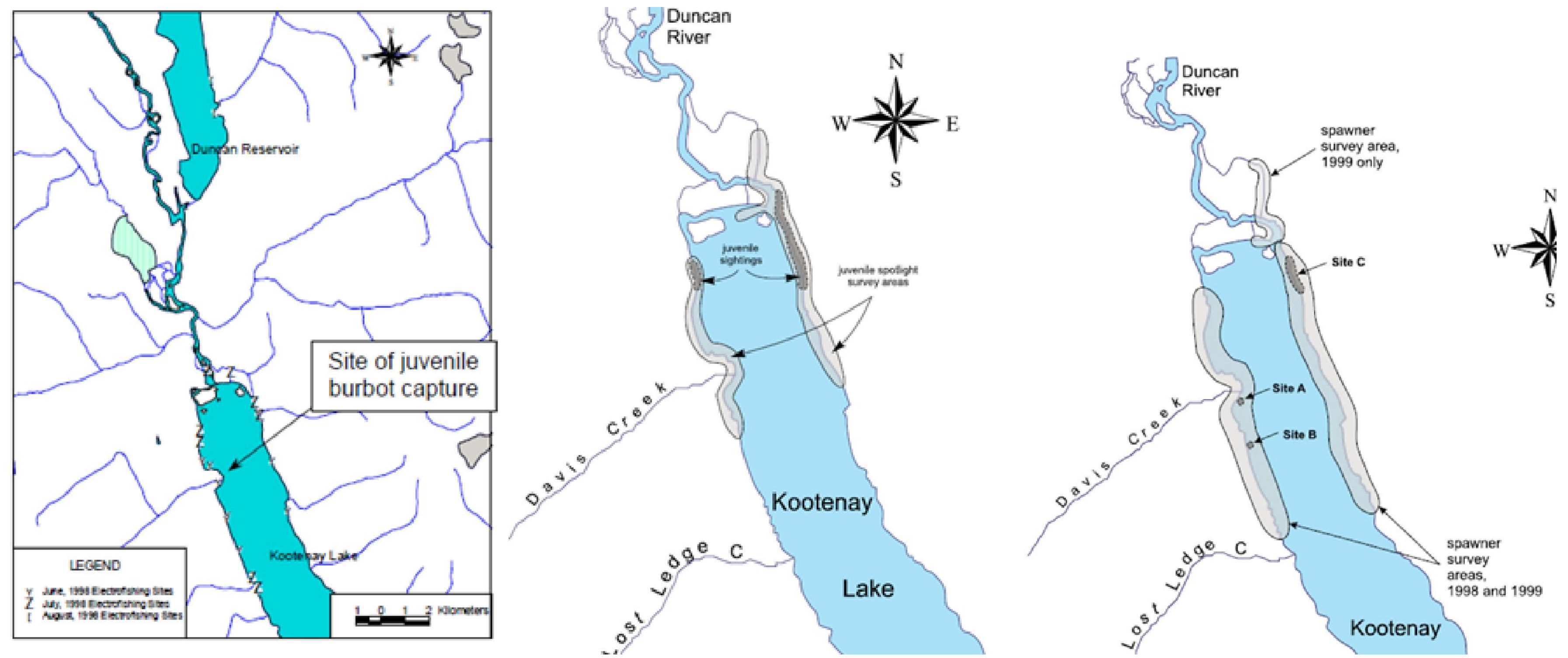
Category	Criteria	In FHSI	Rationale
	High Value Burbot Area (Spawning), continued…	Yes	*The West Arm inlet historically had a traditional and sports fishery, with the highest catch per unit effort (CPUE) reported to have occurred here in February 1972 and 1973 (Andrusak 1974). In 1997 and 1998, hoop trap effort from the inlet to the West Arm south to Akokli Creek also captured two Burbot (in the Balfour area). The success was not as high as that experienced at the north end of the lake, but points to the persistence of a small number of Burbot near the site of the traditional fishery.* Overall, the only current confirmed spawning areas for Burbot on Kootenay Lake are those described above. Spawning is suspected elsewhere, and the hope is with increasing Burbot numbers FLNRORD will be able to re-confirm those and other spawn sites in near future (S. Stephenson, pers. comm. 2021). Confirmed spawning as well as juvenile rearing habitats were mapped as a ZOS using this historical data. Burbot habitat was not mapped in the original Kootenay Lake study.  **Burbot rearing and spawning areas (Spence 1999).**

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	Mussel Bed	Yes	Mussels are considered a fish under the Federal *Fisheries Act*, and native mussels hold First Nations traditional ecological value. The Freshwater Molluscs – Wildlife in BC at Risk Brochure (BC Ministry of Environment, Lands and Parks 2000) summarizes their sensitivity as follows: *Freshwater mussels are the most endangered animal group in North America and are disappearing at the fastest rate of any known group of organisms. More than half of all North American species of freshwater mussels are considered imperiled. As aquatic habitats are degraded or become altered for other uses, the habitat for freshwater mussels is disappearing. Most mussel species have a complex life cycle involving a fish host, free living form, and the more commonly observed mussel. Even where conditions allow the continued existence of the mussels themselves, if the habitat can no longer support the required fish host or if access to the fish host is eliminated by dam construction, water diversion, or alien fish species, the mussels cannot reproduce and will eventually disappear.* In addition to habitat impacts, freshwater mussels are also being impacted by the introduction of non-native mussels (Bogan 1993). During the 2021 FIM field work, there were some limited mussel observations from the boat (e.g., near Nelson). In addition, the Ktunaxa Nation provided the following results from recent observations and detailed work completed from 2016-2017 (Andreashuk pers. comm. 2021): *Although the entire lake was not extensively surveyed, the focus was on what appeared to be preferred habitat. Snorkel survey techniques were used. Species observed were Western Floater, Oregon Floater, Western Pearlshell (respectively, Anodonta kennerlyi, A oregonensis, and Margaritifera falcata). Live mussels were rarely found in water <1 m deep. Several dense native freshwater mussel beds were found, with the bed at Kokanee Creek being the largest in geographical extent and numbers of individuals. Mussel beds were found at all creek deltas explored, and it is thus likely that other creek confluences on the lake with a delta fan will provide mussel habitat. The density at the deltas is suspected to be related to the cool well oxygenated water and food source from the nutrients in the creek.* *In addition to the denser "beds", mussels were also found as scattered individuals over great distances along the shoreline, with examples including:* ● *Lockhart Creek to Kuscanook Harbour – where there was available/preferred substrate.* ● *Sunshine Bay (West Arm) to Bealby Point – generally in areas that did not have sudden drop-off. Also, there were historical scuba diving accounts of dense beds at Sunshine Bay and the Procter-Harrop Ferry crossing at 6-9 m water depths.* ● *Johnstone Road to 6 Mile.* ● *Kootenay Delta near Kuscanook (within the SARA White Sturgeon Critical Habitat) – shell fragments were only found, suggesting that the mussels originated nearby and were crushed and preyed upon. Large divots in the substrate suggest fish such as smaller White Sturgeon or suckers were feeding on the mussels. Literature supports that there is a symbiotic relationship between White Sturgeon and mussels, and that this relationship may help to create new mussel beds.* *A few additional notes on habitat are that mussels move both horizontally (e.g., due to drawdown), and vertically (may bury themselves seasonally or during environmental stress). They have been observed spread out in small pockets of fines and gravels between cobbles and utilizing cover if available (at the base of large macrophyte root stems, up against submerged/embedded LWD). Mussels are not in the BC Freshwater Fishing Regulations and are thus not to be harvested.* Mussel presence was not identified in the original FIMP, as there was no data available. This updated FIMP includes mussel data from the above surveys. Mussels are as marked points or polygons. Polygons represent where mussel presence was expected based on point observations. Only presence was used because mussel densities were not mapped.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	Juvenile Rearing	Yes	Juvenile rearing shoreline habitat value was determined following methods used by Ecoscape in the original project (Schleppe and Carmano 2016): *Juvenile rearing was prepared using a Habitat Suitability Index, which evaluated segments as High, Moderate, or Low Juvenile Rearing Value based on the following criteria: shore type, substrate, aquatic vegetation, littoral width, overhanging vegetation, LWD, migration corridor and spawning stream. The Kootenay Lake index was based upon original juvenile utilization field-based surveys of Shuswap Lake by Graham and Russell (1979) and Russell et al. (1981), which were adapted to Shuswap Lake with DFO (without a field sampling confirmation component) (Schleppe 2010). The Kootenay Lake index was also not field confirmed but is reasonable to use as a current best estimate of productive juvenile areas. Duplicate parameters between the FHSI and the Juvenile Rearing suitability index occur because of correlations that exist between the parameters (i.e., the estimate of shore type productivity is correlated with juvenile rearing habitat suitability for example).* Segments evaluated to have High value rearing habitat are to be considered a ZOS.
	Migration Corridor	Yes	Probable juvenile and adult fish migration routes are important to adfluvial fish (e.g., Rainbow, Kokanee, and Bull Trout) at some point in their life cycle. This involved mapping shoreline areas where fish must either migrate out from or into a river or stream system. To develop these migrations areas, key habitat characteristics were used and included adjacency to spawning streams, outmigration considerations, and review of fish life history characteristics. These areas overlap extensively with staging areas. The value of migration areas was similar to the original Kootenay Lake AHI, recognizing that development intensity around key spawning streams was often high, with an elevated importance of this habitat requisite.
	Staging Area	Yes	Staging areas were mapped based upon best professional judgments. Staging areas generally only encompassed shoreline areas where fish must either migrate out from or into rivers or streams. These areas overlapped extensively with Migration Corridors and were similarly valued to account for the increased development pressure around key salmonid spawning streams.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
Wildlife Zone of Sensitivity	CDC Masked Species and Masked Approved Wildlife Habitat Areas	Yes	The BC CDC (2021) identified one masked sensitive species polygon present on the south-west shore of the main lake. The BC CDC did not provide the masked species details, and the polygon was quite large in order to protect the species from harm. Similarly, the BC Habitat Wizard database (BC MoE 2021) identified eight additional masked polygons along the shoreline designated as Wildlife Habitat Areas (WHA) under the BC Forest and Range Practices Act (FRPA). To obtain details about masked CDC occurrences, email cdcdata@gov.bc.ca, and to request Data Sensitive WHA information, contact SPI_Mail@gov.bc.ca. Provide: rationale for the request, precise location information and activities expected to occur on site or other reasons for requiring the information name of person submitting request, company name, and contact information (business address, email, and phone number). Release of details of masked occurrences is subject to the signing of a Confidentiality and Non-reproduction Agreement and a demonstrated “need-to-know”. This CDC masked data was included in the original FHSI; however, the WHA data are new here. Sensitive species present and rankings are updated and change with time as more information becomes available. During a proposed review, the QEP will need to look up the species and habitat accounts for further details using the CDC BC Species and Ecosystems Explorer and/or iMap. For these reasons, these data were not included in the GIS database; they were however included in the FHSI.
	CDC Red listed species	Yes	The BC CDC (2021) identified the presence one Red Listed species along the Kootenay Lake foreshore, the Western Grebe (Table 6). Red listed species refers to any species or ecosystem that is at risk of being lost (extirpated, endangered or threatened) in BC. Threatened species and ecological communities are likely to become endangered if limiting factors are not reversed. In accordance with the original study, this CDC red-listed accounts were included in the FHSI. Sensitive species present and rankings are updated and change with time as more information becomes available. During a proposed review, the QEP will need to look up the species accounts for further details using the CDC BC Species and Ecosystems Explorer. For these reasons, these data were not included in the GIS database; they were however included in the FHSI.
	CDC Blue/COSEWIC Special Concern Species	Yes	The BC CDC (2021) had polygons mapped for six Blue Listed species along the Kootenay Lake foreshore. Blue listed refers to any native species or ecological community considered to be of Special Concern in BC. These species or ecological communities have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. The following Blue Listed species were considered (Table 6): Western Screech-Owl, Western Skink, Painted Turtle, Western Bumble Bee, American sweet-flag, Wild Licorice. As well, the Coeur d’Alene Salamander was also included although Yellow Listed in BC (secure), because it was listed as a species of Special Concern Federally. In accordance with the original study, this CDC Blue-listed (and COSEWIC Special Concern) accounts were included in the FHSI. Sensitive species present and rankings are updated and change with time as more information becomes available. During a proposed review, the QEP will need to look up the species accounts for further details using the CDC BC Species and Ecosystems Explorer. For these reasons, these data were not included in the GIS database; they were however included in the FHSI.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

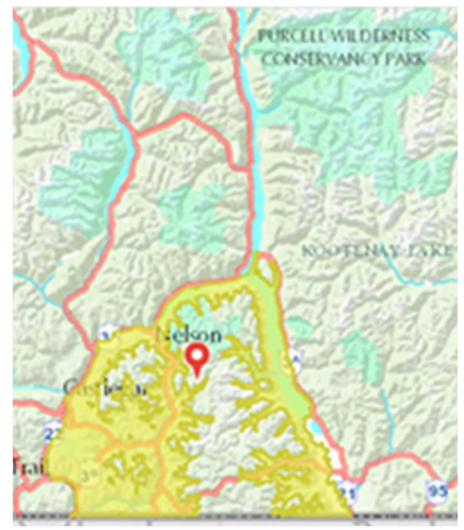
Category	Criteria	In FHSI	Rationale
	Critical Habitat – Caribou (Southern Mountain Population)	No	Approved Critical Habitat for the Southern Mountain Population of Caribou is present throughout a 238,199 ha area that includes the shoreline along the south end of the Main Lake and south side of the West Arm (BC CDC 2022). This species is listed as Endangered by COSEWIC and is also considered endangered (Red listed) in BC. The following summary of the species habitat requirements was obtained from the Federal Recovery Plan (Environment Canada 2014):  *Southern mountain caribou require large ranges of relatively undisturbed, interconnected habitat where they can separate themselves (horizontally and by elevation) from predators; modify their use of habitat in response to various natural and human-caused habitat disturbances and human activities; and can access their preferred food sources. In the Southern Group, where the snowpack is deep, caribou predominantly use high elevation mature and old subalpine forests in mid and late winter where they forage on arboreal lichens. During early winter before snow has consolidated, and during spring, they use lower elevation mature and old forests (with some subpopulations moving down into cedar/hemlock forests in valley bottoms). Due to their specific life history characteristics, southern mountain caribou are limited in their potential to recover from rapid, severe population declines. Habitat alteration (i.e., habitat loss, degradation, and fragmentation) from both human-caused and natural sources, and increased predation as a result of habitat alteration, have led to declining numbers. The Southwest Kootenay population was 22 Caribou in 2014 (in the mapped area shown here, with some extension south into the US).* The Recovery Plan identifies that landscape level plans should prepared and used to address the cumulative effects of habitat alteration and for managing habitat and sensory disturbance. When development (particularly large scale) is proposed in mature forest habitats, FLNRORD or other wildlife specialist input is to be sought, to ensure the development minimizes impacts on this species.
	Heron Rookery	Yes	Great Blue Heron (*Ardea herodias herodias*) is blue listed in BC, and their nests are protected under the BC *Wildlife Act* year-round (see Raptor Nest ZOS below). There was only one active Great Blue Heron rookery present in the project area, and this was in Cedar Hemlock forest stand in Balfour (M. Machmer pers. comm. 2021). Two other active rookeries were identified, but these were south of the shoreline boundary in Creston (M. Machner pers. comm. 2021). There were two additional rookeries identified in the previous FIMP, which have been abandoned because of too much human and/or bald eagle disturbance (M. Machmer pers. comm. 2021): one was near Argenta with no new site identified; and the other was at Proctor and had shifted to Balfour side. As was done in the original study, heron rookeries were evaluated in the FHSI.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	Raptor Nest	Yes	Section 34 of the BC *Wildlife Act* prohibits possessing, taking, or destroying (i) a bird or its egg, (ii) the nest of an Eagle, Peregrine Falcon, Gyrfalcon, Osprey, Heron or Burrowing Owl, or (iii) the nest of a bird not mentioned in (ii), when the nest is occupied by a bird or its egg unless authorized under permit. This ZOS was established to identify the raptor nests requiring year-round protection in accordance with the Act. Osprey (*Pandion haliaetus*) and Bald Eagle (*Haliaeetus leucocephalus*) nests observed along the Kootenay Lake shoreline during the FIM were mapped. In addition, 2021 Osprey and Bald Eagle nest location data for the Main Lake were provided by the Friends of Kootenay Lake Stewardship Society (K. Tillapaugh pers. comm.). For the West Arm, 2021 Osprey data was provided by J. Arndt and E. Moore (pers. comm.), and Bald Eagle data was provided by J. Arndt (pers. comm.). A Peregrine Falcon nest location at the north end of the lake was provided by M. Johnston (pers. comm.) with the following description: "*The exact cliff location of the nest is unknown, and could change slightly from year to year, but the general area is provided. Most observations have been submitted on eBird since first noticed in 2015. The birds arrive in early April and have been seen until early September. Sightings have been confirmed by Jared Hobbs (RPBio), with the subspecies unknown*". As was done in the original study, raptor nests were evaluated in the FHSI.
	Bat Site	Yes	Bat site information was obtained from the Kootenay Community Bat Project (KCBP) biologists. These specialists included Dr. Cori Lausen and Jason Rae of the Wildlife Conservation Society Canada (WSC), and Elodie Kuhnert. These recent unpublished accounts were added to the original FIMP bat data provided by FLNRORD (based on telemetry). It is assumed that the historic telemetry data is now housed in the Species and Ecosystem Data and Information database (SPI). In the Kootenay Region, there are five sensitive bat species, seven species that are not at risk and one species that is unranked (Community Bat Programs of BC 2021): ● SARA listed endangered species: Little Brown Myotis (*Myotis lucifugus*), and Northern Myotis (*Myotis septentrionalis*). ● BC Blue listed species: Townsend's Big-eared Bat (*Corynorhinus townsendii*), Western Small-footed Myotis (*Myotis ciliolabrum;* suspected in Kootenay Region), and Fringed Myotis (*Myotis thysanodes*). ● Species not at risk: Hoary Bat (*Lasiurus cinereus*), Silver-haired Bat (*Lasionycteris noctivagans*), Big Brown Bat (*Eptesicus fuscus*), Yuma Myotis (*Myotis yumanensis*), Californian Myotis (*Myotis californicus*), Long-legged Myotis (*Myotis Volans*), and Long-eared Myotis (*Myotis evotis*). ● Unranked: Eastern Red Bat (*Lasiurus borealis*). All maternity bat roosts in the project area were mapped as ZOS for all species. The following rationale for including species that are currently secure was provided by C. Lausen (pers comm. 2021): *Although not yet documented in BC, white-nose syndrome (WNS) is expected to arrive.* WNS is a fungus that attacks bats during hibernation and is easily spread, which has killed millions of Little Brown Bats in eastern Canada and US (CBP 2021). *Many more bat species are likely to be devastated, and BC scientists have been operating under the assumption that all bat species are likely to receive a listing of some form within the next decade. This is most true of the eight Myotis species in BC, all of which are expected to be vulnerable to WNS die-back. There are also other threats on bat populations including logging and wind energy. The latter is a federally important threat and the three species of 'migratory tree bats' are now under Committee on the Status of Endangered Wildlife in Canada (COSEWIC) review (silver-haired, hoary and eastern red bats). Two of these species (Hoary and Silver-haired bats) occur in the West Kootenays, and the third, Eastern Red bat, is expected to be present, as it has been detected in the East Kootenays. If these species are recommended by COSEWIC for listing, it will likely occur within a few years. Additionally, Ministry of Environment is currently assessing all bat species in BC with NatureServe criteria and are looking to change provincial listings even now before WNS is detected in the province* (Purnima Govindarajulu, announcement made Dec. 1 2021 to BC Bat Action Team).

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

Category	Criteria	In FHSI	Rationale
	Bat Site, continued…	Yes	Mechanisms to protect bats and their habitats are as follows (C. Lausen pers. comm.): *Under the BC Wildlife Act, as a vertebrate - bats cannot be killed, harmed or harassed. In the Kootenay Region, Ministerial Order M213 provides a list of Wildlife Habitat Features that are to be protected, and this includes bat hibernacula and bat nursery roosts. This is restricted to natural features only (i.e., a bat in rock crevice just outside a mine is protected, but if that crevice occurs inside the opening of the mine, it is not protected). There is a "Mines Best Management Practices" by BC MOE that provides guidance for bat hibernacula in mines in BC, but no legal protection is provided by this. Federally listed species have no special protection, unless on federal lands and so that does not apply around Kootenay Lake.* Bat data was included in the FHSI of the original study; however, at that time it was not masked. Bat maternity roost data was included in this FHSI. Bat roost data is now considered sensitive and the locations have thus been masked and buffered 200 m (as recommended by E. Kuhnert pers comm. 2021). If a development is proposed within a Bat ZOS, then the GIS database is to be reviewed to determine the source organization to be contacted. This will either be SPI (SPI_Mail@gov.bc.ca) or the Kootenay Bat Project (kootenaybats@gmail.com). Provide: rationale for the request, precise location information and activities expected to occur on site or other reasons for requiring the information name of person submitting request, company name, and contact information (business address, email, and phone number). Release of details of masked occurrences is subject to the signing of a Confidentiality and Non-reproduction Agreement and a demonstrated "need-to-know".
	Amphibian Site	Yes	Amphibian data was sourced from the 2008 West Kootenay Amphibian Survey (Dulisse and Hausleitner 2009). Within the Kootenay Lake FIMP study area, the study randomly selected four wetlands for sampling, with all sites within the Main Lake. One site was at each of the north and south ends of the lake, and two sites were mid-way along the lake (with a site on the west and another on the east shore). Sampling identified the presence of the Western Toad (*Anaxyrus boreas)* at the north end wetland. This species is sensitive and considered special concern by COSEWIC and SARA (Schedule 1, 2018). The secure species of Pacific Chorus Frog (or Pacific Tree Frog, *Pseudacris regilla*), Columbia Spotted Frog (*Rana luteiventris*), and Long-toed Salamander (*Ambystoma macrodactylum*) were also present at one or more of the sites sampled. In accordance with the original study, this amphibian data was included in the FHSI.
	Painted Turtle Site	No	B. Herbison (pers. comm. 2021) identified the presence of Painted Turtle - Intermountain - Rocky Mountain Population (*Chrysemys picta* pop. 2) at the north end of the lake, in Argenta Marsh/Slough. The north end of the marsh beyond the project boundary has a mapped polygon for this species in BC CDC (2021). This provincial mapping likely needs to be updated, since B. Herbison identified that turtles use the whole length of the marsh and have also been identified in the lake at the marsh outlet. This is a new ZOS added since the original study. This ZOS has not been included in the FHSI, only because it overlaps with many other ZOS at the north end of the lake and is already accounted for.

Table 7. Summary of FIM, ZOS and modification criteria and rationale for inclusion in the FHSI.

<table>
<tr><th>Category</th><th>Criteria</th><th>In FHSI</th><th>Rationale</th></tr>
<tr><td></td><td>Aquatic Vegetation and Wetlands</td><td>No</td><td>In this study, Aquatic Vegetation and Wetland areas were identified as all areas that were either mapped as having emergent or floating vegetation. These areas ranged from simple emergent willows or sedges to very complex habitats with submergent, floating, emergent and overhanging vegetation.

Wetlands provide valuable fish and wildlife habitats and important ecosystem functions. At Kootenay Lake, wetlands have been identified to provide habitat to sensitive species, including but not limited to, amphibians (see Amphibian ZOS) and birds. To exemplify this, the results of surveys on two Kootenay Lake shoreline wetlands from 2013 – 2015, conducted as part of the Canadian Wildlife Service, Secretive Marsh Bird Survey are summarized as follows (Arndt and Drever 2015):
1. Crawford Bay (49.66288 lat, 116.82806 long): Great Blue Herons were detected in all years, with the site used for foraging. Barn Swallows (Hirundo rustica, Blue listed in BC and Threatened under SARA) were also detected in 2013, foraging at the site.
2. Harrop (49.60588 lat, 117.03773 long): Great Blue Herons were detected in 2013 and 2014. This site appeared to be important for foraging aerial insectivores; with three listed species detected. One Purple Martin (Progne subis, Blue-listed in BC) was observed in 2013. Barn Swallows were recorded in 2014 and 2015, Black Swifts (Cypseloides niger, Blue listed in BC and Endangered under SARA) were seen in 2014. This site is within Sunshine Bay Regional Park.

This ZOS was in the previous study, identified as a sensitive aquatic feature. It has also been included in other recent similar studies (Windermere Lake). Wetland values have been accounted for in the FHSI in the FIM category as aquatic vegetation and wetland shore type (above). The sensitive bird species accounts listed above were not added as specific ZOS to this FIMP shoreline mapping, given the timing of data submission to this project. The hope is that the authors (Arndt and Drevor 2015) submitted the findings to the BC CDC and it will become available to the public with time. Finally, in the previous FIM, high values riparian areas were also mapped and have been included.</td></tr>
<tr><td rowspan="5">Modifications</td><td>Retaining Wall</td><td>Yes</td><td>Retaining walls influence fish in a variety of ways and are indicative of further shoreline urbanization (see methods for rationale).</td></tr>
<tr><td>Docks</td><td>Yes</td><td>Dock influence fish in a variety of ways and are indicative of further shoreline urbanization (see methods for rationale).</td></tr>
<tr><td>Groynes</td><td>Yes</td><td>Groynes influence fish in a variety of ways and are indicative of further shoreline urbanization (see methods for rationale).</td></tr>
<tr><td>Boat Launch</td><td>Yes</td><td>Boat launches influence fish in a variety of ways and are indicative of further shoreline urbanization (see methods for rationale).</td></tr>
<tr><td>Marina</td><td>Yes</td><td>Marinas influence fish in a variety of ways and are indicative of further shoreline urbanization (see methods for rationale).</td></tr>
</table>

4.2 Summary of FHSI Calibration

Several iterations (i.e., > 10) of the FHSI analysis were run, each with the weightings adjusted for each criterion to assess the resulting FHSI Ecological Ranks. The results from each iteration outcome and the results of each output were kept in a log for reference. For each iteration, the following items were considered to aid in determination of the final weighting for a criterion:

1. The Ecological Ranks assigned to each habitat segment (and how well they mirrored the professional opinions of the project team).
2. The appropriateness and defensibility of the associated weightings (by category and criterion).
3. The range of the resulting final FHSI scores and how individual criterion or habitat categories could affect the FHSI and act to differentiate habitat values along the shoreline.
4. The identified FHSI score for each segment were categorized between Very High, High, Moderate, Low and Very Low by identifying the largest gap in a histogram of FHSI scores to identify the FHSI Ecological Ranks.
5. Total percentage of shoreline for each FHSI Ecological Rank for each land use type, to understand the influence of FIM attributes and influence of modifications in the FHSI Ecological Ranks.
6. Total percentage of shoreline for each FHSI Ecological Rank for each shore type to understand the influence of shore type using multiple different lines of evidence from habitat categories.

In running these different iterations, the following broad trends were observed:

- There was a high degree of spatial overlap between ZOS used to weight some of the FHSI Categories (e.g., Fish and Wildlife) and FIM attributes such as shore type and substrate. Since ZOS were treated as binary variables (e.g., present or absent from a habitat segment), weighted similarly across Categories, and overlapped extensively, it was apparent that "duplication" in values may be occurring. These criteria were considered both individually, and as a group in review. The final weightings given to ZOS attributes were reduced to account for duplication but were kept to document known presence of high value habitat areas.
- The values of FIM attributes, such as shore type and substrate provided simple physical descriptions of a broad range of habitat values observed that were apparent in many of the ZOS. There were many different criteria and data available for Kootenay Lake. With so many habitat categories present, it was apparent that the FIM dataset needed to have a reasonable influence (meaning a high proportion of the weighting) to better reduce overlapping values to minimize "duplication" in criteria while still considering important ZOS.

Table 8 presents all the FHSI criteria considered, and the associated mathematical methods or logic used to include them in the FHSI. Mapping provided in Appendix B shows base data that were considered.

Table 8. The parameters and logic for the Foreshore Habitat Sensitivity Index of Kootenay Lake.

Category	Criteria	Percent Within Group	Logic	Uses Weighted FIM Data	Value Categories	Percentage of FHSI
FIM - General	Shore Type	31.3%	% of Segment * Percentage of FHSI	Yes	Stream Mouth = Wetland (1) > Gravel Beach = Rocky Shore = Cliff /Bluff (0.8), > Sand Beach (0.5), > Other (0.3)	11.6%
	Foreshore Substrate	25.0%	% Substrate * Percentage of FHSI	Yes	Cobble = Gravel (1) > Boulder = Organic = Mud = Marl = Fines = (0.8), > Bedrock (0.5), > Sands (0.3) >	9.3%
	Percentage Natural	10.4%	% Natural * Percentage of the FHSI	No		3.9%
	Aquatic Vegetation	16.7%	% Submergent * (0.5 *Percentage of the FHSI) + % Emergent * (0.5*Percentage of FHSI)	No	N/A	6.2%
	Overhanging Vegetation	8.3%	% Overhanging Vegetation * Percentage of the FHSI	No	N/A	3.1%
	Large Woody Debris	8.3%	# of Large Woody Debris/km * Relative Value * Percentage of the FHSI	No	N/A	3.1%
FIM - Riparian	Vegetation Band 1	33.3%	Vegetation Band Category	Yes	Vegetation Bandwidth Category 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)	3.1%
	Vegetation Band 1	33.3%	Vegetation Quality		Vegetation Quality Category Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)	3.1%
	Vegetation Band 2	16.7%	Vegetation Band Category	Yes	Vegetation Bandwidth Category 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)	1.6%
	Vegetation Band 2	16.7%	Vegetation Quality		Vegetation Quality Category Natural Wetland = Disturbed Wetland = Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Forest (0.8) > Herbs/Grasses = Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.3) > Exposed Soil (0.05)	1.6%
Fish Zone of Sensitivity	Critical Habitat - White Sturgeon	23.8%	Present (1), Absent (0)	Yes	Present (1), Absent (0)	9.3%
	High Value Kokanee Area (spawning)	28.6%	Present (1), Absent (0)	Yes	Present (1), Absent (0)	
	High Value Burbot Area (spawning)	4.8%	Present (1), Absent (0)	Yes	Present (1), Absent (0)	1.6%
	Mussel Bed	7.1%	Present (1), Absent (0)	No	Present (1), Absent (0)	
	Juvenile Rearing	23.8%	High (1), Moderate (0.6), Low (0.2)	No	High (1), Moderate (0.6), Low (0.2)	7.8%
	Migration Corridor	4.8%	Present (1), Absent (0)	No	Present (1), Absent (0)	1.6%

Table 8. The parameters and logic for the Foreshore Habitat Sensitivity Index of Kootenay Lake.

Category	Criteria	Percent Within Group	Logic	Uses Weighted FIM Data	Value Categories	Percentage of FHSI
	Staging Area	7.1%	Present (1), Absent (0)	No	Present (1), Absent (0)	2.3%
Wildlife Zones of Sensitivity	CDC Masked Species and Masked Approved Wildlife Habitat Area	18.5%	Present (1), Absent (0)	No	Present (1), Absent (0)	3.9%
	CDC Red Listed / COSEWIC Special Concern Species	11.1%	Present (1), Absent (0)	No	Present (1), Absent (0)	2.3%
	CDC Blue Listed Community	3.7%	Present (1), Absent (0)	No	Present (1), Absent (0)	0.8%
	Heron Rookery	29.6%	Present (1), Absent (0)	No	Present (1), Absent (0)	
	Raptor Nest	18.5%	Present (1), Absent (0)	No	Present (1), Absent (0)	3.9%
	Bat Sites	11.1%	Present (1), Absent (0)	No	Present (1), Absent (0)	2.3%
	Amphibian Sites	7.4%	Present (1), Absent (0)	No	Present (1), Absent (0)	1.6%
Modifications	Retaining Wall	14.3%	% Retaining Wall * -2.3	No	N/A	-2.3%
	Docks	7.1%	# of Docks / Km * -0.1	No		-0.1%
	Groynes	7.1%	# of Groynes / Km * -0.1	No		-0.1%
	Boat Launch	28.6%	# of Boat Launches / km * -0.25	No		-0.2%
	Marina	28.6%	# of Marinas / km * -0.25	No		-0.2%

4.3 Summary of FHSI Ecological Rankings

The output of the FHSI was a relative Ecological Rank assigned to each FIM habitat segment. This result is best viewed on the full-scale map (Appendix B). Figure 13 summarizes the FHSI data, showing the range of scores and values where habitat rankings between each FHSI Rank were split. A summary of the percentage of shoreline for each FHSI rank and for each shore type broad land use category is also presented (Figure 14 and Figure 15, Figure 13). Figure 14 presents a summary of the FHSI results in map format at a large scale to portray ecological ranks along the entire shoreline.

Spatial patterns in areas of higher value emerged with the iterative results during calibration. With each iteration of the index, it was possible to visually assess the patterns in the FHSI rankings that resulted from the different criteria, their presence, and their weightings by reviewing these summary figures. The location of the break between High and Very High was challenging to determine because of longer shoreline segments in more natural areas. The FHSI ultimately identified numerous important and high value areas around Kootenay Lake.

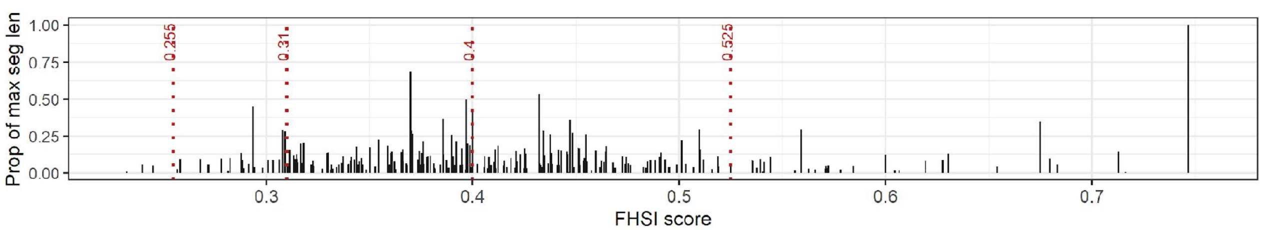


Figure 13. Proportion of shoreline/segment length for the range of calculated FHSI scores, and within each of the Ecological Rankings (breaks shown as vertical dashed lines).

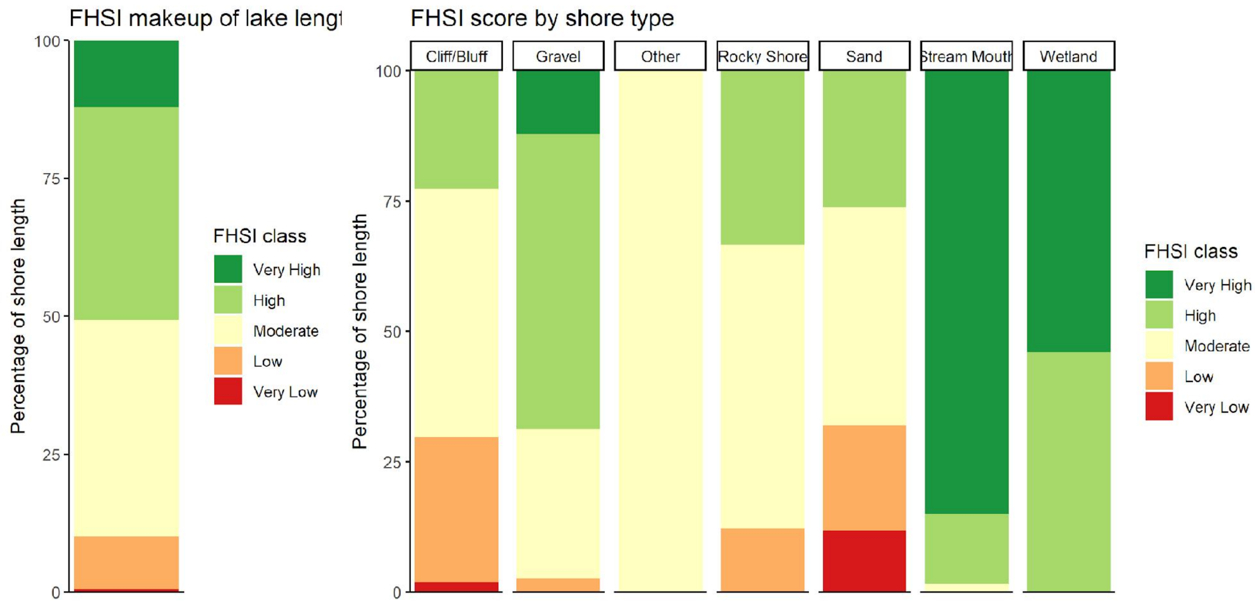


Figure 14. **FHSI Ecological Rankings, summarized as percent of shore length for the entire lake (left), and for the various shore types (right).**

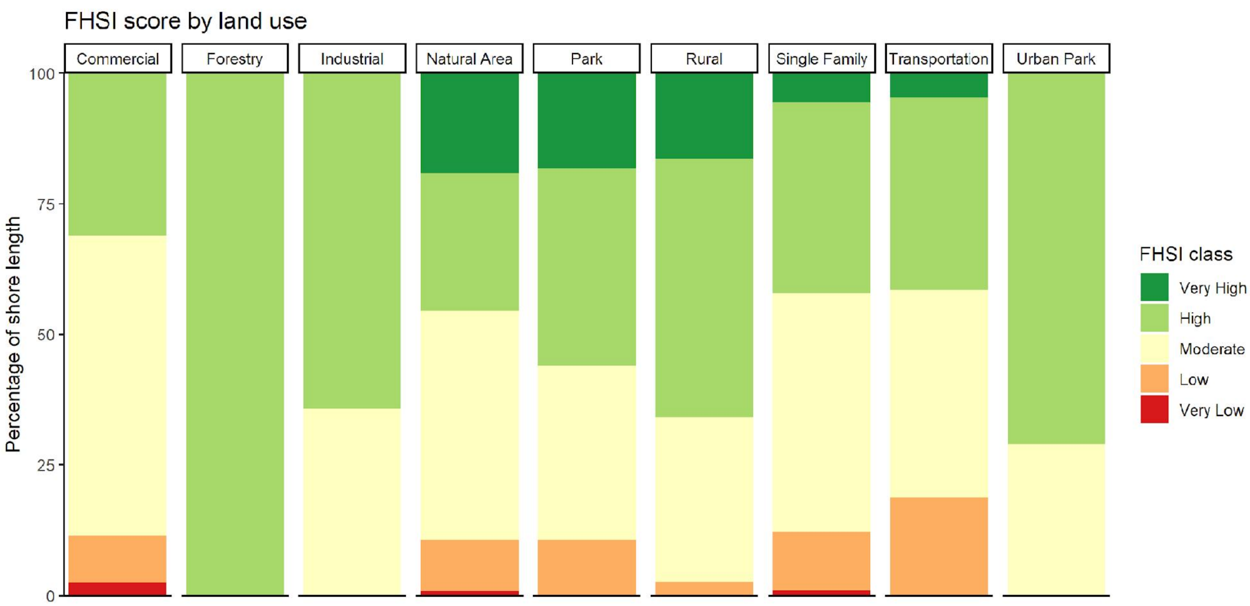


Figure 15. **FHSI Ecological Rankings, summarized as percent of shore length for the various shore types (top) and land uses (bottom).**

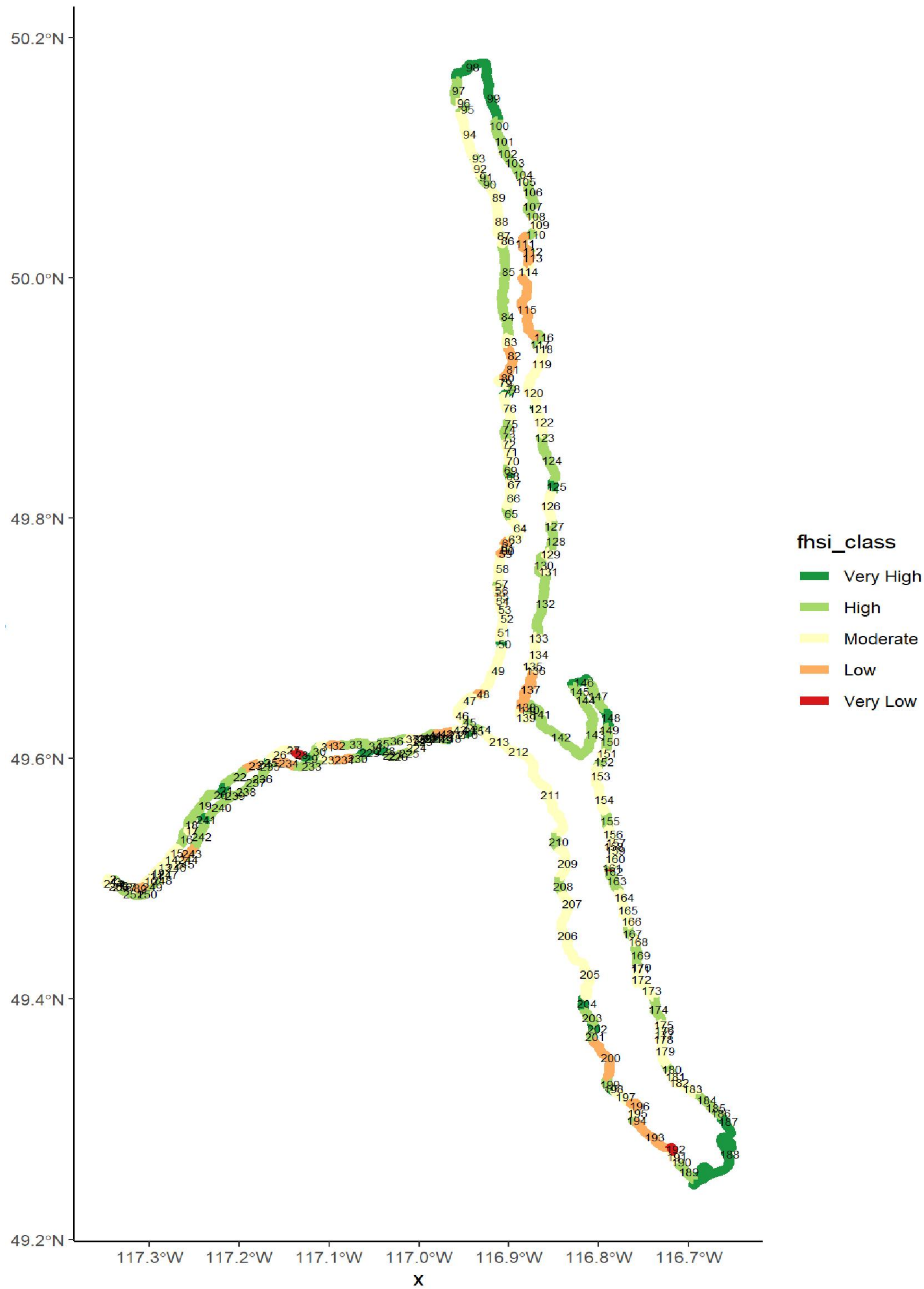


Figure 16. Overview of FHSI Ecological Rankings for Kootenay Lake.

The FHSI identified that 11.1% of shoreline had a Very High Ecological Rank, and 32.3% of the shoreline had a High Rank, which translates to approximately 45,355 and 131,183 m of shoreline, respectively. Many of the segments in the Very High category were longer in nature, which tended to skew the relative distributions of shoreline lengths for these rankings. All Wetland and most Stream Mouth shore types were ranked as Very High or High. These areas had numerous overlapping fish and wildlife ZOS, contributing directly to their high value. A large proportion of Gravel Beach Shore Type was also ranked Very High or High resulting from overlapping values present.

The areas of Moderate ranked shoreline accounted for 42.3% of the shoreline or 172,065 m. These areas occurred in locations that had fewer overlapping ZOS or were areas with important ZOS that were impacted by development. These areas were represented by all land use types and were common along all shore types except stream mouths and wetlands.

Areas of Low and Very Low Ecological Rank occurred along 14.3% or along 58,208 m of shoreline. These areas occurred predominantly in areas of increased development intensity, such as industrial or commercial areas. This was expected, as areas with more intense development often lose many of the habitat values that were originally present, highlighting the importance of protection of natural areas in any development process.

When comparing the 2012 to 2021 results, approximately 22% of the segments varied, with 40% of them increasing in value. Segments increased in value, typically because of addition of new sensitive occurrence data. In cases of decreased value, the following were contributing factors:

- Segments that had the addition of burbot and mussel ZOS in 2021 typically increased in value, whereas those without this habitat either remained the same or decreased slightly. Decreases occurred because of the relative drop in overall values when compared to segments that contained these new habitat features. The influence of any given parameter decreases within the FHSI with each new parameter added which also contributes to the observations and must be noted.
- In some segments, differences were attributed to disturbances.

The FHSI criteria used in the index, regardless of iteration, identified the following larger scale patterns, which are considered important ecological results:

1. Segments with critical habitat for Sturgeon were ranked as High and Very High in the northern and southern regions of the lake and in Crawford Bay.
2. Stream confluences are important for aquatic and terrestrial species. The criteria considered in the FIM attributes and in Fish and Wildlife Categories all identified these areas as important. During iterations, these segments were always ranked Very High or High depending upon how criterion were valued.

3. Kokanee spawning areas were limited and overlapped with areas of increased urbanization. Nonetheless, habitats with these Kokanee spawning areas were generally ranked in the High or Very High range, depending on the index weighting for the iteration. Appropriately weighting the Kokanee ZOS was very important, since these habitats were often urbanized, and urbanized areas generally had lower overall FHSI values.
4. There were new ZOS identified and a greater number of features for some pre-existing ZOS. Effort should be made to identify the spatial mapping locations of these feature in future assessments (for example of mussel beds) to improve future FIM mapping and the FHSI.
5. Urban areas with sand or gravel beach habitat were generally ranked lower by the FHSI due to the higher level of disturbance and habitat disruption. This result was evident despite the inherent positive value of gravel for fish for spawning or foraging, for example (i.e., FIM Shore type Gravel Beach had a high influence in the FHSI).

2.0 CONCLUSIONS AND RECOMMENDATIONS

The FIM showed that the rate of change of loss of natural shoreline was approximately 0.12% per year, consistent with a shoreline that has not experienced significant new development of rural or natural areas, but continues to experience slow, incremental loss and degradation. In areas of re-development, restoration was not commonly observed. The data suggest that there were still several, high value areas remaining, and protection of these resources is important. This assessment can act to help document ongoing, long-term changes surrounding the lake to help aid in long range land use planning at the local, Provincial and Federal levels of government. An integrated response to lakeshore and ultimately watershed management planning is imperative if these areas are to function ecologically and provide fish and wildlife habitat.

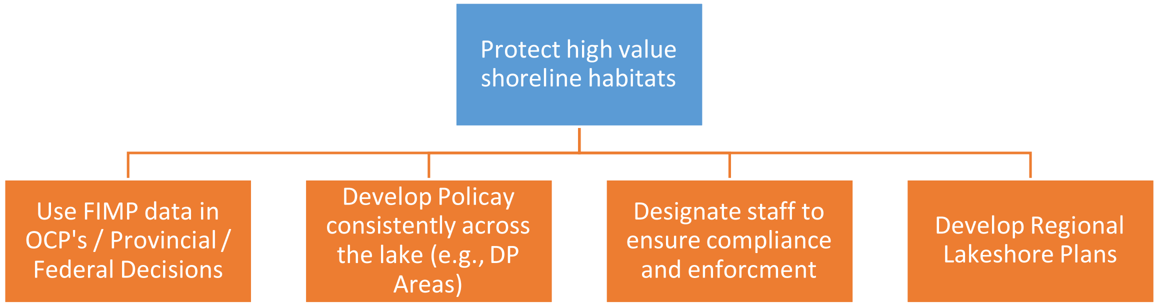
General recommendations to help protect, conserve, and better manage urban impacts on the foreshore of Kootenay Lake are provided below. These recommendations highlight that effort should focus on finding ways to integrate lakeshore planning across and between all levels of government and First Nations. Also, restoration should be highly promoted. The best habitat improvements include re-naturalizing or softening the shoreline on a lot-by-lot basis using riparian restoration, floodplain restoration at important stream confluence and wetlands, and bioengineering. Recommendations are categorized and are generally directed to different levels of government.

There are numerous challenges in the future and shoreline planning must carefully consider that much information is still unavailable. Data gaps can result in high value areas not being identified. Further, impacts of climate change need to be considered to ensure that important refugia habitats that contribute to the resiliency of species and overall lake health are identified and maintained. Examples of these important habitats include floodplains, old growth forests, wetlands, and vegetated shoreline areas. Integrating these habitats into appropriate land use decisions as identified by Amec and Pandion (2018) should be a priority to minimize continued incremental losses.

4.4 Overview and Road Map

The recommendations below are broken down into a variety of different categories, with some specific to each different level of government. Ultimately, collaboration between the different levels of government, through groups such as the KLP is extremely important. Often, each different level of government needs to *rely* upon another governmental level for actions such as enforcement (i.e., *Water Sustainability Act* or *Federal Fisheries Act*), land use policy (i.e., land use decisions mostly occur at the local government level), and implementation (i.e., all levels). Initial land use decisions for any new proposed development typically occur at a local government level. During this initial process, if environmental considerations important to either provincial or federal agencies are not incorporated (e.g., SARA, shore spawning, etc.), these governments would be positioned to consider future applications that fall under their jurisdiction. For example, parcels rezoned and subdivided to create single family lots where a ZOS occurs but has not been considered, could subsequently result in a future application for docks, retaining walls, etc. While each example is small on an individual scale, the cumulative impacts add up. The data in this report continues to highlight that lake wide change of shoreline habitat is a slow process but can have large habitat related impacts, even if managed with appropriate permits and processes. This change is likely occurring on nearly every lake in BC that has private holdings on the perimeter. It was apparent that some developments on Kootenay Lake are not compliant with standard BMP's, and it is not understood if these developments are currently receiving the appropriate level of environmental review at either the local, provincial, or federal levels. These problems occur for a variety of reasons, including certain OCP's not requiring development permits, OCP's not having a linkage to the FIMP, an enforcement failure of the provincial or federal agencies, and/or the number landowners or contractors who are simply ignoring or are unaware of the environmental requirements.

The following is a road map of the key steps to better incorporate and effectively implement these FIMP results and recommendations to protect high value shoreline habitats:



1. **Incorporate new data, such as identified ZOS, into appropriate planning documents (i.e., RDCK and municipality OCPs).** A FDG has been prepared as a starting point for consideration, which can be adapted into the previous shoreline development guide, even if this is just incorporation of newly identified ZOS.

2. **Establish Development Permit areas for the *entire lake* within each Electoral Area and / or municipality***.* Many local governments already have some development processes in place. However, they do not appear consistent across the lake and often do not specifically identify how best to consider ZOS as areas intended for conservation. This report clearly identifies losses are occurring around the entire lake regardless of location and that these losses are typically observed during redevelopment of existing lots or as build out on new lots. This means that failure to implement a Development Permit process will continue to be a contributing factor to change, and particularly if ZOS are not designated as areas for conservation. Areas without any established guidelines will likely experience greater rates of loss than those with some type of policy for protection of habitat.

   Further, once new structures are observed and proponents realize that there are no consequences, many other adjacent property owners follow suite. This example is best seen with retaining walls, for example. On Shuswap Lake, it was observed that a particular rock stacked retaining wall was observed in many locations and upon brief investigation, one contractor had been referred to many different landowners because the "aesthetics" of the wall were desired and subsequently repeated on property after property. Conversely, once neighbouring landowners see that there have been consequences of poor development practices (e.g., fines or requirements for removal), then the others will more likely follow suit with proper planning. The hope is that the good environmental development practices will be noticed and appreciated for their aesthetic values and consequently copied by neighbours.

   Examples from other regions may be sought to help with this step. For example, in the Windermere Lake OCP, the Regional District of East Kootenay (RDEK) currently requires development permits for works within 15 m of shoreline areas designated in the original FIMP as being red (very high and high ecological value) and anywhere within the boundary of an orange zone (ZOS) (RDEK 2019). The RDEK is currently working on aligning the OCP development permit requirements based on the updated FIMP (K. MacLeod pers comm., Schleppe and McPherson 2021).

3. **Ensure that enforcement action is taken, is consistent, and occurs on an ongoing basis in collaboration between agencies.** During our 11-day survey, numerous examples of ongoing and active construction were observed. Many of these were in plain sight. Enforcement effort will not be effective if it is implemented in a half hazard manner. Enforcement is necessary at all levels of government, which should work collaboratively on lake front development challenges. As identified in this report, land use has a direct impact on shoreline impacts, which are generally governed by local government. However, many observed impacts were directly adjacent to the lake at, near, or below Present Natural Boundary. These observed impacts were likely in violation of either Provincial (WSA) or Federal (FFA) policies.
4. **After initial guidelines and enforcement are established, effort should be focused on development of regional lakeshore plans such as a greenspace legacy plan or using tools for watershed planning under the *Water Sustainability Act*.** These regional initiatives are extremely important. This report identifies the processes of densification (i.e., rezoning and subdivision) as the most important determinant affecting rates of loss of nearshore habitat. It is expected that these impacts will continue to occur even because over time, small incremental change is inevitable even with effective enforcement and compliance. For example, once a home is constructed, trees may become hazardous and require removal or small patches of native shrubs will be lost slowly over time and often these changes occur because no permit is necessary or the change is so small, people would not think a permit was needed. Thus, the larger scale regional plans are important to ensure that sufficient green space and habitat remain as part of rural reserves or areas that are understood to be less developable. **For success of this step, all levels of government must work collaboratively, with partnerships such as KLP being very important.**

4.5 Land Use Policy and Lakeshore Planning

4.5.1 All Levels of Government

1. All agencies need to work in collaboration. Federal and provincial agencies should work with local government and First Nations to help implement important tools available within existing legislation, such as the *Water Sustainability Act*, *Land Act*, *Fisheries Act,* and municipal bylaws. These pieces of legislation and tools can act together as part of a larger, more regional approach to watershed planning. An integrated watershed management plan with all these linkages is important, because no one level of government has all the tools necessary to appropriately plan and manage lake shoreline areas. Use of the Kootenay Lake Partnership as a mechanism for ongoing communication is encouraged, as there have been numerous benefits identified from this group.

2. Incorporate all ZOS into revised planning documents such as OCPs, bylaws, or other policy documents as appropriate. Many of the original ZOS were updated with more spatial accuracy or inclusion of new sites or relevant data. These ZOS are intended to identify areas of conservation priority, and are, at minimum, to act as flags so that government can understand quickly where important habitats may exist. For instance, the *Federal Fisheries Act* protects all fish, and mussels, which are included as fish in this definition (see Section 2 of Federal *Fisheries Act* for definition of a fish, which includes all shellfish). Further, ZOS identify critical habitats for SARA species such as White Sturgeon, and should act as important triggers that initiate formal processes such as permit submissions for SARA species. Thus, it is important for all agencies to understand where this habitat is. This recommendation pertains to local, Provincial and Federal governments. *It was noted that much of the data available is not easily accessible and it may be useful to find ways to improve data sharing and access.*
3. There appears to be very little government effort/funding that goes into enforcement and compliance, including of Crown land encroachments, best management practices, OCP adherence in DPAs, the *Water Sustainability Act* or the *Federal Fisheries Act* in the region. Increased effort and funding should go towards this, similarly to what is being done in the Okanagan, Shuswap, and coastal regions. Specifically concerning was the extent of ongoing disturbance of the lakebed (i.e., substrate modification to construct groynes), and/or immediate lakeside disturbance to create, flat, usable areas. This encroachment often directly impacts floodplain vegetation communities, and subsequently creates a secondary need for erosion control.

   On Kootenay Lake, there was at least one active construction project that would have most likely required a *Federal Fisheries Act* Authorization or at minimum, letter of advice, among numerous other likely permits (e.g., Section 11 under the WSA). In this case, the active construction was reported to the BC Report all Poachers and Polluters (RAPP) Line to allow agencies to confirm that appropriate permits and authorizations were in place. There were many other active construction projects, and in many cases, numerous values were present that may have required consideration, such as the presence of freshwater mussels or important riparian or foreshore substrate conditions (i.e., much of the natural emergent vegetation along rocky or gravel shorelines is being continuously removed slowly over time).
4. Refer to the list of actions identified in the Kootenay Lake Conservation Fund Guidance Document, (Amec and Pandion 2018), and consider them across the landscape (not just in the private RDCK Electoral Areas A, D and E. In particular, address the Very High and High ranked actions. *The Very High actions are aimed at protecting critical or high value target habitats (i.e., via acquisition, covenant establishment, or landowner agreement), and implementing recovery plan recommendations. High ranked actions include conducting assessments to identify*

rare, or regionally sensitive species and target habitats and threats they are experiencing (e.g., climate change); and to implement stewardship actions that enhance these species and habitats.

5. First Nations and associated groups are encouraged to seek funding to further integrate archeological and cultural information into the shoreline planning process. While these data are separate from FIM datasets, there is often a high level of overlap in regards to concern areas. Thus, continued collection of these data are important as part of an adaptive management planning process.

6. The Kootenay Lake Partnership may wish to establish a referrals body for application processes, like the Environmental Advisory Commission (EAC) of the Regional District Central Okanagan (RDCO). The created commission would have specific term of reference and provide guidance as needed. In the RDCO, the EAC provides the Regional Board recommendations on referrals to the commission. As a public commission, this would function most similar to an Advisory Planning Commission, commonly used by Local governments.

4.5.2 Local Government

1. Use the environmental information in this report to update the Official Community Plans and associated Development Permit Area designations for Kootenay Lake. This will help identify, plan, and design around these important biological features. Where possible, ZOS should be identified as areas for conservation. Also, consider this information for Regional Growth strategies, and other planning and policy tools. Where possible, link these planning documents with other regulatory tools (see Recommendation 1). Work collaboratively to incorporate this information with previous FIM data, and other regional planning works (e.g., Amec and Pandion 2018).

2. Development permit areas should be prepared and identified for all watercourses including Kootenay Lake and its tributaries or adjacent wetlands. Development permit area buffers should be consistent for the entire lake, consider ZOS, and other important features, regardless of location on the local, Electoral Area, municipality, or other type of jurisdiction. It is noted here that even with Development Permit areas in place, loss will still occur, but the rate of loss will be reduced if policies such as Development Permits are created. Without consistency around the lake, development may become focused on areas with lesser requirements, and could create greater lake wide impacts.

3. Carefully consider any permit applications that will densify the shoreline or further urbanize it. Many remaining rural areas were deemed of Very High or High Ecological value and were typically overlain with ZOS. Regardless of protection measures, it has been observed that slow, incremental losses will inevitably continue to occur when a shoreline urbanizes, as was found in this study. The simple increased intensity of use will result in increased disturbances along the shoreline

area. Shoreline densification and urbanization that is likely the single most important factor affecting shoreline change. The biggest risks typically occur when rural is re-zoned to a denser land use such as single family, multi family, industrial, or commercial.

4. Riparian setbacks are an important consideration. Appropriate setbacks for development should be determined using the top of bank and/or using a stream boundary definition that includes consideration of the biological floodplain processes. In some cases, the benchmark used for HWM may vary from a surveyed Present Natural Boundary or property line, depending on vegetative cover, floodplains and their processes. Setbacks should generally occur from the edge of these floodplain areas to ensure adequate riparian protection buffers and these should be surveyed and field reviewed by a qualified professional with suitable experience. Notwithstanding, it is recognized that the processes and concepts of floodplain are more challenging on a lake such as Kootenay that is both regulated and contains "pinch points" or more riverine lake areas that have a direct influence on water elevations.

5. Local government may wish to establish waterfront zoning. This has been an often-controversial topic however, and many local governments have struggled with establishment of them or defining what should and should not apply. However, there are benefits of some zone establishment, which include the ability to: a) use Bylaw enforcement: b) establish a list of acceptable activities on the water or number of structures (i.e., only one dock of a certain size), with deviations requiring a variance); and, c) have more control over activities that may have a direct impact on the foreshore. However, it is noted that any process such as this has associated costs and can be complicated in areas with overlapping jurisdictions .

4.5.3 Provincial Government

1. Unpermitted Crown Land encroachments were likely in many locations, from either retaining walls, boat houses, or other types of overwater/near water modifications. Many encroachments appeared to be recently renovated or constructed. Substrate modification was one of the most significant disturbances observed below the HWM or in floodplain areas. Loss of vegetation cover was also evidenced. The modifications contribute to habitat loss as impacting other ecosystem functions. For example, loss of vegetation cover can lead to erosion and destabilization of the lakebed, as, the natural armour is removed. The following are recommendations to help address these encroachment issues:
    a. Conduct an inventory of encroachments and develop a plan to determine the next appropriate steps to bring structures into compliance.
    b. Initiate a process to remove illegally constructed structures, as is commonly occurring in the Okanagan and Shuswap regions.

c. Conduct public consultation to educate owners about Crown Lands and their legal requirements to place structures at or below the HWM on Crown Land.
d. Use the permit application review period to bring structures into compliance, as this is when a review of the structures and their locations is conducted.
e. Setup appropriate referrals between relevant agencies to ensure that one permit issuance does not supersede another (e.g., Crown Lands releases tenure for a Marine Rail system, that would also require a Development Permit from a local government for a Boat House).

It is strongly recommended that the provincial Crown Land Branch works with other agencies on enforcement and establishment of appropriate tools for land owners to begin the process of addressing any permitting requirements. It was apparent in surveys that without more effort, that ongoing alterations to the lakebed would occur, and will have a significant impact along the shoreline over time.

2. Retaining wall structures were often present in front of residences, with many built below the HWM. These structures were of variable types, with most constructed of local rock or lakebed rock. These structures can impact the shoreline, by eliminating complex habitat features, important to fish and wildlife. Often the installation of a retaining wall along a property means that the erosive forces are transferred to the neighbouring property, which then triggers additional installations. The following are recommendations to address this issue.

    a. Conduct an inventory and determine what is needed to help facilitate removal and transition of these walls to bioengineered erosion control structures under the *Water Sustainability Act* .

    b. Develop an erosion control structures toolkit that addresses permitting and submission requirements (i.e., including what is most appropriate and where). This will aid in application submissions and facilitate removal of these structures. For some locations it may be nearly impossible to remove some vertical walls due to other legally approved infrastructure. Whereas, in others it may be easily feasible. The toolkit could likely be developed in conjunction with other Provincial regions.

These recommendations would also be applicable to local government, who may need to authorize access through a riparian area as part of a development permit process.

3. Ensure that all permitting and associated data collected by Provincial Agencies is accessible. This could be achieved using a model similar to the *Fisheries Act*

Registry[4]. This goal is to have a repository of retaining wall / groyne / erosion control projects for the lake. Habitat related improvements made should also be documented. Together, this information can facilitate adaptive management and best results. For instance, these data would be useful to help determine the best ways to engineer and construct habitat improvements and continue to monitor them over time. These data could also be valuable to help adaptively manage to prepare for climate change. The structure inventory can be started/updated during FIM inventories, if GIS data are provided. This inventory of modifications is important to aid agency staff in understanding what works have been done, where, and what values may be present or impacted.

4.5.4 Federal Government

1. Ensure that all permitting and associated data collected by Federal Agencies is accessible (as outlined above for the Provincial government).
2. There appears to be very little government effort/funding that goes into enforcement and compliance of the Federal Fisheries Act. To address this, see Recommendation 3 above).

4.6 Addressing Cumulative Impacts

4.6.1 All potential levels of Government

1. Motorized access area restrictions are important to minimize environmental impacts to wetland and upland habitats. It may be important to identify and develop legal restrictions to make important habitat areas off-limits to motorized watercraft. The restriction reflects that motorized access may cause: abandonment of nests, harassment of wildlife, increased predation, flooding of nests from boat wakes, destruction of emergent vegetation, bank erosion and siltation, and increased invasive plant abundance and spread (Province of BC 2021). Kootenay Lake is very large, with ample deep-water areas, meaning there is much of the lake where impacts are minimal. However, this also means that where key areas occur, protection is more warranted.
2. Concern was expressed with the increasing human recreational use, especially in the last year, at the north end of the lake impacting sensitive foreshore habitats (B. Herbison pers. comm). The issue has been summarized as follows: "*Off leash dogs are a primary concern. Shorebirds have been identified to be disrupted by off leash dogs frequently. Where there used to be tracks of otter and other wildlife there are*

[4] Fisheries Act Registry. Available: https://open.canada.ca/data/en/dataset/2c09d2fd-9a8e-4d8c-b5af-95747e36eaac

now myriads of dog tracks, etc. The problem has increased somewhat with the opening of the lower Duncan to Bull Trout fishing, as well houseboats accessing the area from the Lardeau side, etc." One measure to help address this issue could be through the appropriate signage, which states the values, sensitivities, concerns and respectful actions the public should take.

3. Work with local, Provincial and Federal agencies and First Nations on a recreational usage carrying capacity study that addresses both safety of people and protection of important habitats. Carrying capacity is the concept of identifying a peak or total amount of an activity that can occur before a tipping point is reached. On lakes, there are two important carrying capacities to consider:
    a. First - a recreational carrying capacity or total number of vessels that can use the lake safely.
    b. Second, there is an environmental carrying capacity, which varies by habitats present along the lake (e.g., wake overtopping nests; pollution; noise; and physical harm such as prop scaring, prop wash, and beaching boats, etc.).

    The carrying capacity of Kootenay Lake should be determined considering these two elements. The results will identify the most appropriate areas for recreation to occur and the quantity or density of vessels that a particular space can safely support without harm to either people or the habitats the lake can support.

    There are many examples of biological data from this assessment that can be considered and incorporated to help identify areas where boating recreation will have the lowest impact. For example, areas of emergent vegetation important to nesting birds that can be impacted from boat wakes can be identified (and avoided). As can appropriate travel corridors to maintain shallow, littoral areas (to protect mussels, spawning fish etc.).

    A carrying capacity study was conducted on Kalamalka and Wood Lake in the Okanagan. Water quality, boat recreation and use, and habitat values were combined to help aid local government identify and map areas where recreation was preferred (Schleppe et al. 2016). These data have also been useful to help all levels of government engage with different agencies to better manage lakes using available regulatory processes. An example is Transport Canada who can help identify and regulate appropriate travel corridors on navigable waterways.

4. Prepare a greenspace legacy plan that designates a total quantity of greenspace that is desired to be maintained into the future to support a healthy and vibrant shoreline. To support this plan, scenarios can be presented that highlight what the shoreline would look like in different development intensities (e.g., status quo versus directed development versus no policy, etc.). The goal would be to sustain both residents and tourism, as well as habitats and species that rely upon the lake. This plan should also include maintenance of appropriate connectivity to upland ecosystems and wildlife habitats over the long term.

The plan should involve public consultation. This will allow residents to be informed about what change may occur, so they will understand how they can contribute to protection of the shoreline. By bringing stakeholders together, and committing to a greenspace legacy, there will be a reduction in the potential for ongoing and incremental losses that are impacting the shoreline habitats remaining.

This planning exercise should identify, map, and ensure planning and policy are consistent between all agencies and stakeholders to maintain important habitats along the shoreline of Kootenay Lake. Lands would then be protected in local, Provincial, or Federal policy aimed at prohibiting densification of areas intended to remain as greenspace. For instance, Local Government (regional or municipal) could incorporate this information into both Regional Growth Strategies, Bylaws, and Official Community Plans. Provincial government could help facilitate use of tools within the *Water Sustainability Act* (e.g., Water Sustainability Plans can link land and water decision policy in a long-term watershed or ecosystem-based framework, see Curran & Brandes 2019). This type of planning is critical because most current policy focusses on addressing site specific impacts, which has helped ensure a low rate of change around Kootenay Lake, but may not provide adequate long-term protection for shoreline areas.

5. Linked to the previous Green Space recommendation, establish 'Climate Refugia' as outlined in the Kootenay Lake Local Conservation Fund Guidance Document (Amec and Pandion 2018). The concept of climate refugia is described as follows (Amec and Pandion 2018):

   "Species may' become extirpated through parts of their geographic ranges and protecting 'climate refugia' may reduce such losses (Conservation Biology Institute 2018). Climate refugia are diverse and stable conservation areas that promote persistence of biodiversity as environmental conditions change. They are locations that biodiversity can retreat to, persist in, and potentially expand from under changing climate. Approaches and tools for identifying refugia (at the population, species, ecosystem and landscape scale) are currently being developed and pilot tested in the US (Conservation Biology Institute 2018). Most approaches emphasize topographic and geologic complexity. No work has been done in the West Kootenay and addressing climate refugia locally would require development of criteria, an accepted methodology, and then a series of mapping/modeling evaluations to be undertaken."

6. It is highly suspected that the ongoing development pressure, groyne construction, intensive recreational use and moorage along the shoreline will continue to impact important emergent and submergent vegetation areas, through slow and incremental losses. Education and compliance, and enforcement are required to reduce the potential for ongoing impacts. Local government may also wish to develop policies that apply to areas within 30 m of the shoreline for things such as

mooring buoy placement, or moorage. While this requires budget to manage, local governments often have a better ability to achieve a desired outcome than deferring to agencies such as FLNRORD or Transport Canada. The Kootenay Lake Partnership may be a good conduit for education, while periodic Conservation Officer presence could help with compliance and enforcement. It is recommended that signage, educational programs, and other forms of communication with lakeside residents and tourists alike are used to help avoid the small, incremental impacts to these important areas.

7. Invasive aquatic species such as Eurasian Watermilfoil (*Myriophyllum spicatum*), Zebra Mussel (*Dreissena polymorph*) and Quagga Mussel (*Dreissena bugensis*) when present, result in severe impacts to the economy and environment. There should be continued recognition and financial support for invasive aquatic plant and mussel species. It is important to detect invasive species early so that a rapid management response can be implemented.

4.6.2 Provincial Government

1. A reconciliation of FIM data collected with existing Crown Land licenses or tenures was not undertaken in this assessment. Many of the structures on Crown Land are a significant component of the cumulative impacts observed. Simple removal of concrete boat launches that do not have appropriate licenses of tenures in place would easily restore lakebed disturbance in many areas. For instance, if 15 launches were removed, and each was 2 m wide and 3 m long, a total of 90 m^2 of lakebed habitat would be restored. The removal of illegally constructed structures on Crown Land would likely be a significant consideration to help reducing cumulative impacts observed.
2. The habitat in the Kokanee shoreline spawning locations is vulnerable to physical alteration from boat and recreational use in spawning season. Substrate alteration should be avoided in these areas, unless part of a habitat enhancement program. Educational signage and public notice would help educate the public and there are likely many grants available to help with this type of program.

4.6.3 Federal Government

1. Work with municipal and Provincial agencies and First Nations on the recommendations outlined above (see Section 5.2.1).

4.7 Restoration

4.7.1 All levels of government

1. Shoreline planning should include riparian restoration in all new or redevelopment scenarios. The incremental, slow losses of riparian habitat can only be balanced with appropriate commitment to incremental shoreline restoration. Otherwise, ongoing

losses will occur and only a few remnant patches will remain over time. The outcome of shoreline restoration planning will also be slow and incremental because it would likely occur with each home rebuild. It is recommended that a minimum requirement of 25% of the riparian areas be restored with each development proposal. While more restoration is encouraged, committing to a minimum such as this will help slow and possibly stop the slow rates of loss observed, or even possibly reverse them.

A specific analysis could be completed to determine a percentage, with appropriate contingencies, that would be needed to reverse the observed rates of loss (or at least try and set them to zero). This analysis would utilize data within this assessment, such as rate of loss, total length of urban development shoreline; as well as rate of application for new or redevelopment. If undertaken, analyses such as these are imperative to incorporate into policies such as Regional Growth Strategies, where appropriate benchmarks can be set, and monitored over time to determine their effectiveness. Feedback loops such as this help aid policy and help adaptively manage shoreline related risks over time; a necessity given that change is currently occurring in a slow, incremental fashion. Short term policy measures, without appropriate adaptive management may end up failing to achieve their intended results.

4.7.2 Local Government

1. Landscaping plans should be considered for all lakefront developments, and it is important that they are endorsed by a suitably qualified professional. Professional endorsements of the plans ensure that restoration planning is incorporated in some manner, natural riparian vegetation disturbance is reduced, and native species are incorporated. Clear guidelines regarding what is and what is not appropriate are important to aid proponents in planning. In particular, large patios, outdoor living spaces, lakeside cabins or cabanas, are all considered structures that should occur outside of riparian areas.

4.7.3 Provincial

1. Wherever possible, Provincial authorities should consider a bioengineered solution for erosion control. The BC *Water Sustainability Act* requires a professional engineer to endorse all shoreline erosion control applications. However, the most appropriate design guideline is not clear. For instance, if a 1:200 year design guideline is required, many shoreline areas transition from gravel beaches to armoured rip rap. While this solution is more robust from an engineering perspective, it can still impact shoreline areas by reducing the ability for natural vegetation to establish. In many cases, the best option is to focus on grading shorelines to stable angles, and possibly allowing some importation of appropriate material to maintain shoreline grades to aid in appropriate vegetation

establishment. Every scenario is different; and feasibility, constructability, existing and legally constructed infrastructure, and associated risks must all be considered. The focus of this recommendation is to try and facilitate a broader consideration of design guidelines that also incorporate consideration of natural shoreline processes. At a minimum, guidelines should ensure that vertical and hard structures are only permitted in cases where no other viable option is possible. Even in these cases, a minimum grade of 2:1, with benches incorporated and planted should be incorporated.

4.8 Education

All agencies need to participate in education. Education can take many forms and is often supported by data collection. Foreshore Inventory and Mapping, FHSI, and ZOS can all be used in educational materials. The idea is to promote awareness and voluntary compliance with policies and regulation, but also to advise owner of necessary and legal permitting requirements such as Development Permits, *Fisheries Act* Authorizations (or advice), and Provincial *Water Sustainability Act* applications as an example.

1. The data in this report should be used in educational outreach to shoreline residents. For example, the Okanagan Collaborative Conservation Program used data from FIM mapping of Okanagan Lake to generate outreach public materials (see: http://lakeshore-living.okcp.ca/). These materials should also include information regarding Crown Lands, and the need to avoid disturbance unless appropriate permission is obtained.

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Appendix A. Foreshore Inventory and Mapping GIS Map

Appendix B. FHSI and ZOS Maps

Appendix C. Foreshore Development Guide

The Foreshore Development Guide (FDG), which was drafted according to the updated 2020 Foreshore Integrated Management Planning (FIMP) methods, remains in final draft form at the time of publication (March 31, 2021). The intent is to amend the FDG to include an updated First Nations Archaeological and Cultural inventory/component when the 2012 inventory is revised. The timeframe of that update is currently unknown. Until further notice, the current Kootenay Lake Partnership Shoreline Development Guide (2019) shall be followed.