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West Arm Kootenay Lake Foreshore Inventory Monitoring (FIM) Analysis

Submitted to:

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Executive Summary

The area surrounding the West Arm of Kootenay Lake in southwest British Columbia has been experiencing increased levels of development over the last number of years. Concerns have been raised by the Fisheries & Oceans Canada (DFO) as to what impacts development along the foreshore may be having on fish and fish habitat in this area. In order to address this issue and gather background information for a lake management plan, a baseline Foreshore Inventory Mapping (FIM) survey was conducted along the foreshore of the West Arm in October 2008. This survey was an update to one previously completed for portions of the West Arm in 2002. The foreshore was separated into segments with similar characteristics during both the 2002 and 2008 surveys, and the information gathered was then mapped and analyzed.

The results of the 2008 survey of the West Arm of Kootenay Lake reveal that the majority of high impact development has occurred on the northern shore including the City of Nelson and its surrounding areas. For the entire West Arm in 2008, the most common land use was natural, the dominant shore type was sand beach, the highest numbers of foreshore modifications observed were groynes, and the majority (60%) of the foreshore had a medium to high level of impact. While the northshore had an overall medium-high level of impact, the majority of the southshore was classified as having a low level of impact and dominated by abundant, mature-mixed forest with veteran trees and snags. The CPR railway line which runs along most of the southshore is assumed to be the controlling factor for major new developments and thus retains its more natural state. Also, low impact areas between Harrop and Bealbys Point are boat access only, which may limit the number of developments here. Areas west of the City of Nelson such as Grohman Narrows and upstream of the Taghum Bridge (Highway 3A) on portions of the north and south shores remain undeveloped likely due to accessibility issues and parkland protection.

A comparison between the 2002 DFO and present 2008 surveys was also conducted. However, the comparison could only be carried out between lake segments along the northshore of the West Arm between Nelson and Balfour since the entire West Arm of Kootenay Lake was not surveyed in 2002. In the comparison area there was an overall increase in areas designated as having a high level of impact in 2008 that were originally designated as low in 2002. This corresponded to the observed 15% increase in urban residential land use, with an overall net loss of riparian vegetation of approximately 11 m (ranged from 5 to 80 m loss), as well as an increase in the number of foreshore modifications such as groynes and retaining walls. The increase in urbanization and a higher level of impact observed in these areas may negatively impact the foreshore and cause impacts to fish and fish habitat.

With the increase in residential development and observed increases in foreshore modifications along the northshore of the West Arm of Kootenay Lake, decisions about the

future of this area need to be made. As development in the West Arm area is expected to continue at a similar pace, a new strategy and cooperation needs to be developed between local, provincial and federal governments. Compliance and enforcement for those foreshore activities that are not permitted or allowed is required by all levels of government. Also, residents living along the foreshore and in surrounding communities need to develop a lake stewardship ethic and participate in lake management initiatives.

1.0 INTRODUCTION

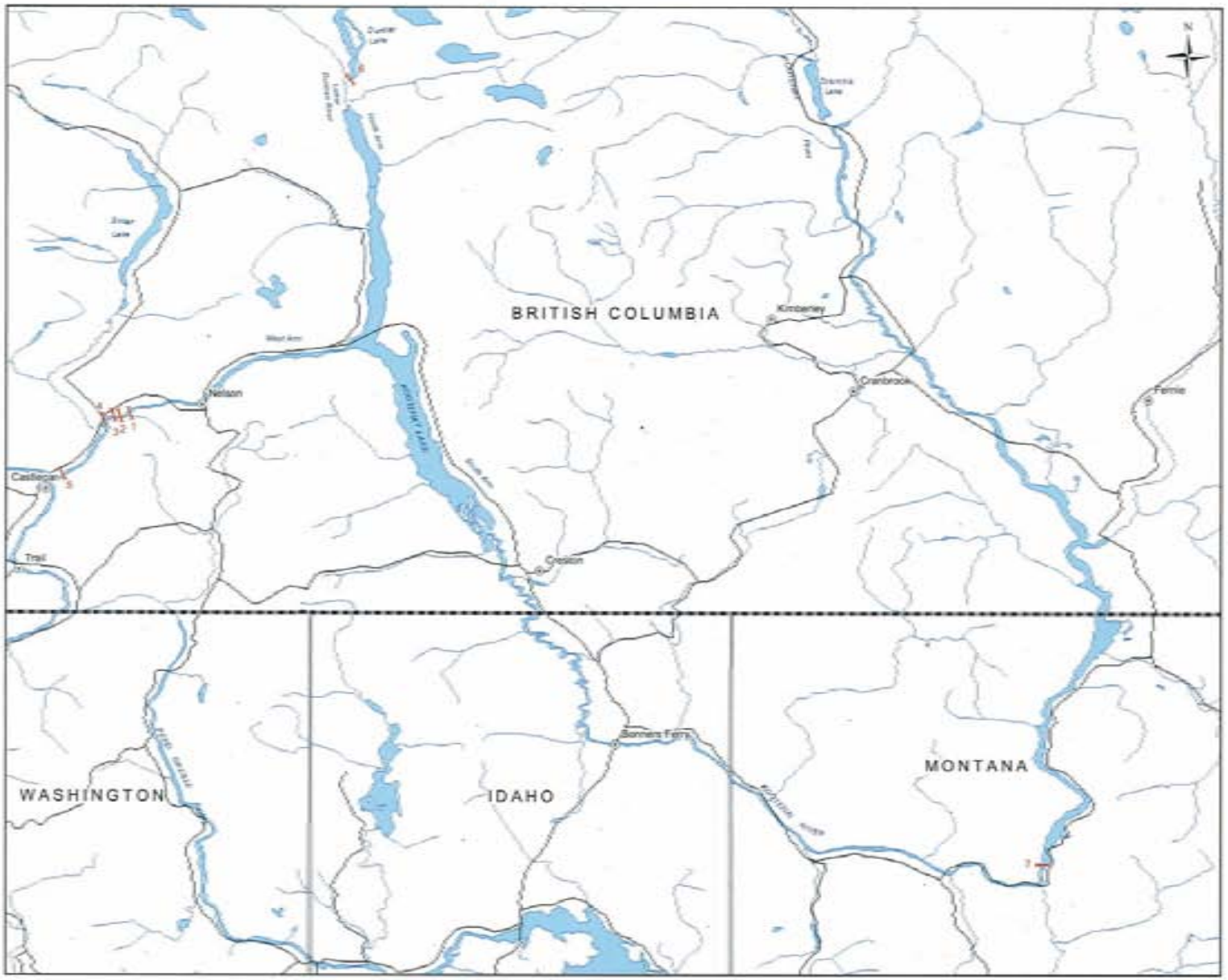
Kootenay Lake, located between the Purcell and Selkirk Mountain ranges, provides an idyllic location in which to find one of British Columbia's most unique sport fisheries (Figure 1). With a rich history of boom and bust times on the surrounding land, the lake has continued to support a diverse and exciting freshwater fishery. Over the past decade, the foreshore has been experiencing increased development pressure as more people are drawn to this attractive area to build vacation homes and for recreation. Concerns as to what increased foreshore development may have on Kootenay Lake, especially along its west arm, have warranted a closer look at potential impacts to fish and fish habitats.

Fish and fish habitat are currently protected in Canada by the federal *Fisheries Act* (R.S.C., 1985, c. F-14), which is administered and enforced by Fisheries & Oceans Canada (DFO). The habitat protection provisions of the Act (i.e., Section 35(1)) are the focus of DFO's Habitat Management Program (HMP). Section 35(1) of the Fisheries Act prohibits the "*harmful alteration, disruption or destruction (HADD) of fish habitat.*" Fish habitat is defined as: *"the spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes."* This broad definition also encompasses features found along the foreshore of lakes such as beaches and adjacent riparian vegetation which are important for fish to carry out their life history.

In 1986, DFO implemented their Habitat Policy to: i) support the habitat provisions of the Fisheries Act; ii) help minimize negative impacts of development activities; and, iii) promote sustainable development with respect to fish and fish habitat (DFO, 1986). The Habitat Policy states that DFO's long-term objective is 'the achievement of an overall *net gain* of the productive capacity of fish habitats." A main focus of HMP is the conservation of fish habitat by ensuring that the productive capacity of existing habitats is maintained by applying the *No-Net-Loss (NNL) of the productive capacity of fish habitat* guiding principle.

Land Development Guidelines were also created in 1992 as a joint venture between DFO and the Ministry of the Environment (MOE) (Chilibeck 1992). The purpose of these guidelines is to protect fish populations and their habitat from the damaging effects of land development activities such as foreshore development. These guidelines provide information to developers on regulations and requirements associated with the protection of aquatic habitat including (note that the term watercourses refers, in this case, to waters containing fish or fish habitat):

- Provision and protection of leave strips adjacent to watercourses;
- Control of soil erosion and sediment in runoff water;
- Control of rates of water runoff to minimize impacts on watercourses;
- Control of instream work, construction and diversions on watercourses;
- Maintenance of fish passage in watercourses for all salmonid life stages; and,
- Prevention of the discharge of deleterious substances to watercourses.



Legend

- Dam
  1. Corra Linn
  2. Upper Bonnington
  3. Lower Bonnington
  4. South Slocan
  5. Brilliant
  6. Duncan
  7. Libby
- City / Town
- River
- Waterbody

Scale: 1:1,000,000

20 10 0 20 40

Kilometres

Reference

Road - National Atlas

Hydrology - Geo Community

Client:	Fisheries and Oceans Canada
Project:	West Arm Kootenay Lake SHIM
	Overview of Kootenay Lake and Kootenai River Watershed
Date: March 18, 2009	Figure 1
Job No: VE51847	
File: watershed_overview.mxd	
Projection: CDS	Datum: NAD83

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Encouraging stewardship, which is defined as 'actively caring for something of value', is one way of encouraging private landowners to make decisions which will maintain the unique biodiversity of British Columbia that supports a range of fish and wildlife populations. Manuals have been produced which provide landowners with basic steps on how to preserve the ecological integrity of their land and adjacent waterways when considering development. One such handbook is Stewardship Options For Private Landowners in British Columbia (Penn 1996). When discussing waterways, stewardship ideas include building fences to keep livestock out of the water, planting native riparian vegetation if the buffer has been removed, and leaving logs in the water as a source of nutrients and cover. Engaging landowners to make choices which protect the quality of nearby habitats, thus becoming stewards of their own land, is essential in conserving fish habitats for present and future generations (Penn 1996). DFO has also been involved with stewardship programs in the Pacific Region for over 25 years. These programs go beyond the legal obligations to protect fish and fish habitat for which DFO is responsible; stewardship programs address the moral responsibilities that are entrusted to waterfront landowners. The Oceans, Habitat and Enhancement Branch (OHEB) Stewardship and Community Involvement (SCI) unit website (http://www-heb.pac.dfo-mpo.gc.ca/community/scihome_e.htm) maintains a listing of programs in the Pacific Region. These include community and school programs, events, partnerships, and tools for stewardship. By investing in these stewardship programs at a local level, DFO is addressing the role that private land owners have in caring-for and sustaining fish habitats.

Locally, DFO-Nelson has produced Beach Grooming Guidelines for Lake Environments in the Columbia Basin to avoid or minimize potential impacts to fish habitat (DFO-Nelson unpublished). These guidelines were created to address the fact that waterfront landowners will modify the shoreline to create beaches. The guidelines provide examples of how homeowners can go about these grooming activities without negatively impacting fish habitat.

DFO has also produced a Foreshore Inventory Mapping (FIM) and Sensitive Habitat Inventory Mapping (SHIM) assessments as methods to inventory and map sensitive lake foreshore and stream habitats. In British Columbia, information collected in FIM and SHIM inventories is made public via the Community Mapping Network (CMN). The mandate of the CMN is to promote the planning of sustainable communities. The CMN integrates data from many sources and makes it accessible through a user-friendly mapping system. Access to a variety of atlases is available at http://cmnbc.ca/.

In order to ensure that development along the foreshore of Kootenay Lake is sustainable and that the NNL principle is maintained, DFO conducted a baseline inventory of the West Arm of Kootenay Lake (Nelson, BC). The inventory is an update of a previous inventory conducted in 2002 and extended from Grohman Narrows Bridge (Hwy 3A) to the downstream portion of Queen's Bay (Figure 1). This inventory was intended to provide baseline information for the development of a plan to aid discussions on development of a plan and guidelines and to promote sustainable land development and protection of fish and fish habitat in the area.

1.1 Objectives of the Baseline Inventory of the West Arm of Kootenay Lake

The study objectives of the project were to:

- Conduct a SHIM GPS survey along the foreshore of the West Arm of Kootenay Lake from the Grohman Narrows Bridge at Hwy 3A to the downstream portion of Queen's Bay, where the future site of Kootenay Village at Proctor is being developed; this includes mapping an equal portion of shoreline on the opposite bank;
- Produce overview and segment maps of the shoreline highlighting development and sensitive features observed during the field surveys;
- Conduct basic habitat analyses to compare 2002 and 2008 survey data and provide table summaries; and,
- Produce a report that includes objectives and methods, results of 2002 and 2008 field surveys. The report will also include a comparison of 2002 and 2008 habitat data, GIS maps, photographs, as well as a discussion of the results and recommendations, where applicable.

2.0 BACKGROUND

2.1 Historic and Current Fisheries

Historically, recreation and commercial fisheries have existed for rainbow trout, Dolly Varden, whitefish, burbot, and kokanee (Andrusak 1987). Burbot (*Lota lota*), for example, were once an important commercial and recreational fishery in the West Arm of Kootenay Lake with an estimated annual harvest of up to 26,000 fish (Martin 1976). Spawning masses of burbot were historically observed near Balfour, however, today few spawning areas remain and include the lower Goat River near Creston, and the Kootenai River at Bonners Ferry, Idaho (Redfish 1998, Paragamian et al. 2005). The Kootenay Lake fishery collapsed in the 1970's as dramatic declines in the burbot population occurred and the species is now Red Listed in BC. Around the same time, the abundant sport fishery which targeted kokanee (*Oncorhynchus nerka*) between 1kg and 4kg in the upper West Arm of Kootenay Lake also collapsed (MOE unpublished). Suggested reasons for the collapse of both of these fisheries include unsustainable harvest rates, decreased lake productivity, and destruction of spawning habitats, and installation and operation of hydroelectric dams. Meanwhile, a recreational fishery for mountain whitefish (*Prosopium williamsoni*) experienced very high catch rates in the late 1960's, but the fishery was soon abandoned although abundances remained high (Andrusak 1987). White sturgeon (*Acipenser transmontanus*), another historically significant species, was also abundant in the Kootenay River and occasionally used the West Arm of Kootenay Lake, but were mainly found at Creston Delta, Duncan Delta, and Crawford Bay (Porto 2008).

The fishery which Kootenay Lake is most famous for is that of the Gerrard rainbow trout (*Oncorhynchus mykiss*) which produces trophy sized trout often exceeding 10kg. This is a thriving fishery which draws anglers throughout the world to Kootenay Lake, as it is the only lake to which the fish are indigenous. Gerrards are piscivorous, relying heavily on kokanee

as their food source (Andrusak and Parkinson 1984). This link has meant that Gerrards are susceptible to "bottom-up" changes to the food chain. In the 1950's and 1960's, productivity of Kootenay Lake was very high due to unregulated releases of phosphorus upstream on St. Mary's River near Kimberly (Northcote 1973). By the mid 1980's, after the plant was shut down and the Libby Dam was constructed, nutrient productivity had decreased and kokanee stocks, the main prey item for Gerrards, began to decline. A nutrient fertilization program was initiated in the main lake in 1992 in hopes of restoring the nutrient balance which had been confounded by the construction of dams on the Duncan and Kootenay Rivers. The results have been positive, with abundant kokanee populations in the North and West Arms as exemplified by escapements from the Meadow Creek Spawning Channel reaching 1.1 million fish in 2004 and in-lake abundance estimates increasing through the early 2000's (Schindler et al. 2007). It is hoped that the continuation of the nutrient fertilization program will continue to maintain a healthy kokanee population in the lake, and thus a permanent food source for Gerrard rainbow trout. These healthy populations are exemplified by current fishing regulations which allow 15 kokanee to be caught daily in the main lake, and 5 rainbow trout over 50 cm annually (MOE 2008). A listing of all fish species found in Kootenay Lake and their conservation status is found in Table 1.

In the West Arm itself, the most abundant fisheries are located at Balfour and Fraser Narrows, where kokanee, mountain whitefish, and rainbow trout are captured. Many of the tributaries along the West Arm are important spawning grounds for kokanee and rainbow trout stocks (i.e. Kokanee, Redfish, Harrop, Duhamel, Lasca, and Grohman Creeks). In general, only the lower one quarter to one half kilometer of the stream is valuable spawning habitat for the fish due to accessibility and where preferred spawning substrates can be found (Redfish 2007). More recently, kokanee have been observed to spawn along the shoreline in September/October at the Duhamel Creek and Sitkum Creek alluvial fans (Redfish 2007).

Table 1: Fish species present in Kootenay Lake. Both provincial and federal conservation status is listed for each species

Common Name	Scientific Name	Status	
		BC Listing[1]	COSEWIC[2]
Bridgelip Sucker	*Catostomus columbianus*	Yellow	-
Brook Trout	*Salvelinus fontinalis*	Exotic	-
Bull Trout	*Salvelinus confluentus*	Blue	-
Burbot	*Lota lota*	Yellow	-
Carp	*Cyprinus carpio*	Exotic	-
Dolly Varden	*Salvelinus malma*	Blue	-
Kokanee	*Oncorhynchus nerka*	n/a	-
Lake Chub	*Couesius plumbeus*	Yellow	DD
Lake Whitefish	*Coregonus clupeaformis*	Yellow	-
Largemouth Bass	*Micropterus salmoides*	Exotic	-
Largescale Sucker	*Catostomus macrocheilus*	Yellow	-
Leopard Dace	*Rhinichthys falcatus*	Yellow	NAR
Longnose Dace	*Rhinichthys cataractae*	Yellow	-
Longnose Sucker	*Catostomus catostomus*	Yellow	-
Mountain Whitefish	*Prosopium williamsoni*	Yellow	-
Northern Pike Minnow	*Ptychocheilus oregonensis*	Yellow	-
Peamouth Chub	*Mylocheilus caurinus*	Yellow	-
Prickly Sculpin	*Cottus asper*	Yellow	-
Pumpkinseed	*Lepomis gibbosus*	Exotic	-
Pygmy Whitefish	*Prosopium coulterii*	Yellow	-
Rainbow Trout	*Oncorhynchus mykiss*	Yellow	-
Redside Shiner	*Richardsonius balteatus*	Yellow	-
Slimy Sculpin	*Cottus cognatus*	Yellow	-
Torrent Sculpin	*Cottus rhotheus*	Yellow	-
Westslope Cutthroat Trout	*Oncorhynchus clarkii*	Blue	-
White Sturgeon	*Acipenser transmontanus*	Red	E
Yellow Perch	*Perca flavescens*	Yellow	-

[1] **Source:** FISS (2008); n/a = not applicable.
[2] **Source:** BCCDC (2008). DD = data deficient; NAR = not at risk; E = endangered.

2.2 Historic and Current Land Uses

Like many areas in southern British Columbia, a development boom hit the Kootenay Lake area during the mid-late 1800s. Placer mining for gold was the first to begin along the lake shore. A layer of soil would be extracted, usually using water pressure, to reveal bedrock out of which gold would be mined. This mining process has impacts on nearby land and streams, especially due to increased siltation from runoff at mining sites (Stubblefield et al. 2005). Mining expanded quickly throughout the area. The Bluebell Mine near Riondel on the main body of Kootenay Lake was a leading producer of lead, zinc, and silver. A silver

mine was located at the head of Kokanee Creek on the West Arm, and in 1900, 787 tonnes of silver ore was moved on an aerial tramway above the treeline to the shoreline. Nelson sprung up as a shipping and receiving hub for mining operations on the lake. Due to a lack of environmental remediation policy in the day, tailings from the mines, such as Bluebell, were generally pumped directly into Kootenay Lake or left on the shore (Donald et al. 2001).

The abundance of transportation options around Kootenay Lake encouraged industrious settlers to develop sawmills, orchards, farms, and storefronts along the foreshore. Paddle wheelers and steamers moved people and supplies between settlements, while barges moved railway cars from the southern tip of Kootenay Lake to Sunshine Bay as they traveled the CPR's "Crow's Nest Line". Resource extraction has continued to play an important role in the lives of people who live in the area throughout the past century.

Other foreshore modifications on Kootenay Lake included dyking between Creston, B.C. and Bonner's Ferry, Idaho, which began in the 1880's to prevent the flooding of agricultural lands (Figure 1). Further flood control and hydroelectric development came with the installation of dams on the inflowing Kootenay (Libby Dam) and Duncan (Duncan Dam) rivers. Besides blocking fish migration, dam construction often destroyed fish habitat by dredging upstream (i.e. Corra Linn hydroelectric dam) to increase water storage area. Flood control benefited farmers in the Creston Valley (B.C.) since fertile farming areas currently remain adjacent to Kootenay Lake, especially along its south arm.

The foreshore and waterways in the Kootenay Lake area were also modified throughout the 20th century. In the 1980's and 1990's development included re-routing of streams and rivers to accommodate roadways, the removal of gravel from rivers and lakes for use in development projects, and infilling foreshore habitat to increase waterfront area for development. For example, in the City of Nelson infilling of the foreshore occurred to develop an airstrip and commercial area to house a shopping mall and hotel.

The history of resource extraction throughout the Kootenay Lake area continues to provide income and employment to residents, but not to the extent it once did. Tourism, recreation, and retirement are becoming the predominant income generating activities in the area, to which the lakeshore provides an excellent backdrop (Wilson 2009). The West Arm of Kootenay Lake has seen increases in population similar to other areas of B.C. over the last 150 years (Wilson 2009). Recently, the West Arm has experienced rapid development, as evidenced by the rise in the number of building permits issued by the Regional District of Central Kootenay (RDCK) in the West Arm of Kootenay Lake (M. Crowe, Planning Technician, RDCK, pers. comm., 2009). Building permits rose by approximately 1.8 times since 2002 and over half of these permits issued were for single family dwellings and mobile homes (M. Crowe, pers. comm., 2009).

2.3 Effects on the Foreshore

The foreshore is defined as the part of the shore between high-water and low-water and provides an important link between aquatic and terrestrial environments (McPherson and Michel 2007). The balance of life in the foreshore is very sensitive, as the relationship between different environments develops slowly and any modifications can negatively

impact this area. An ultraoligotrophic lake, such as Kootenay Lake, relies on nutrient additions from adjoining lands and waterways. When the foreshore and adjacent lands are developed, it changes the capacity of the land to transport water and nutrients to the lake itself. Changing the nearshore environment from a pervious and absorptive substrate to a more impervious landscape (i.e. roads, buildings, and pastures) removes the natural water filtering mechanism of the soil column, reducing water storage ability and water quality in drainage bodies (Booth et al. 2002).

Land development along the foreshore may include dredging the foreshore for docks and boat ramps, addition of large angular boulders to build groynes, the removal of important riparian vegetation for land clearing to build homes; removal of natural shoreline substrates so landowners can have sandy beaches; deposition of deleterious substances into the lake via direct sewage releases; and, the hardening of the shoreline where retaining walls protect homes that are built too close to the natural high water mark. These development changes, in turn, potentially impact fish and fish habitats by the following examples (adapted from Kahler 2000):

- Effecting patterns of predation and prey refuge habitat through alterations of nearshore substrates and vegetation.
- Impacts to food resources from decreased productivity due to the removal of riparian and littoral plants.
- Impacts to fry migration along the shoreline through the creation of groynes to protect shorelines and watercraft.
- Increased turbidity from construction which impacts water quality and increases fish stress responses. And,
- Disturbances to fish behaviour associated with increased recreational pressure via boat noise and other activities.

Fish species that spawn along the foreshore and/or use associated habitats may also be more directly impacted by adjacent land use and developments. In the West Arm, kokanee have been recently reported to spawn along the shoreline in September/October at the Duhamel Creek and Sitkum Creek alluvial fans (Redfish 2007). Kokanee redds (spawning nests) found along the shoreline of the lake are not only more susceptible to stranding if water level fluctuations occur, but since fry do not emerge until early March (Redfish 2007), any "improvements" to the foreshore such as beach grooming and structures built in spawning areas may disturb redds and impact fry survival.

3.0 STUDY AREA

Kootenay Lake lies between two mountain ranges: the Selkirks to the west and the Purcells to the east (Figure 1). The lake is fed by two major tributaries, Kootenay and Duncan rivers (Figure 1). The Duncan River is influenced by the inflows from the Lardeau River, though the Lardeau itself is not a tributary of Kootenay Lake (Vonk 2001). The Kootenay River (called the Kootenai River in the USA) provides 80% of the lake's inflow. Its headwaters are located near Mt. Assiniboine (near Banff, AB) and it weaves its way south from BC through northern Montana and Idaho before flowing into the south end of Kootenay Lake, near

Creston, B.C. (Figure 1). The Lardeau River is fed by Trout Lake while the Duncan River originates in the Purcells and both flow into the north end of Kootenay Lake. The lake itself consists of three arms: the south, north, and west (Figure 1). The south and north arms make up the main lake which has a length of 107 km, a mean depth of 100 m, a surface area of 420 km^2, and a water retention time of 1.5 years (MOE unpublished).

The West Arm, the main study area, is a narrow branch of the lake with a length of 35 km, a mean depth of 13 m, and a water retention time of 5.5 days (MOE unpublished). The West Arm joins the main lake south of Queen's Bay and is separated by a shallow sill (Figure 1). It is the most riverine of the three arms, with a variety of narrow sections along its length. The West Arm ends near the City of Nelson where it becomes the lower Kootenay River, which is the only outflow for Kootenay Lake (Figure 1). The lower Kootenay River then runs south where it passes through five dams (Corra Linn, Upper Bonnington, Lower Bonnington, South Slocan, and Brilliant) before it exits into the Columbia River at Castlegar, B.C. (Figure 1). The Kootenay Canal also runs adjacent to the lower Kootenay River for approximately 5 km before rejoining it at the South Slocan Dam.

4.0 METHODS

4.1 2008 Survey

A GPS SHIM survey was conducted along the West Arm foreshore from 29 to 31 October 2008 with a crew of two (boat operator, GPS/data surveyor). Louise Porto was the GPS surveyor and has conducted similar surveys on Windermere and Slocan Lakes for DFO. An aluminium jet boat (18"; 225 hp) mounted with a GPS antennae was used to conduct the SHIM survey. The boat was kept approximately 20 m from the shoreline so that a better view of the segment area could be assessed and for safety reasons. In shallower areas or areas with marinas or ferry traffic, this offset distance was approximately 50 m.

A Trimble GeoXM GPS receiver was used to collect data points and enter data pertinent to the survey. The Trimble unit had been uploaded with DFO's Lakeshore SHIM data dictionary (SHIM Lake 2004 v2.0) provided by B. Mason (Biologist, Fisheries & Oceans Canada, Vancouver, B.C.), which has been used to map and inventory lakes in the Kootenay region (e.g., McPherson and Michel 2007). Appendix A provides an overview of how the data dictionary is set up and its multiple tiered data entry tools. Direct data entry was possible using this standard DFO data dictionary, which facilitated simultaneous GPS and feature data collection. A hard copy of the 2002 West Arm Kootenay Lake SHIM survey, conducted previously by DFO, was also used during the 2008 survey to replicate segments for direct comparison between 2002 and 2008 (see below). Photographs were taken throughout the survey and photo numbers were recorded on field data sheets.

Surveying began along the northshore of the West Arm at the Highway 3B Bridge (known as the big orange bridge) and continued in an upstream direction to Queen's Bay, where the survey was redirected across the lake to the southshore of the West Arm and continued downstream to Taghum (Appendix B – overview map). The section from Taghum to the Highway 3B Bridge was also surveyed (Appendix B – overview map). When surveying

areas which had not been covered in 2002 (i.e., the majority of the southshore), segments were delineated based on areas with similar foreshore characteristics as per the SHIM methodology for segment classifications (Mason and Knight 2001). The following discussion refers to the 'northshore' which includes the northern shore of the West Arm from the Taghum bridge (Highway 3A) to Queens Bay (Segments 1 to 48, 78 to 86), while areas referenced as the 'southshore' includes the southern shore from Proctor to Grohman Narrows Provincial Park (Segments 49 to 77) (Appendix B – overview map).

4.1.1 Segment Classifications

Segment classifications included shore type, land use, level of impact and livestock access (Appendix A).

Shore type classifications are defined in Table 2 and included cliff/bluff, gravel beach, sand beach, vegetated shore, low rocky shore, alluvial fan, wetland and other. Figure 3 provides photographic examples of these five shore types classified during the survey in the West Arm. In 2002, the wetland and other classifications were not used; these classifications were also not observed in 2008 (Figure 2).

Table 2: Shore type qualifiers (RDCO 2005)

Shore Type	Description
Cliff/Bluff	Adjacent to steeper slopes, usually indicating a steep-sided lake basin or sudden drop-off.
Gravel Beach	Often associated with low gradient foreshore, coves with pockets of riparian vegetation among steeper hillsides or alluvial fans.
Sand Beach	Often associated with alluvial fans or other shoreline deposition areas.
Vegetated Shoreline	Characteristic of undisturbed foreshore with narrow littoral width. Vegetation is commonly shrubs and small trees. Overhanging vegetation occurs to the mean water level.
Low Rocky Shore	Cobble, boulder or bedrock substrate often prevalent along the base of steeper shorelines.
Alluvial Fan	A fan-shaped deposit of gravel, sand and silt dropped by a stream where there is a decrease in slope, for example, from mountains onto a level plain or into a lake or stream
Wetland	Characteristic of wide littoral zones with fine substrates promoting abundant emergent vegetation such as sedges, reeds, and cattails.
Other	Shore types which do not fit the descriptions above.

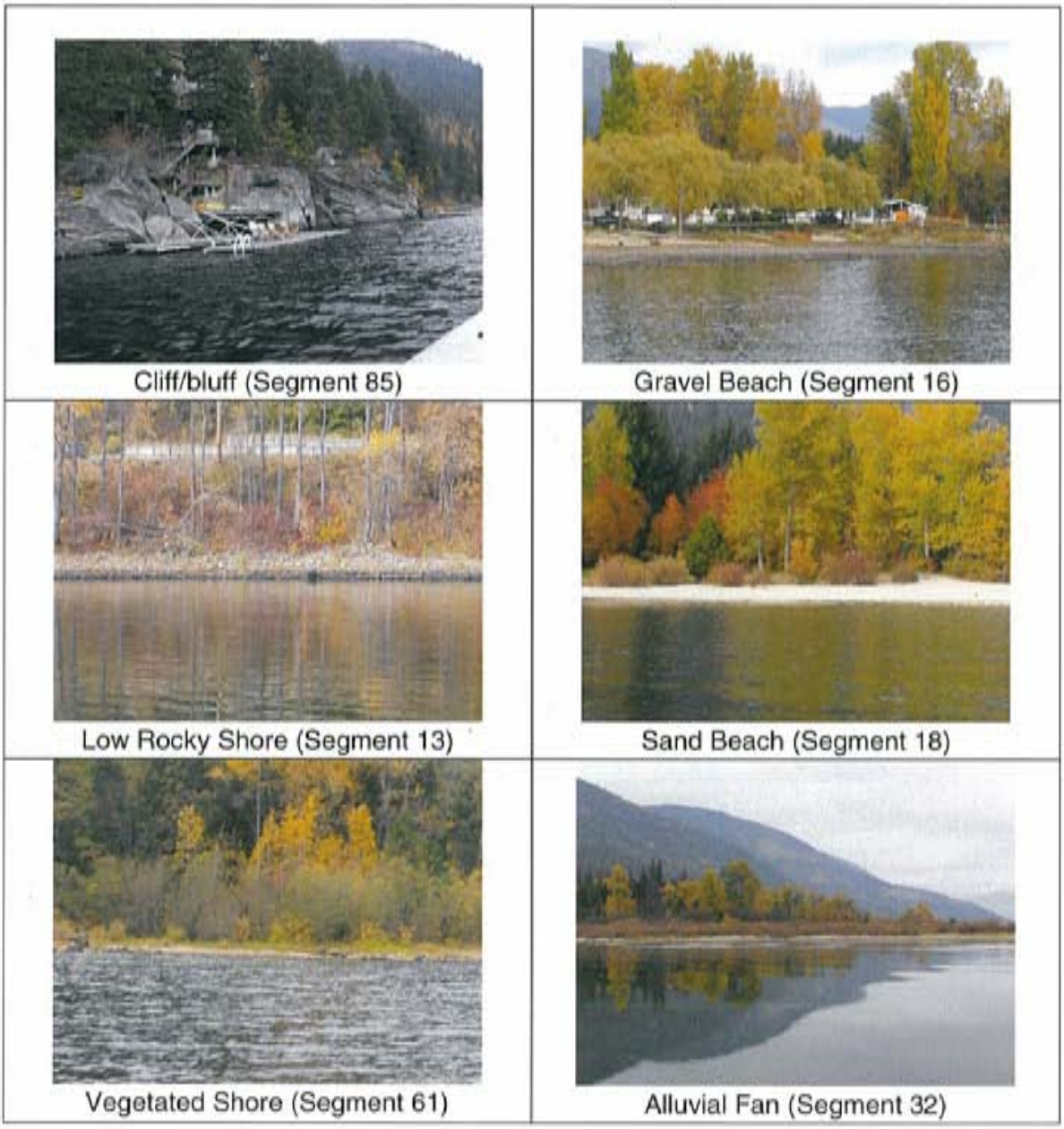


Figure 2: ***Examples of predominant shore types along the West Arm of Kootenay Lake***

Land use was classified during the survey as natural, agricultural, urban development, park, recreation, forestry, industrial, disturbed (Table 3).

Table 3: Land uses adjacent to the foreshore (adapted from RDCO 2005)

Land Use Designation	Purpose
Natural	Shoreline is unmodified.
Agricultural	To accommodate agricultural operations and related activities on parcels usually located on the Agricultural Land Reserve.
Urban Residential	To accommodate varied density residential use.
Park	To accommodate areas available to the general public that includes natural protected areas.
Recreational	To accommodate lands used for recreational purposes such as private beaches, resorts, or parks.
Forestry	To accommodate resource management lands.
Industrial	To accommodate industrial activities.
Disturbed	Foreshore has been modified through human alteration.

An overall level of impact (i.e., low, medium, high) was also assigned to each segment during the survey. Level of impact is a cumulative measurement which takes into account factors including the extent of foreshore disturbance, riparian characteristics, number of foreshore modifications, and type of adjacent land use (McPherson and Michel 2007). This classification is a simple way of gauging the overall health of the foreshore but is highly subjective like the assignment of shore type and land use. Definitions for low, medium and high level of impact are provided in Table 4 and photographic examples from the West Arm in 2008 are illustrated in Figure 3.

Table 4: Level of impact qualifiers (RDCO 2005)

Level of Impact	Description
Low	Segments that show little or limited signs of foreshore disturbance and impacts. These segments exhibit healthy, functioning riparian vegetation. They have substrates that are largely undisturbed, limited beach grooming activities, and no to few modifications.
Medium	Segments that show moderate signs of foreshore disturbance and impacts. These segments exhibit isolated, intact, functioning riparian areas (often between residences). Substrates (where disturbed) exhibit signs of isolated beach grooming activities. Retaining walls (where present) are generally discontinuous. General modifications are well spaced and do not impact the majority of the foreshore segment.

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

The final segment classification was livestock access which was qualified in the data dictionary as either yes or no (Appendix A).

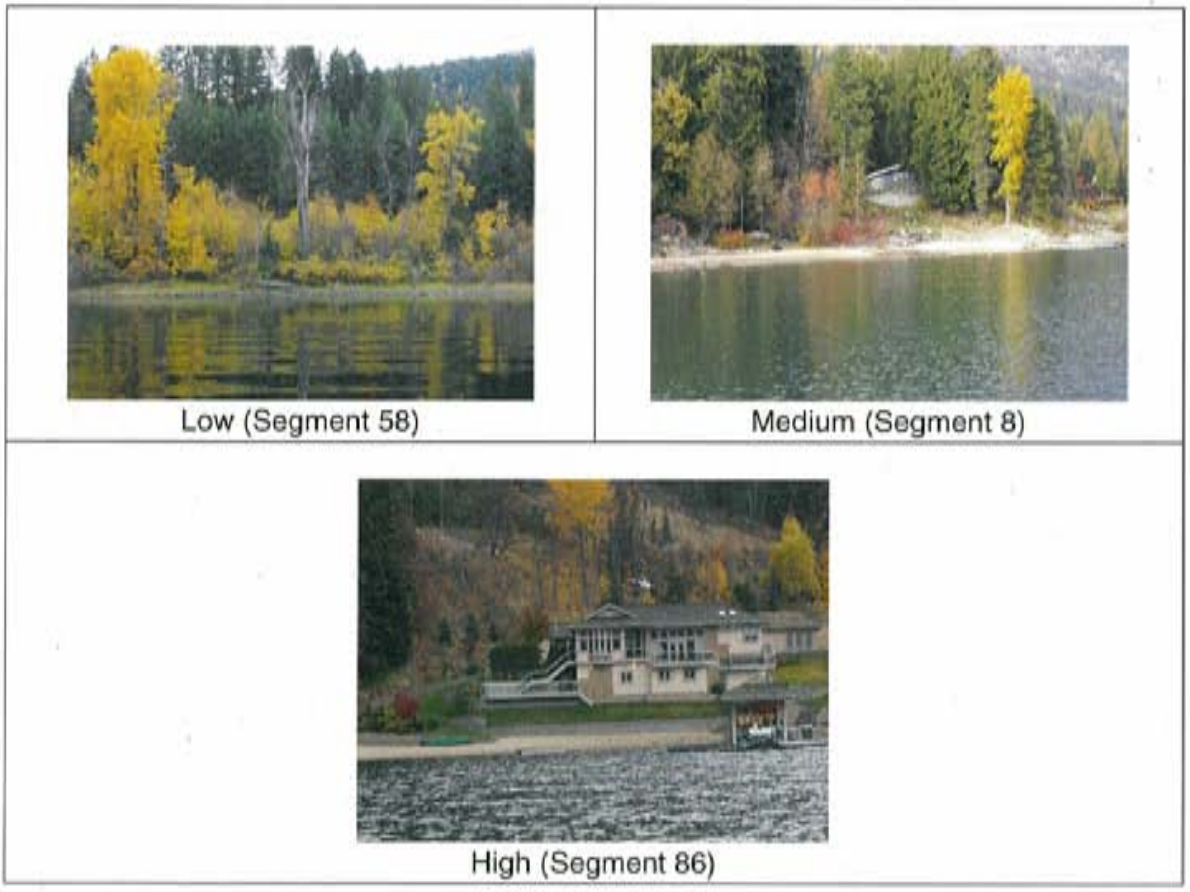


Figure 3: Examples of low, medium and high levels of impact along the West Arm of Kootenay Lake

4.1.2 Percent Land Use, Shore Type & Substrate

In addition to the overall segment classifications used above, visual observations qualitatively determined the estimated percent land use, shore type, and substrate within

each segment. The percent land use was divided by the following classifications: urban/residential; commercial; rural; agriculture; park; industrial; natural; and, disturbed (Appendix A). Definitions are similar to those included in Table 3 above, with the addition of commercial (includes commercial, retail and service uses; RDCO 2005) and rural (pertaining to less-populated, non-urban areas). The percent of each shore type outlined in Table 2 and substrate along the foreshore (e.g., % fines, gravel, cobble, boulder, bedrock) were also estimated during the survey (Appendix A). Substrate compaction along the foreshore was classified as low, medium, high or unknown and was based on visual observations from the boat; no actual measurements of substrate or compaction were taken.

These percentages allotted to land use, shore type and substrate also helped to determine the overall segment classification used above. For example, a segment may be recorded as 80% urban residential and 20% natural, may have resulted in an overall qualifier of urban development.

4.1.3 Riparian Foreshore

The riparian area along the foreshore was also described for each segment during the survey. Riparian foreshore classification included the following drop down list of qualifiers to select for describing the segment of interest:

Riparian Class – coniferous forest; broadleaf forest; mixed forest; shrubs; herbs/grasses; exposed soil; natural wetland; disturbed wetland; row crops; and, rock.

Riparian Qualifier – natural; agriculture; urban residential; recreation; disturbed; unknown; and, other.

Riparian Stage – low shrubs <2m; tall shrubs 2-10 m; young forest; mature forest; and, old forest.

Shore Cover – none; sparse (<5%); moderate (5-20%); and, abundant (>20%).

Riparian Veterans and Snags – none; <5; and, >= 5 (large veteran trees and wildlife trees, respectively).

The riparian area was also qualified by estimating the amount of riparian band width within a 30 m zone and the slope of the bank along the foreshore; these values were qualified and not directly measured. Overhanging vegetation and submergent/emergent aquatic vegetation was also qualified as present/absent during the survey for each segment.

4.1.4 Littoral Zone

The littoral zone of the overall segment was classified as shallow, moderate or steep (Appendix A) based on a qualitative assessment and depth observed on the boat's depth sounder. Spawning habitats appropriate for salmonids were also qualified as suitable, unsuitable or unknown for each segment.

4.1.5 Modifications

The existing modifications were also described and enumerated for each segment surveyed in 2008. Modifications included docks, retaining walls, groynes, boat launches, marine

railways and marinas (Table 5). Each of these modifications was counted during the 2008 survey for each segment. The dominant material used for docks, retaining walls and groynes were also qualified (Appendix A). The number of modifications also contributed to the overall level of impact classification for each segment (Table 4). Figure 4 provides photographic examples of each of the modifications listed in Table 5 that were observed in the west arm during the 2008 survey.

Table 5: Foreshore modification qualifiers (RDCO 2005)

Modifications	Description
Docks	Long, narrow structures stretching into a body of water.
Retaining Walls	Structural walls with the primary function of supporting soil from behind or any caused by wave action.
Groynes	Protective structures of stone or concrete that extend from shore into the water to prevent a beach from washing away.
Boat Launches	Sections of foreshore dedicated to launching boats and removing boats with vehicles.
Marine Railway	Railway tracks used to lift boats in and out of the water or to adjacent boat houses.
Marinas	Harbours specially designed to moor a collection of boats.

4.1.6 Flora & Fauna

A description of any flora and fauna was also included for each segment during the 2008 survey, when applicable (Appendix A).

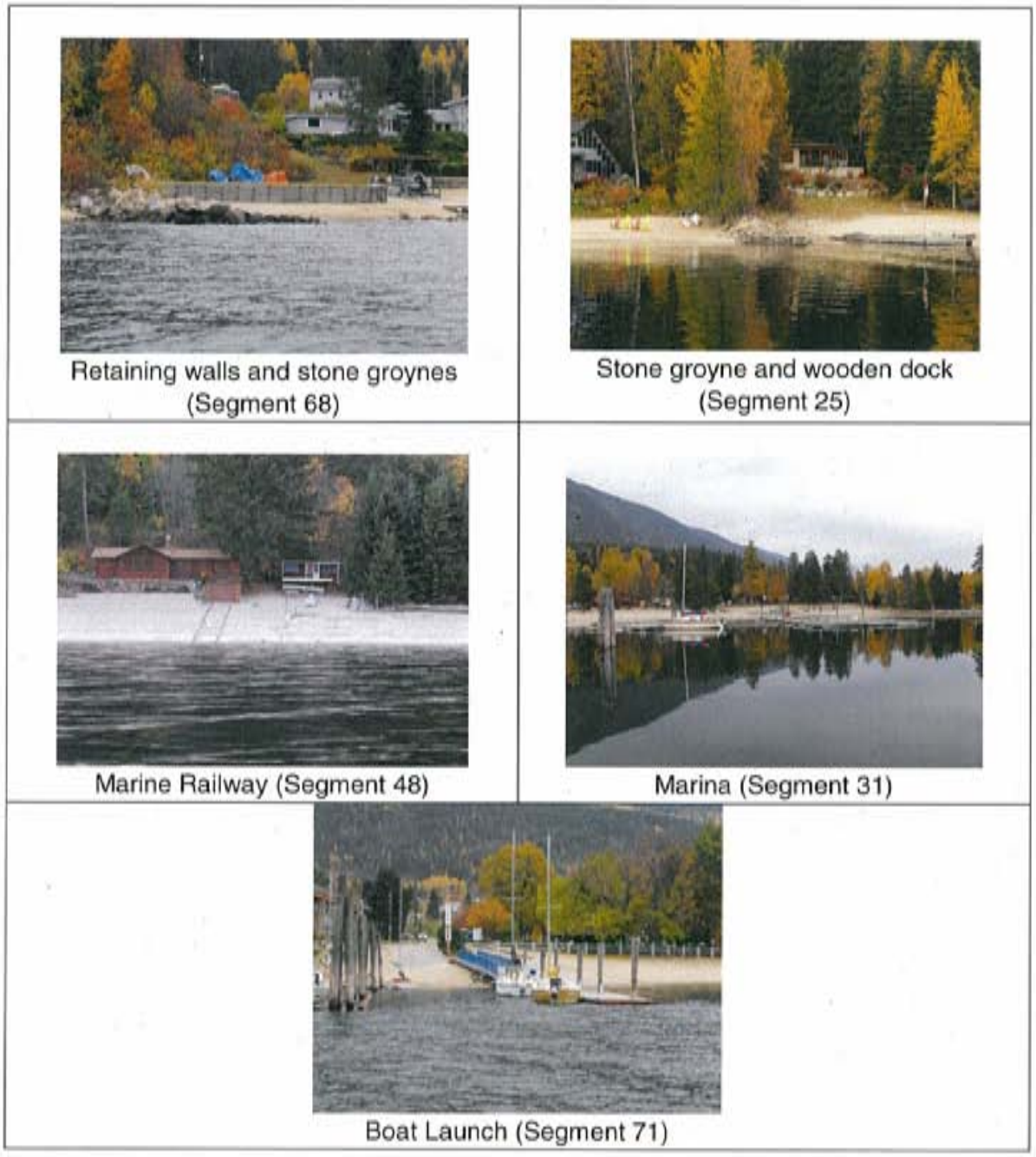


Figure 4: ***Examples of foreshore modifications along the West Arm of Kootenay Lake***

4.2 2002 Survey

In 2002, the area surveyed by DFO included the north shore of the West Arm from the big orange bridge in Nelson to Balfour (Appendix B – overview map). It also included small areas of the south shore at the Lasca Creek alluvial fan, a stretch between Eight Mile and Tunstall Creeks, and the Tunstall Creek alluvial fan (Appendix B – overview map). The 2002 survey was conducted using standard FIM methods from 20 to 21 March. However, the data dictionary used was a previous version from the one used during our 2008 surveys. Differences between data collected in 2002 versus 2008 are attributed to the differences in the data dictionaries used. The data dictionary used in 2008 was more complete and provided a better baseline standard than that used in 2002. However, data collected in 2002 was still useful for comparison between the two surveys.

The following are the differences in the 2002 survey compared to the 2008 survey methods (indicated above):

- Percent land use and shore type were not estimated for each segment;
- Riparian class was qualitatively described with a comment and drop down categories such as coniferous forest, broadleaf forest etc. were not included;
- Retaining walls were recorded as present/absent and continuous or discontinuous and not enumerated for each segment;
- Marinas and marine railways were not included or enumerated; and,
- Railway lines along the foreshore were not noted.

Data collected in 2002 was conducted by DFO-Nelson and is available at:

http://204.244.79.12/mapguide2009/kootenay/kootenay_frameset.php. Data files for survey comparisons were provided in excel from Brad Mason (DFO, Vancouver, B.C.).

4.3 GIS Analysis & Map Development

The GPS was downloaded and 2008 survey information was converted to .shp files in Trimble Pathfinder Office for further processing. GPS points were initially post-processed, however, this eliminated a large portion of the data. Therefore, uncorrected data was used for further analyses and is similar to that used for other lake surveys (e.g., Windermere and Slocan lakes). The uncorrected data has an accuracy of between 5 and 10 m, which is adequate for the FIM assessment (B. Mason, pers. comm., 2008).

Section breaks and other point features were interpolated using GPS data, overlaid with TRIM level lake line work and available imagery. The result being lake shore sections shaped as TRIM lakes, segmented by corrected GPS section breaks. The lakeshore sections depicted in Appendix B (Maps 1 through 14) should be used for cartographic purposes and larger scale mapping may require further refinement. Orthophoto imagery was not available at the time of map/report production (J. Heath, Terrasaurus Ltd, pers. comm., 2009) and therefore could not be included in our final maps. Offsets used during the

field survey were automatically incorporated by the Trimble unit and further processing was not warranted.

Maps were developed using ArcView GIS and 2008 segments were plotted by level of impact designation. A segment having a High level of impact designation was delineated as 'red', Medium as 'yellow', and Low as 'green'.

The total linear distance (meters) surveyed was calculated in ArcView GIS and divided into each segment surveyed to allow for additional analyses and percentage calculations. This was completed for both 2002 and 2008 survey data, where applicable.

4.4 Data Analysis & Survey Comparisons

Segment data and GPS points collected in 2002 and 2008 were converted to Excel for further analyses (Appendix C, Table C1 and C2). Segments were grouped as location designations that were based on common area names that were obtained from general topographic maps of the West Arm (82 F/6, 82 F/10, 82 F/11) to facilitate comparisons between years and make it easier to describe an area.

Comparisons using linear distance were made between data collected during the 2002 and 2008 lake surveys, where applicable. However, due to different mapping priorities between years, a smaller section of the West Arm was surveyed in 2002. In order to make comparisons, only data for segments 1 through 46 could be compared between both 2002 and 2008 data sets which include the northshore of the West Arm of Kootenay Lake from the big orange bridge in Nelson to Balfour, near the confluence with the main body of the lake (Appendix B – overview map). Note that this is slightly different than the area referred to as the northshore in descriptions of 2008 data, which included areas which were not surveyed in 2002.

The linear distance for each overlapping segment surveyed during both years was totalled in order to calculate percentages for direct comparisons between years. Percent comparisons were made for land use, shoreline type, level of impact, riparian characteristics, substrate characteristics and foreshore modifications between years, where applicable. Only analogously collected foreshore characteristics could be compared, since slight differences were observed between the 2002 and 2008 data sets due to survey changes in 2008 (as described above).

5.0 RESULTS

The results of the 2008 survey are presented initially to describe information collected with the updated data dictionary. A comparison between the overlapping segments and features collected in both 2002 and 2008 follows the 2008 results.

5.1 2008 Survey

In total, approximately 85,349 m of foreshore area was surveyed from the Taghum Bridge (Highway 3A) to Queen's Bay along the West Arm of Kootenay Lake in 2008 (Table 6). The foreshore was divided into a total of 86 segments ranging from approximately 97 to 4900 m

(Appendix C, Table C2). Overall segment classification, percent land use, shore type and substrate, as well as riparian foreshore, littoral zone, modifications, and flora and fauna descriptions are provided in Appendix C, Table C2. Location designations for 2008 grouped segments and their representative photos are presented in Appendix D. A summary of predominant land use, shoreline type, level of impact and foreshore modifications observed in 2008 is provided below.

5.1.1 Land Use

Approximately half of the predominant land use adjacent to the foreshore in 2008 was classified as natural, followed by urban residential (35%), industrial (6%), park (5%), disturbed (4%), commercial (3%), and lastly agricultural (<1%) (Table 6). The section along the south shore from Sunshine Bay to Troup Junction (Appendix B, Maps 4-12) was classified mostly as natural (Figure 5), whereas the City of Nelson area was highly urban residential (Appendix B, Map 3; Figure 6). The main industrial and commercial areas were observed at Nelson (Figure 7), while the park and only agricultural areas were located at Kokanee Narrows Northshore and Taghum, respectively (Figure 8 and 9). Areas in Proctor and the Northshore at 1 mile were described as disturbed because new developments are in progress, but residences have yet to be constructed (Appendix B, Maps 3 and 4).

Table 6: Land uses adjacent to the shoreline of the West Arm of Kootenay Lake, 2008

Land Use	Length (m)	% of total
Natural	40,337	47.3
Urban Residential	29,523	34.6
Industrial	5,389	6.3
Park	4,439	5.2
Disturbed	3,181	3.7
Commercial	2,239	2.6
Agricultural	241	0.3
Total	**85,349**	**100.0**

Figure 5: Natural land use along the southshore in Segment 65 (Troup Junction)

Figure 6: Urban residential land use in Segment 70 (Nelson)

Figure 7: Commercial and industrial land use in Segment 74 (Nelson)

Figure 8: Park land use in Segment 32 (Kokanee Narrows Northshore)

Figure 9: Agricultural land use in Segment 79 (Taghum)

5.1.2 Shore Type

Approximately 35% to 40% of the predominant shore type in 2008 was classified as both sand beach and low rocky shore (Table 7). Cliff/bluff and vegetated shore comprised approximately 12% each of the shore type described for all the segments surveyed in 2008, whereas gravel beach accounted for only 3% (Table 7). All other shore types were not present in significant amounts (Table 7). Figure 3 illustrates the major shore types surveyed in the West Arm in 2008.

Table 7: Shore types along the West Arm of Kootenay Lake, 2008

Shore Type[a]	Length (m)	% of total
Sand Beach	32,564	38.2
Low Rocky Shore	29,142	34.1
Cliff/Bluff	10,716	12.6
Vegetated Shore	10,217	12.0
Gravel Beach	2,623	3.1
Unclassified	84	0.1
Alluvial Fan	0	0
Wetland	0	0
Total	**85,349**	**100**

[a]Alluvial fan and wetland shore types were not observed during the 2008 survey.

5.1.3 Level of Impact

The level of impact for the entire foreshore of the West Arm was distributed fairly evenly with approximately one-third of the entire shoreline length being classified each as low, medium and high (Table 8). Figure 3 (above) illustrates examples of low, medium and high level of impact designated for segments surveyed in 2008.

Table 8: Level of impact along the West Arm of Kootenay Lake, 2008

Level of Impact	Shoreline length (m)	% of total
Low	34,083	39.9
High	26,591	31.2
Medium	24,673	28.9
Total	**85,349**	**100%**

Locations within areas designated as having a low level of impact included the northshore from Taghum to Grohman Narrows (Segments 78, 80-82 and 84, Appendix B, Maps 1 and 2), Kokanee Narrows (Segment 32, Appendix B, Maps 9 and 10), a small section along the northshore of Harrop Narrows (Segments 39 and 40, Appendix B, Map 12) and most of the southshore from Sunshine Bay to Troup Junction (Segments 53, 54, 56 and 58-67, Appendix B, Maps 4-12); these were mostly comprised of parkland/agriculture/rural. Areas designated as having a medium level of impact included segments from Taghum and Grohman Narrows Provincial Park (Segments 76, 77 and 79, Appendix B, Map 1), Grohman Narrows Northshore and Burns Point (Segments 83 and 85, Appendix B, Map 2). Some segments along the Nelson Northshore to Queens Bay (Segments 3, 5, 6, 8, 10, 11, 15-18, 20, 25, 29, 35, 42, 44 and 45-47, Appendix B, Maps 3-14), Proctor (Segments 50 and 51, Appendix B, Map 14), and Harrop (Segment 57, Appendix B, Map 11) were also designated as having a medium level of impact. These areas were mostly comprised of a mixture of land uses which included some developed and some natural areas. Areas designated as having a high level of impact included segments along the majority of the northshore from

Burns Point to Queens Bay (Segments 1, 2, 4, 7, 12-14, 19, 21-24, 27, 30, 31, 33, 34, 36-38, 45, 48 and 86, Appendix B, Maps 3-14), Proctor (Segment 52, Appendix B, Map 14), Harrop (Segment 55, Appendix B, Map 11), and Horlick-Bealbys Point to the City of Nelson (Segments 68-75, Appendix B, Maps 3 and 4). These areas were composed mostly of urban residential land uses.

5.1.4 Riparian Characteristics

The predominant riparian class observed during the 2008 survey was mixed forest (76,742 m, 89.9%), followed by herbs/grasses (6,592 m, 7.7%), shrubs (1,917 m, 2.2%), and exposed soil (97 m, 0.1%). Herbs/grasses were found only in Nelson and Nelson Northshore (Appendix B, Maps 3 and 4), while shrubs were found along Northshore to 1 Mile and Shannon Point (Appendix B, Maps 3 and 4). Mixed forest was found in every other location surveyed, except the City of Nelson.

The predominant riparian stage observed during the 2008 survey was mature forest (72,980 m, 85.5%) followed by shrubs lower than 2 m (6,983 m, 8.2%), young forest (3,345 m, 3.9%), and tall shrubs 2 to 10 m (2040 m, 2.2%). Low shrubs and young forest were mainly found at the City of Nelson and Northshore at 1 Mile (Appendix B, Maps 3 and 4); tall shrubs were found at the City of Nelson and at Shannon Point (Appendix B, Maps 3 and 6). Mature forest was found in all locations, except the City of Nelson.

Riparian shore cover was mostly classified as abundant (39,951 m, 46.8%), followed by moderate (32,987 m, 38.7%), sparse (11,921 m, 14%), and none (488 m, 0.6%). Segments with sparse cover were located at the City of Nelson (Appendix B, Map 3) and between Nelson Northshore at 1 Mile and Crescent Bay (Appendix B, Maps 3-8).

The number of veterans in each segment was qualified as none, less than five, and more than five. Forty segments had more than five veterans (combined length of these segments was 51,508 m, 60.4% of total foreshore length), 28 segments had no veterans (18,299 m, 21.4%) and 17 segments had less than five veterans (15,540 m, 18.2%). The number of snags were accessed with the same scale and 50 segments had no snags (42,688 m of total foreshore, or 50%), 18 segments had more than 5 snags (28,066 m, 32.9%), and 17 had less than 5 snags (14,594 m or 17.1%). The locations that had neither veterans nor snags in any of their segments included Northshore to 1 Mile, the Northshore between 2 and 5 Mile, Kokanee Landing, and Nelson (Appendix B, Maps 3,4, and 10)

5.1.5 Shoreline Substrate Characteristics

The substrate of just under half of the foreshore surveyed in 2008 was composed of fines (Table 9). Boulder (22.3%) and cobble (20.4%) were the next most prevalent substrate, and both bedrock (8.2%) and gravel (2.9%) occupied less than 10% of the foreshore (Table 9). The majority of areas were composed of a mixture of substrate types. Some locations did, however, have segments composed entirely of fines. These locations included Shannon Point, Willow Point, Kokanee Narrows southshore, Atabara, Troup Junction, Horlick-Bealbys Point, and Grohman Narrows northshore (Appendix B, Maps 2-8).

Table 9: Substrate types and abundances along the West Arm of Kootenay Lake, 2008

Substrate	Shoreline Length	% of total
Fines	39,134	45.9
Boulder	19,031	22.3
Cobble	17,407	20.4
Bedrock	6,964	8.2
Gravel	2,517	2.9
Unclassified	294	0.3
Total	**85,349**	**100**

5.1.6 Foreshore Modifications

Foreshore structures observed during the 2008 survey included retaining walls, groynes, docks, marinas and marine railways. Figure 10 depicts the total number of foreshore modifications enumerated within all 86 segments surveyed along the West Arm in 2008. A large number of groynes (n=479) and docks (n=406) were counted with the highest numbers located at Burns Point (west end of Johnson Road, City of Nelson; Segments 85 and 86) and Proctor (Segments 49-52). Approximately 68 retaining walls were also enumerated with many observed in Burns Point (Segments 85 and 86) and Balfour (Segments 45 and 46). Fewer marine railways (n=48) and marinas (n=19) were observed throughout the West Arm compared to other modifications with the majority of marine railways located near Queen's Bay (Segments 47 and 48) and most marinas located along the northshore, especially along the Northshore between 2 Mile and 5 Mile (Segments 5-9) and Balfour (Segments 45 and 46) (Appendix C, Table C2).

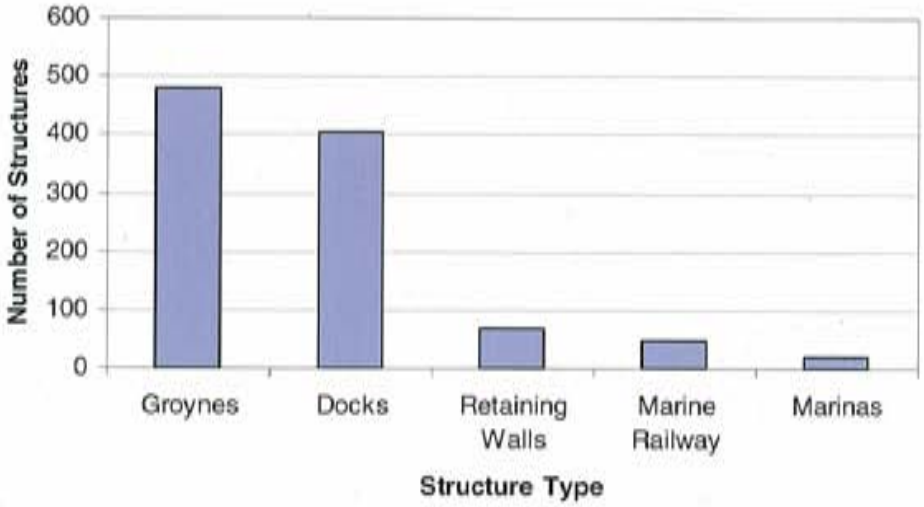


Figure 10: Total number of foreshore modifications along the West Arm of Kootenay Lake, 2008

5.2 Comparison between 2002 and 2008 Surveys

In 2002, only approximately 30% (36,863 m) of the surveyed 2008 foreshore length (85,349 m) was classified due to time constraints and DFO priorities to map the more highly developed areas. As mentioned previously, 2002 surveys focused on the northshore of the West Arm of Kootenay Lake with some locations along the east shore, which were related to a DFO assessment of rearing habitat (B. MacDonald, Section Head, DFO Nelson, BC, pers. comm., 2009). However, in 2008 the baseline survey classified the entire West Arm and included both the north and east shorelines. Therefore, comparisons between 2002 and 2008 surveys could only be made using segments 1 to 46 (Table 9) and are referenced as the northshore of the West Arm of Kootenay Lake.

It is important to keep in mind that the comparisons presented below are valid for only a portion of the West Arm that was comparable between years and do not represent the entire West Arm as a whole. Representative descriptions for the entire West Arm were provided above for 2008 results.

5.2.1 Location Designations

Location designations and their associated segment numbers surveyed in 2002 and 2008 are provided in Table 10. This table also includes total foreshore length by location designation. Even though the survey conducted in 2008 carefully divided up segments along the northshore to closely match those designated in 2002, some slight differences in starting/end points of each segment may have occurred therefore the resulting linear distances are not exactly the same (Table 10). Percentages have been used where possible to make comparisons relevant between years.

Table 10: Location designations and their associated segments along the West Arm of Kootenay Lake, 2002 and 2008. Areas denoted with "-" were not surveyed in 2002

Location Name	2008		2002	
	Segment Numbers	Foreshore Length (m)	Segment Numbers	Foreshore Length (m)
Taghum	78-79	1,690	-	-
Grohman Narrows (northshore)	80-84	4,193	-	-
Burns Point (Johnson Rd. access)	85-86	2,765	-	-
Northshore Nelson (1 Mile)	1-4	1,927	1-4	2,252
Northshore (2-5 Mile)	5-9	3,229	5-9	3,532
Shannon Point	10-14	1,884	10-14	1,529
Willow Point/ 6 Mile	15-19	2,799	15-19	3,144
McDonalds Landing	20	507	20	765
Cedar Point	21-24	2,659	21-24	2,673
Nine Mile Narrows	25-26	1,205	25-26	1,376
Crescent Bay	27-31	3,081	27-31	3,073
Kokanee Narrows (northshore)	32	2,629	32	2,891
Kokanee Landing	33-34	1,966	33-34	1,917

Location Name	2008		2002	
	Segment Numbers	Foreshore Length (m)	Segment Numbers	Foreshore Length (m)
Longbeach	35-36	2,055	35-37	2,022
Harrop Narrows (northshore)	38-41	2,244	38-41	2,157
Fraser Narrows	42-44	2,355	42-44	3,050
Balfour	45-46	4,487	45-46	2,537
Queens Bay	47-48	1,742	-	-
Proctor	49-52	4,808	-	-
Sunshine Bay	53-54	3,465	-	-
Harrop (southshore)	55-59	5,995	-	-
Kokanee Narrows (southshore)	60-61	4,237	-	-
Atbara (9 Mile Narrows southshore)	62	4,903	47, 50-51	3,137
Seven Mile Point	63-64	3,133	48-49	808
Troup Junction (5 Mile point)	65-67	3,939	-	-
Horlick-Bealbys Point	68-69	2,042	-	-
City of Nelson	70-75	5,761	-	-
Grohman Narrows Provincial Park	76-77	3,649	-	-
Total		**85,349**		**36,863**

5.2.2 Land Uses

The dominant land use type in both 2002 and 2008 was classified as urban residential accounting for approximately 60% and 75%, respectively, of the total foreshore length for the segments surveyed along the northshore that could be compared between both years (Figure 11). Photographs taken of the same location in Segment 2 (Nelson Northshore at 1 Mile) in 2002 and 2008 depict an increase in the density of residential dwellings (Figure 12). Other land use qualifiers such as natural and recreation remained similar between years (Figure 11). The percent length described as disturbed also increased in 2008 (Figure 11). In 2002, a 'modified' category was used that was not used in 2008. This modified category referred to areas that had observable work being conducted such as beach grooming or areas being prepared to make groynes and was slightly different than the disturbed category (T. Cashin, Environment and Land Use Manager, City of Kelowna Community Sustainability Division, pers. comm., 2009). However, these activities were included in the disturbed category in 2008.

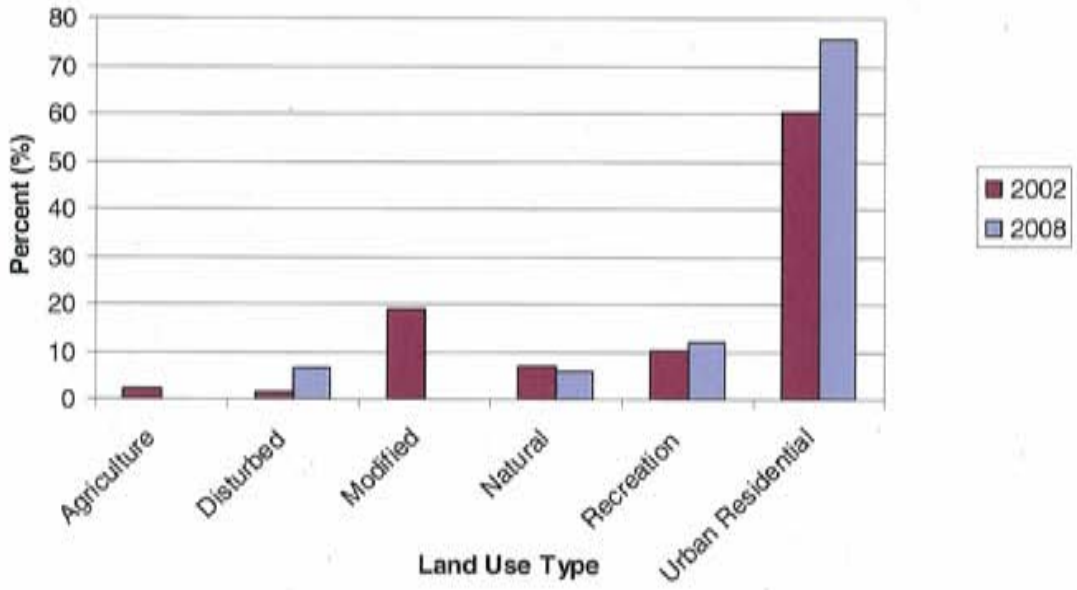


Figure 11: ***Percent land use type on the north shore of the West Arm of Kootenay Lake, 2002 and 2008***

2002

2008

Figure 12: ***Photos taken in Segment 2 (Nelson Northshore at 1 Mile) in 2002 (top) and 2008 (bottom). Note replacement of middle residence and addition of new docks and moorings***

5.2.3 Shore Type

The predominant shore type along the northshore of the West Arm of Kootenay Lake was sand beach (approximately 50%) followed by low rocky shore (approximately 40%) and cliff/bluff (approximately 3%) in both 2002 and 2008; these values remained similar between years (Figure 13). The amount of vegetated shore classified in 2008 was double that classified in 2002, whereas gravel beach was delineated in 2008 but not in 2002 (Figure 13).

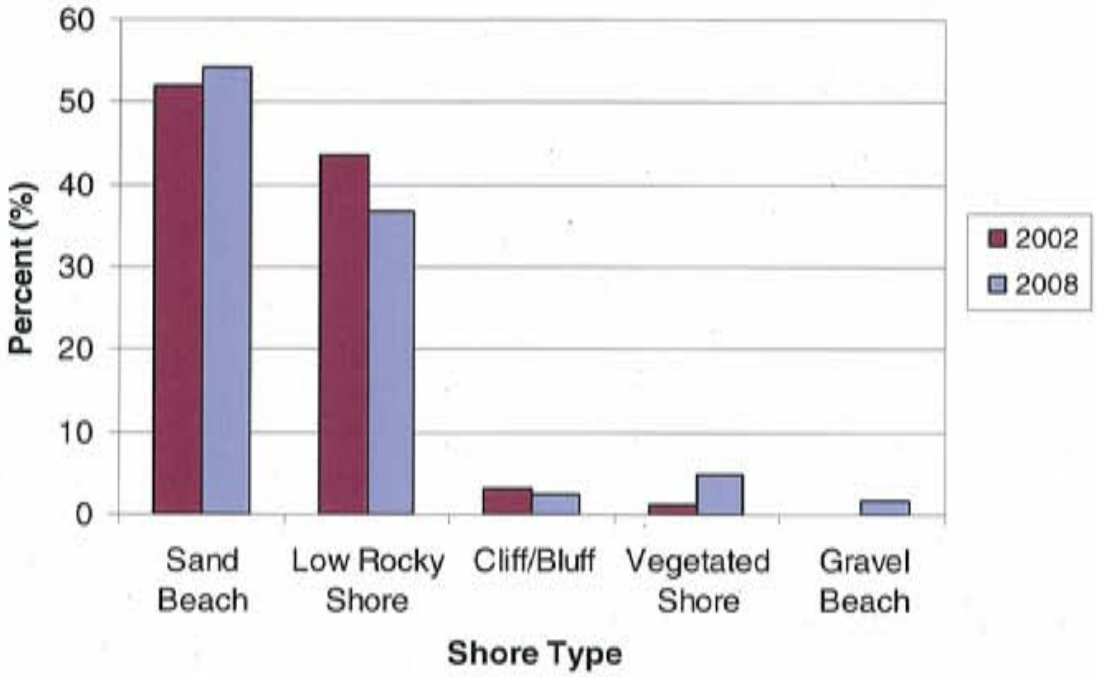


Figure 13: Percentage of foreshore occupied by various shoreline types along the northshore of the West Arm of Kootenay Lake, 2002 and 2008

5.2.4 Level of Impact

Overall, the level of impact designated as high along the northshore of the West Arm increased by approximately 5% from 2002 to 2008 (Figure 14). This corresponded with an approximate 6% decrease in areas designated as having a low level of impact from 2002 to 2008 (Figure 14). Approximately 50% of the northshore was designated as having a medium level of impact for both years, with an approximate 1% higher value in 2008 (Figure 14).

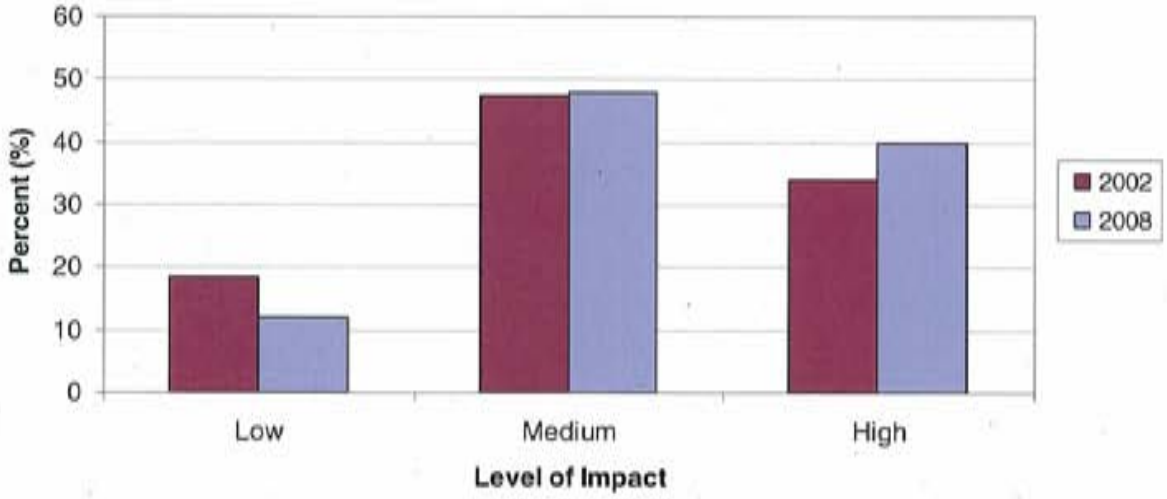


Figure 14: ***Proportion of the foreshore designated at low, medium or high level of impact along the northshore of the West Arm of Kootenay Lake, 2002 and 2008***

5.2.5 Riparian Characteristics

5.2.5.1 Riparian Band Width & Slope

In both survey years, the riparian band width was estimated along the foreshore for each segment. On average, the riparian band width decreased from 29 m in 2002 to 18 m in 2008 along the northshore of the West Arm that was comparable between surveys. Table 11 provides a summary of riparian band width for each location designation. Please note that estimates of band width were used and may not be repeatable between years or between surveyors. Therefore, a change in band width by 5 to 10 m may not be due to removal of riparian vegetation. However, larger changes over 10 m may indicate changes to the riparian area.

Table 11: Comparison of riparian band width along the northshore of the West Arm of Kootenay Lake, 2002 and 2008

Location	Segment	Riparian Band Width (m)		Change (m)
		2002	2008	
Nelson – Northshore (1 Mile)	1	30	30	0
	2	50	20	-30
	3	25	30	5
	4	10	30	20
	mean	**29**	**28**	**-1**
Northshore (2 Mile to 5 Mile)	5	20	10	-10
	6	0	10	10
	7	60	15	-45
	8	25	30	5
	9	30	0	-30
	mean	**27**	**13**	**-14**
Shannon Point	10	20	30	10
	11	15	10	-5
	12	25	0	-25
	13	60	0	-60
	14	80	20	-60
	mean	**40**	**12**	**-28**
Willow Point/ 6 Mile	15	10	10	0
	16	80	30	-50
	17	0	-	N/A
	18	10	30	20
	19	10	15	5
	mean	**22**	**21**	**-1**
McDonalds Landing	20	60	15	-45
	mean	**60**	**15**	**-45**
Cedar Point	21	30	15	-15
	22	40	10	-30
	23	0	20	20
	24	15	10	-5
	mean	**21**	**14**	**-8**
Nine Mile Narrows	25	10	20	10
	26	10	30	20
	mean	**10**	**25**	**15**
Crescent Bay	27	20	10	-10
	28	10	10	0

Location	Segment	Riparian Band Width (m)		Change (m)
		2002	2008	
	29	20	5	-15
	30	0	15	15
	31	0	20	20
	mean	**10**	**12**	**2**
Kokanee Narrows (northshore)	32	20	30	10
	mean	**20**	**30**	**10**
Kokanee Landing	33	80	0	-80
	34	30	0	-30
	mean	**55**	**0**	**-55**
Longbeach	35	50	30	-20
	36	10	10	0
	37	10	-	N/A
	mean	**23**	**20**	**-3**
Harrop Narrows (northshore)	38	20	20	0
	39	80	20	-60
	40	60	30	-30
	41	20	20	0
	mean	**45**	**23**	**-23**
Fraser Narrows	42	25	20	-5
	43	0	30	30
	44	0	30	30
	mean	**8**	**27**	**18**
Balfour	45	60	20	-40
	46	10	20	10
	mean	**35**	**20**	**-15**
Grand mean		**29**	**18**	**-11**

Overall, there has been a decrease in the riparian band width observed from 2002 to 2008 (Table 11). Of the 14 location designations listed above, 10 locations demonstrate a decrease in riparian band width (Table 11). The changes in riparian band width vary by location designation but also by segment and range from 5 to 80 m (Table 11). For example, along the Nelson northshore at 1 Mile there is an overall decrease by only 1 m between years. However, in Segment 2 riparian band width decreased from 50 m to 20 m between years, a change of 30 m (Table 11). In Segment 4 of this same location designation, there was an overall increase in riparian band width by 20 m (Table 11).

Larger decreases (between 20 and 80 m) in riparian band width were observed at: Segments 2 and 9 along the northshore between 2 Mile and 5 Mile; Segments 12, 13 and 14 at Shannon Point; Segment 16 at Willow Point (6 Mile); McDonalds Landing (Segment

20); Segment 22 at Cedar Point; Segment 33 and 34 at Kokanee Landing; Segment 35 at Longbeach; Segment 39 and 40 at Harrop Narrows (northshore); and, Segment 45 at Balfour (Table 11).

Small increases (approximately 10 to 15 m) in riparian band width were observed at: Segment 6 along the northshore between 2 Mile and 5 Mile; Segment 10 at Shannon Point; Segment 25 at 9 Mile Narrows; Segment 30 at Crescent Bay; Segment 32 at Kokanee Narrows (northshore); Segment 46 at Balfour (Table 11). Larger increases (approximately 20 to 30 m) in riparian band width were observed at: Segment 4 along the Nelson northshore at 1 Mile; Segment 18 at Willow Point (6 mile); Segment 23 at Cedar Point; Segment 26 at 9 Mile Narrows; Segment 31 at Crescent Bay; and, Segment 43 and 44 at Fraser Narrows (Table 11).

Although riparian bank slope (%) may also demonstrate changes along the foreshore, this measure was highly subjective and not directly measured so it was not used as a comparison for the current analysis. Also, the 2002 survey was conducted during lower water levels compared to 2008, which may also cause differences in estimated bank slope.

5.2.5.2 Riparian Stage

Changes along the northshore indicate a 6% decrease from 2002 to 2008 in the amount of shoreline classified as mature forest, the dominant riparian stage in both years (Table 12). Young forest also decreased, while both low (8%) and tall (1%) shrubs increased in 2008. Riparian shrubs were mainly found at the City of Nelson and along the northshore opposite Nelson, from 1 mile to Shannon Point (Appendix B, Maps 3-5). These areas were almost entirely classified as mature forest in 2002 (Appendix C, Table C1).

Table 12: Comparison of riparian stage along the northshore of the West Arm of Kootenay Lake, 2002 and 2008. "-" denotes not recorded

Riparian Stage	2002		2008	
	Length (m)	% of total	Length (m)	% of total
Mature Forest	28,629	87	26,705	81
Young Forest	3,823	12	3,345	10
Tall Shrubs (2-10m)	-	-	250	1
Low Shrubs (<2m)	-	-	2,724	8
Not Classified	467	1	-	-
Total	**32,919**	**100**	**33,023**	**100**

5.2.5.3 Veteran Trees & Snags

A comparison between the number of veteran trees and snags along the northshore of the West Arm was not currently conducted, since the surveys were completed at different times of the year and results would not be comparable. For example, Figure 12 illustrates that the number of veteran trees and snags enumerated in 2008 may have been underestimated compared to 2002 because of the foliage still on the trees.

5.2.5.4 Riparian Cover

Comparisons were made between the percent riparian cover, though slightly different scales were used in 2002 and 2008. In 2002, a percent cover greater than 33% was considered abundant and a percent cover between 5 to 33% was considered moderate. In 2008, greater than 20% was considered abundant, and 5 to 20% was considered moderate. In both survey years, percent cover less than 5% was considered sparse.

Overall, there was an approximate 20% decrease in the amount of foreshore classified with abundant riparian cover observed from 2002 (45%) to 2008 (25%) (Figure 15). This decrease corresponds to the increase in the amount of foreshore length classified with moderate riparian cover observed in 2008 (Figure 15). However, due to differences in classifying abundant cover between years, the loss of abundant cover apparent during the 2008 survey may be underestimated. The foreshore length classified as having sparse riparian cover remained similar between years at approximately 18% (Figure 15). Also, the amount of unclassified riparian cover in 2002 referred to Segment 17 that was described as a sandy beach (Figure 15).

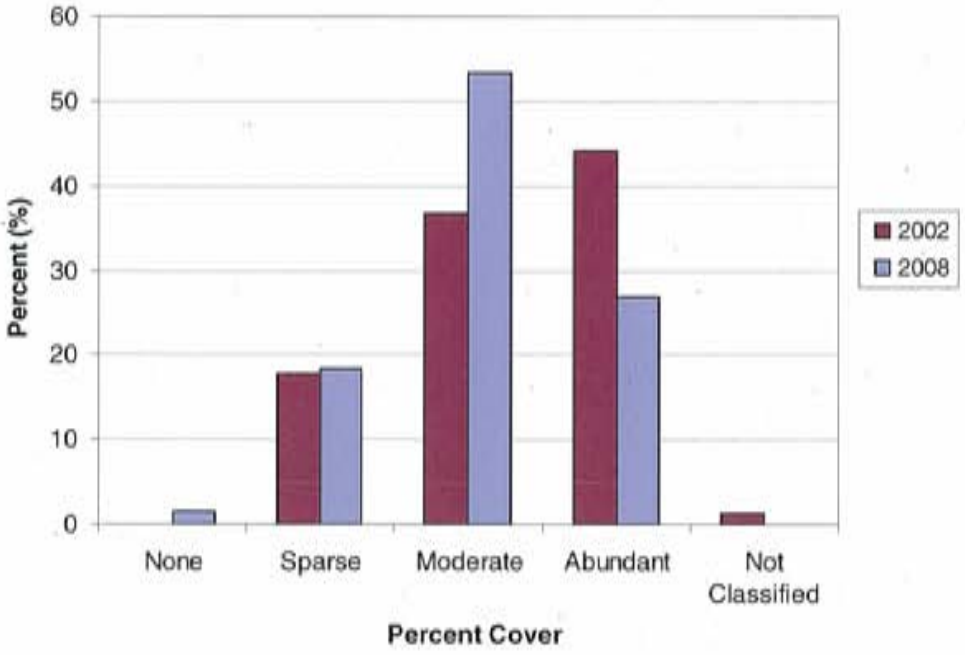


Figure 15: Percent riparian cover along the northshore of the West Arm of Kootenay Lake, 2002 and 2008. Note only one segment (17) was not classified in 2002

5.2.6 Shoreline Substrate Characteristics

Shoreline substrate characteristics were relatively similar between survey years, with fines being the predominant substrate (Table 13). The change in relative contribution of each substrate fluctuated only by 1 to 3% which may be attributed to surveyor differences.

Table 13: Comparison of substrate composition along the northshore of the West Arm of Kootenay Lake, 2002 and 2008. "-" denotes not recorded

Substrate	2002		2008	
	Length (m)	% of total	Length (m)	% of total
Fines	17,475	53.1	18,258	55.3
Boulder	6,995	21.2	74,80	22.7
Cobble	7,954	24.2	7,024	21.3
Bedrock	495	1.5	136	0.4
Gravel	0	0	0	0
Unclassified	-	-	126	0.4
Total	**32,919**	**100**	**33,023**	**100**

5.2.7 Foreshore Modifications

The number of foreshore modifications compared for each location designation enumerated in 2002 and 2008 is presented in Table 14. A direct comparison between the number of docks and groynes could only be made between years, since retaining walls, marinas and marine railways were not enumerated in 2002; retaining walls were just classified as present/absent (Table 14).

Since 2002, the numbers of both docks and groynes have increased by approximately 40% along the northshore of the West Arm of Kootenay Lake (Table 14). However, the number of docks may be artificially inflated due to the time of year both surveys were conducted. For example, floating docks may have still been present from the summer/fall recreation period in October 2008, whereas in March 2002 docks were most likely put away for the winter period. However, it is more than likely that the majority of docks do not get removed (B. MacDonald, pers. comm., 2009).

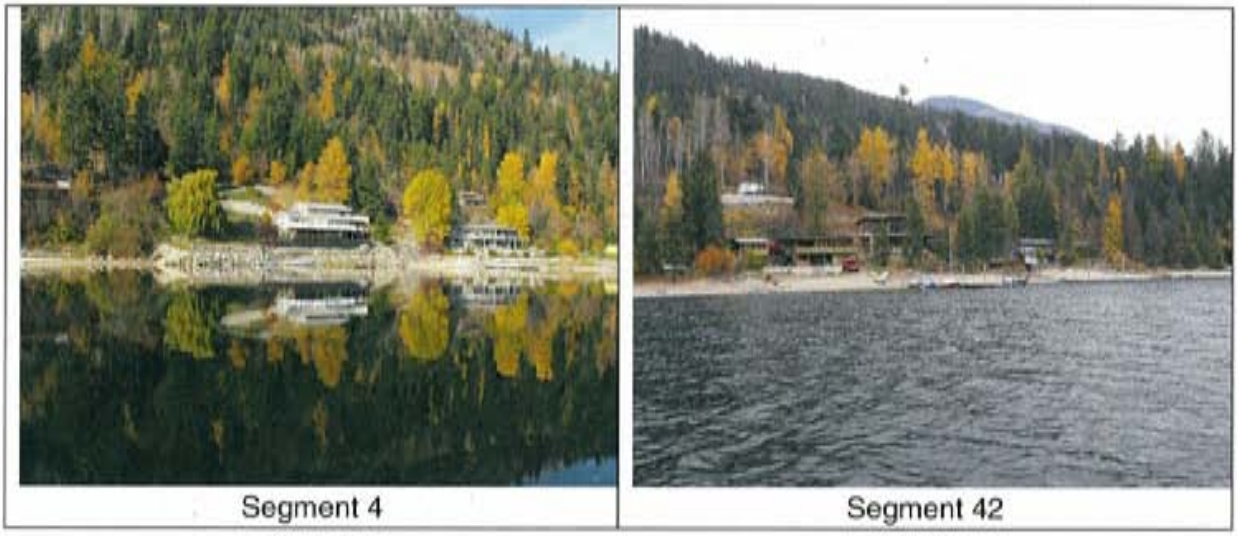
Even though the number of retaining walls could not be directly compared due to survey differences indicated above, a number of location designations that did not contain retaining walls in 2002 had retaining walls present in 2008 (Table 14 and Figure 16). The locations that did not have retaining walls along the northshore of the West Arm in 2002 included (number of retaining walls counted in 2008 are provided in parentheses):

- Nelson Northshore at 1 mile (n=4);
- McDonalds Landing (n=1);
- Fraser Narrows (n=3);
- Balfour (n=8); and,
- Atbara across from 9 Mile Narrows (n=1).

Balfour had the largest number of retaining walls built since 2002 followed by the northshore of Nelson at 1 mile and the Fraser Narrows (Figure 16). Areas that did not have any retaining walls observed both in 2002 and 2008 included Taghum, Kokanee Landing, Kokanee Narrows (east shore), Seven Mile Point, and Grohman Provincial Park; these are mostly natural areas or parklands (Table 14). In 2002, a retaining wall(s) was noted at the north shore of Kokanee Narrows but not in 2008; it is unknown if it was removed (Table 14).

Table 14: Number of foreshore modifications along the northshore of the West Arm of Kootenay Lake, 2002 and 2008. "-" denotes not recorded

	2002			2008				
Location	**Retaining Wall**	**Dock**	**Groynes**	**Retaining Wall**	**Dock**	**Groynes**	**Marina**	**Marine Railway**
Taghum	-	-	-	0	0	0	0	-
Grohman Narrows (northshore)	-	-	-	1	2	0	1	-
Burns Point	-	-	-	9	36	50	0	2
Nelson – Northshore (1 Mile)	No	1	15	4	20	30	1	-
Northshore (2 Mile to 5 Mile)	Yes	21	30	7	13	31	2	-
Shannon Point	Yes	39	38	2	11	20	0	-
Willow Point/ 6 Mile	Yes	9	19	4	24	35	1	1
McDonalds Landing	No	6	11	1	3	3	0	-
Cedar Point	Yes	16	33	4	13	42	0	2
Nine Mile Narrows	Yes	10	21	1	4	14	0	1
Crescent Bay	Yes	30	41	3	28	32	1	-
Kokanee Narrows (northshore)	Yes	9	12	0	0	0	0	-
Kokanee Landing	No	3	1	0	17	16	1	1
Longbeach	Yes	18	24	1	16	25	2	2
Harrop Narrows (northshore)	Yes	16	12	1	22	15	0	2
Fraser Narrows	No	40	24	3	30	35	1	-
Balfour	No	3	0	8	51	13	6	1
Queens Bay	-	-	-	1	1	12	0	20
Proctor	-	-	-	4	52	31	1	6
Sunshine Bay	-	-	-	2	8	3	0	4
Harrop (southshore)	-	-	-	3	28	27	0	5
Kokanee Narrows (southshore)	-	-		0	2	5	0	-
Atbara (9 Mile Narrows)	No	11	17	1	9	11	0	-
Seven Mile Point	No	2	1	0	0	0	0	-
Troup Junction (5 Mile point)	-	-	-	1	0	4	0	-
Horlick-Bealbys Point	-	-	-	3	7	14	0	1
Nelson	-	-	-	4	9	11	2	-
Grohman Provincial Park	-	-	-	0	0	0	0	-
Subtotal	**-**	**234**	**299**	**68**	**406**	**479**	**19**	**48**
Grand Total Modifications		**533**			**835**			**1020**



Segment 4 | Segment 42

Figure 16: Example of retaining walls in Segment 4 (Nelson Northshore at 1 Mile) and Segment 42 (Fraser Narrows)

6.0 SUMMARY & DISCUSSION

6.1 2008 Survey

The results of the 2008 survey of the West Arm of Kootenay Lake reveal that the majority of high impact development has occurred on the northern shore including the City of Nelson and its surrounding areas (Appendix B – overview map). For the entire West Arm in 2008, the most common land use was natural, the dominant shore type was sand beach, the highest number of foreshore modifications observed was groynes, and the majority (60%) of the foreshore had a medium to high level of impact. While the northshore had an overall medium-high level of impact, the majority of the southshore was classified as having a low level of impact and dominated by abundant, mature-mixed forest with veteran trees and snags. The CPR railway line which runs along most of the southshore is assumed to be the controlling factor for major new developments and thus retains its more natural state. Also, low impact areas between Harrop and Bealbys Point are boat access only, which may limit the number of developments here. Areas west of the City of Nelson such as Grohman Narrows and upstream of the Taghum Bridge (Highway 3A) on portions of the north and south shores remain undeveloped likely due to accessibility issues and parkland protection.

6.2 2002 vs. 2008

Although the entire West Arm of Kootenay Lake could not be compared between 2002 and 2008, the areas that were comparable are those that likely have the most development pressure. Overall, there was a 15% increase in the amount of land use designated as urban residential in 2008. This is consistent with level of impact rating which demonstrated a change in the amount of areas designated as low to high from 2002 to 2008. In fact, the number of permits issued by the Regional District of Central Kootenay (RDCK) for building

single family dwellings (SFD), mobile homes and some commercial buildings in the West Arm increased by approximately 50% since 2002 (Figure 17, RDCK unpublished). The number of building permits for SFD/mobile fluctuated between years with the lowest number of permits in 2002 (n=4) to the highest number in 2007 (n=25; Figure 17). The increase in urbanization observed in these comparison areas (i.e., northshore from City of Nelson to Balfour) may have negatively impacted the foreshore and fish and fish habitats for a number of reasons that are outlined below.

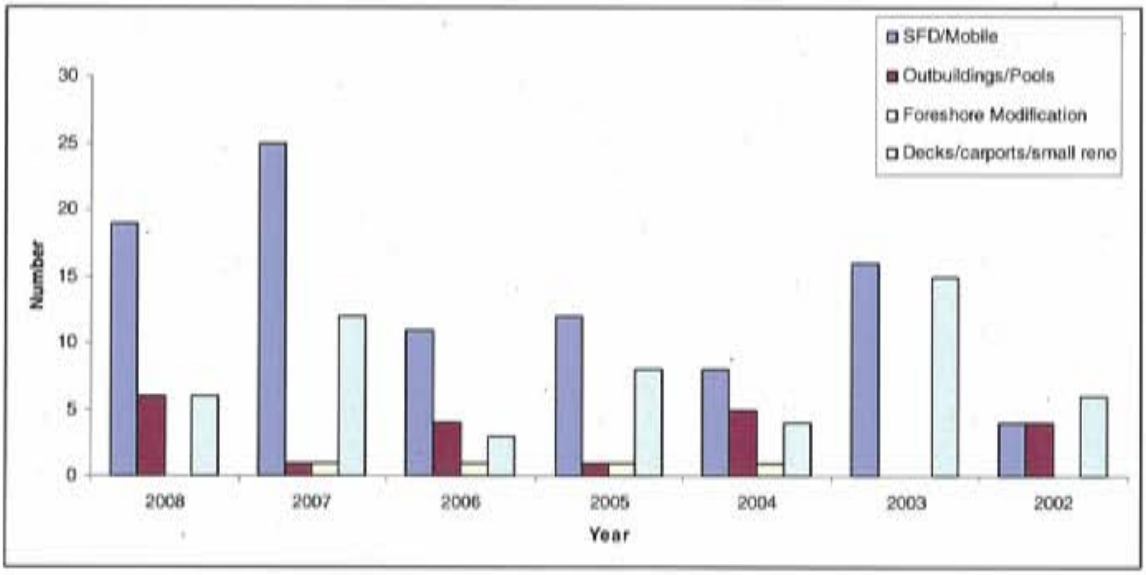


Figure 17: Building permits issued for the West Arm of Kootenay Lake from 2002 to 2008. SFD = Single Family Dwelling; Foreshore Modification includes retaining walls and pumphouses

First, there was an overall net loss in riparian vegetation and changes were observed in the quality of this riparian vegetation. Since 2002, there has been approximately a 20% decrease in the amount of riparian vegetation classified as abundant (> 30% cover) along the northshore. This also corresponded to an overall decrease in riparian band width by approximately 11 m. Although this amount may seem negligible, the extent of this loss ranged from 5 to 80 m depending upon the segment and location designation. The overall loss of riparian band width from 2002 to 2008 has not been compensated for by the gains observed between years (i.e., riparian vegetation had increased in some segments) because the quality of the vegetation has also been degraded from a mature forest to more shrub-type vegetation. In fact, an approximate 6% decrease in the amount of mature forest was observed from 2002 to 2008. In 2008, some segments did not contain any riparian cover along the foreshore. The riparian zone is considered fish habitat and the productivity of aquatic and riparian habitat is interlinked by reciprocal exchanges of material and therefore is directly important for healthy fish stocks (e.g., Naiman and Latterell 2005).

Second, the foreshore has been modified for recreation and for the protection of property lines (Figure 18). A 40% increase in the number of groynes was observed between 2002

and 2008, which may also be reflected by the increase in the classification of segments to sandy beach from low rocky shore between years. Groynes are often formed by beach grooming and shoreline protection activities that remove larger rocky substrates to clear an area of finer substrates (i.e., sandy beach). With an increase in the amount of the northshore classified as urban residential, it seems viable that more attractive beachfronts may be developed as a result. A lack of compliance with local beach grooming guidelines may exacerbate the rate at which beachfronts are developed (B. MacDonald, pers. comm., 2009). Also, current beach grooming guidelines for Kootenay Lake may not be appropriate (or should not apply) in some areas if SFD/mobile density increases and all adjacent property owners clear larger substrates to make a sandy beach. Adding sand fill or removing larger substrates such as cobbles and boulders to create sand beaches is a common practice for both permanent residences and holiday homes and the higher density residential areas were observed to mostly have sandy beaches during the 2008 survey (e.g., Photo #160, #490, and #551 on CD). Changing the substrates to contain more fines in certain areas may decrease the amount of preferred habitat used by various fish species. For example, larger cobbles and boulders can be used as cover from avian predators by juvenile fishes that are often found in the shallows feeding. Also, although shore spawning kokanee have been observed spawning in less preferred sand-gravel substrates (preference for gravel-cobble) along the foreshore at 6 Mile and 9 Mile (Redfish 2007), any beach grooming or substrate modification activities may impact larval survival in these areas.

Although a direct comparison of the number of retaining walls could not be made between years there was an apparent increase in some locations along the northshore during the 2008 survey. A total of 17 new retaining walls were enumerated in 2008 for areas that did not previously contain retaining walls in 2002. For example Balfour went from having no retaining walls in 2002 to eight in 2008. It is probable that the number of retaining walls along the northshore of the West Arm could have increased by more than these 17 that were newly counted in 2008, since retaining walls were just enumerated as present/absent in 2002 and a total count could not be compared between years. Even though the number of RDCK permits issued for foreshore modifications such as retaining walls and pumphouses in the West Arm remained relatively steady (averaged 1 per year) since 2002 (Figure 17), these statistics do not match our results since this average would only account for 7 new retaining walls in the past 7 years and not the 17 new retaining walls that were observed in 2008. The majority of foreshore property owners likely do not either know or ignore the fact that they need to obtain a permit for building retaining walls, docks and other structures along the foreshore (personal observations) and this may demonstrate a lack of stewardship ethic along the West Arm.

Foreshore modifications, such as marinas and marine railways, were not comparable between years due to survey differences but the survey conducted in 2008 can serve as a baseline for subsequent surveys. Also, an increase in the number of docks was evident in 2008. However, it is possible that these numbers are not entirely representative since homeowners along the shore often pull in their docks during the winter months. However, since the 2002 survey did not count the number of other modifications (e.g. marinas, marine

rail, railway, and retaining wall numbers) and our results could only be compared along the northshore, the extent of altered foreshore habitats remains uncertain.

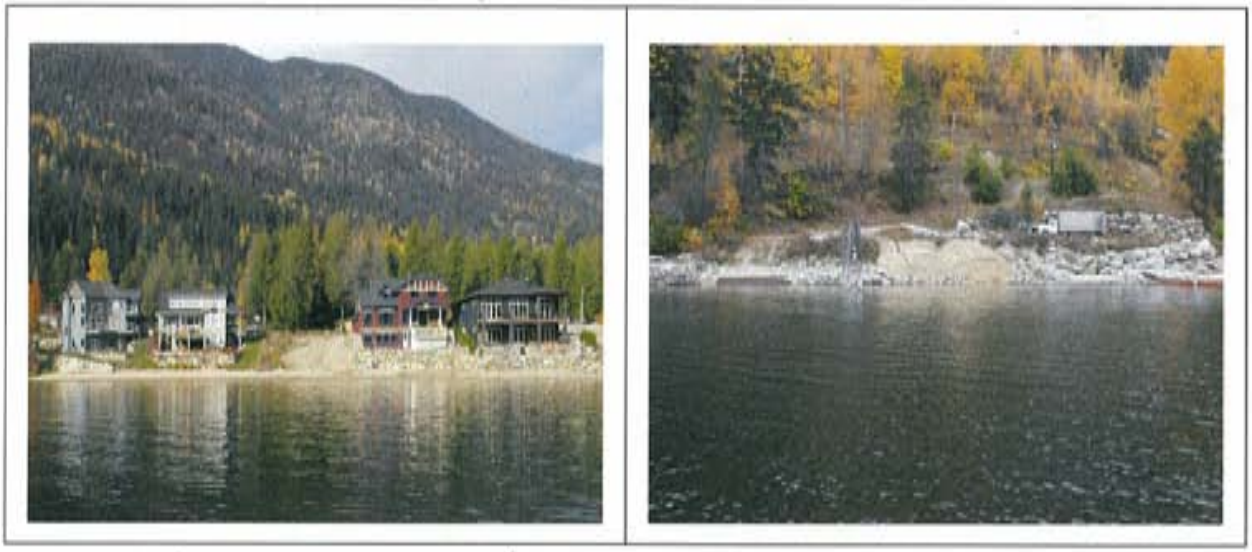


Figure 18: Developments along the northshore of the West Arm of Kootenay Lake including retaining walls and lack of riparian vegetation (left) and sand fill being dumped along the shoreline (right), 2008

6.3 Potential Impacts to Fish and Fish Habitat and Current Development in the West Arm

In general, foreshore modifications usually involve the removal of riparian vegetation and hardening the shoreline. Disruptions to the foreshore observed during the present survey included lack of riparian vegetation, sand fill dumped to the waterline, no fence separating agricultural areas from the shoreline, retaining walls along the shoreline, replanting of non-native and invasive vegetation, and homogenized substrate like sand beaches (Figure 18). These changes can impact adjacent fish habitat by increasing sedimentation and erosion, decreasing allocthonous and autocthonous inputs (i.e., food sources for fish and invertebrates), increasing run-off and introducing pollutants into the lake (e.g., MWLAP 2004, Naiman and Latterell 2005). However, the riparian habitat of lakes is almost universally ignored in management and conservation – an oversight with severe implications for the long-term productivity and the ability to support freshwater diversity (Naiman and Latterell 2005). Another impact of development is the removal of floating and emergent vegetation by dredging activities which can occur because of degraded water quality, increased shoreline disturbance due to recreation and boat wakes, and physical removal. The loss of this vegetation has been shown to reduce the natural buffering capacity of the shoreline, leading to erosion, and reduce fish production (Radomski and Goeman 2001). However, changes to aquatic vegetation within the shoreline were not presently conducted.

Current RDCK building requirements state that the minimum setback is 7.5 m from the natural water boundary. The natural boundary has been loosely defined as "the line along the foreshore where vegetation starts to grow." (RDCK 2007). Building must also be 1.5 m above the flood line (RDCK 2007). However, the land development guidelines put out by DFO and MOE indicate that between 15 to 30 m set back should occur from the high water mark (Chilibeck 1992). Clearly, the regional directive of 7.5 m versus the federal/provincial guidelines of 15 to 30 m is contradicting. The RDCK indicated that if construction is within 15 m of the natural boundary, DFO has jurisdiction over any alterations to riparian habitat, even if development has been approved (RDCK 2007). However, there appears to be no cooperation between the agencies and local governments to address growth impacts. Also, with varying jurisdictions taking precedence over different aspects of the same areas, it can be confusing for both developers and landowners to distinguish exactly what the requirements are. If the RDCK provides a permit to build, it is often taken as a blanket statement by the developer as a go ahead. Reduced funding to government agencies has hindered their ability to mitigate, monitor and prosecute infractions.

Local DFO/MOE offices in the Kootenay Region have tried to work with the RDCK on these issues; however, protection of the foreshore has not been successful as demonstrated by the results of this survey. On March 7, 2008 DFO and the Federation of Canadian Municipalities (FCM) signed a Memorandum of Understanding (MoU) on Fish Habitat Management to collaborate in the application of fish habitat protection provisions of the Fisheries Act (DFO 2009). This MoU also aims to promote sustainable development and stewardship through more effective and efficient conservation, protection and enhancement of fish and fish habitat. Implications of this new MoU stand to benefit the preservation of healthy fish habitat. It is important for municipalities to incorporate provisions from the Fisheries Act into their own lakeshore development requirements. For the RDCK, this would mean not approving development permits which are within 15 m of the foreshore until DFO has reviewed the impact on riparian habitat, or adjusting the minimum setback to a distance greater than 7.5 m to accommodate for the development pressures that such a close setback has on the foreshore. By agreeing to this MoU, both parties must now develop strategies to accomplish the outlined goals, most notably, the protection of fish and fish habitat.

Community planning also plays an important role in outlining what is necessary to ensure the long-term well being of communities as long as zoning development permit areas and bylaws are included. Currently, only RDCK Electoral Area F, stretching the northshore of the West Arm from Bonnington to Kokanee Creek has an Official Community Plan (OCP). Should it arise in the future that Electoral Area E (the remaining areas of the West Arm) adopts to create an OCP, information regarding requirements of the Fisheries Act should be provided during the planning process as well as the results of these surveys be used as baseline information.

With the increase in residential development and observed increases in foreshore modifications along the northshore of the West Arm of Kootenay Lake, decisions about the future of this area need to be made. As development in the West Arm area is expected to continue at a similar pace, a new strategy needs to be developed between local, provincial

and federal governments. The legislation to protect fish and fish habitat is sound and the "DFO mandate is simple and straight forward, however, it is hard to achieve adequate results when those mandates are juxtaposed to many conflicting mandates of other levels of government – especially the province and local governments" (Langer 2008). The public also plays a substantial role in maintaining the health of the West Arm. By respecting current regulations and embracing their role as lake stewards, it is the lakeshore homeowners and recreational users who can ultimately decide what the future holds for the West Arm of Kootenay Lake.

7.0 RECOMMENDATIONS

The following recommendations were made based on the results of the 2008 baseline survey and comparison between years.

1. Create an updated set of GIS maps (as per Appendix B) using updated orthophoto imagery. These updated maps will provide more detail and actual segment characteristics can be viewed. Orthophoto imagery was not available for the current report (J. Heath, Terrasaurus Ltd, pers. comm., 2009).

2. It is suggested that if future lake surveys occur, they should happen at the same time of the year as previous surveys. There are seasonal variances in the amount of the foreshore and foreshore modifications exposed due to fluctuating water levels; riparian coverage can be over or underestimated; and some foreshore modifications (e.g. docks) are removed at certain times of the year. By doing the surveys at the same time of year, these issues can be negated.

3. Continue the FIM process to come up with a foreshore management plan. This includes adding information on fish and fish habitats and sensitive areas to this baseline data and protecting areas that have high value fisheries.

4. Increase the minimum building setback in the RDCK. Changes need to be made to current permitting requirements to prevent future developments from further impacting the foreshore. A further setback would inherently decrease the impact on the foreshore by leaving more natural shoreline than is currently required. A minimum setback of 15 to 30 m (following the Chilibeck 1992) is suggested.

5. Include provisions to address alterations to the riparian zone in RDCK development permitting. Though DFO has jurisdiction over any alterations made to the riparian zone 15 m from the natural boundary, development permits can currently still be approved in this area.

6. Increase public awareness about the permitting required for the creation of foreshore modifications in the RDCK. Many West Shore residents do not seem to be aware that they are legally obligated to obtain a permit before building structures such as retaining walls, docks, and groynes along the foreshore. Information on building regulations and the penalties associated with not following them needs to be provided to near shore residents.

7. Foster stewardship so that residents living along the foreshore and in surrounding communities play a role in lake management initiatives.

8. Increase compliance and enforcement by all levels of government for those foreshore activities that are not permitted or allowed.

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