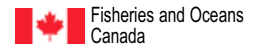




CENTRAL OKANAGAN LAKE FORESHORE INVENTORY AND MAPPING

FINAL REPORT





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FINAL REPORT
OCTOBER 2005

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A PROJECT FUNDED BY:

Regional District of Central Okanagan, The Real Estate
Foundation, The City of Kelowna, Ministry of Environment,
Fisheries and Oceans Canada and The District of Lake
Country.



In the summer of 2004, the Regional District of Central Okanagan, in partnership with Ministry of Environment, City of Kelowna, District of Lake Country, The Real Estate Foundation and Fisheries and Oceans Canada, conducted a detailed inventory of the foreshore of Central Okanagan Lake. The aim of the project was to categorize the foreshore according to near shore and upslope characteristics such as foreshore morphology, land use, existing riparian condition, and anthropogenic alterations. The project used Global Positioning System (GPS) technology and detailed digital shoreline video to capture foreshore characteristics.

The results show that integrity of the foreshore has been compromised by residential and urban development, as well as by agriculture, parks, industrial, and commercial uses. Over half of the foreshore area has been disturbed through anthropogenic alterations, including lake infilling, beach grooming, shoreline armoring, riparian vegetation removal, and shoreline development. This has led to widespread degradation and fragmentation of foreshore habitats that are relied upon by a variety of aquatic and terrestrial species. Despite these foreshore impacts, almost half of the foreshore within the study area remains undisturbed, which presents challenge and opportunity in the management of foreshore habitats.

Kokanee shore-spawning activities on Central Okanagan Lake are commonly associated with cliff/bluff and low rocky shore types that have either boulder- or bedrock-dominated substrates. Areas that are not as highly used for spawning include gravel beaches and vegetated shorelines, although limited spawning does occur in these areas. Most of the recorded spawning locations were associated with areas characterized as low or moderate disturbance level.

The information collected will be provided to local and senior government agencies to assist in the management of the foreshore (including adjacent upland) ecosystems. It will aid in developing regulations, standards, policies, education materials, and other management tools and will promote strong community stewardship and awareness. It will also serve as a benchmark for agencies by documenting land use and riparian habitat changes, providing evidence for regulatory investigations, and assessing objectives set out in foreshore protection initiatives. Recommended actions include: developing a foreshore protection plan, identifying and protecting critical areas, prioritizing activities, addressing modifications and monitoring.

The following report is presented in three parts. Part I summarizes the state of the foreshore of Central Okanagan Lake including results, discussion, and recommendations. Part II presents an analysis of the foreshore data in conjunction with existing kokanee shore-spawning data. Part III includes the technical methodology, technical recommendations, and detailed descriptions of the foreshore segments.



This report is the result of a continued belief by many organizations, including the Regional District of Central Okanagan, that if sensitive ecosystems are to be protected, they must first be identified. The project would not have been possible without Fisheries and Oceans Canada's Habitat Conservation Stewardship Program and the continued support and guidance of the Ministry of Environment.

We would like to thank the following organizations for making the project a success:

- Fisheries and Oceans Canada helped guide the development of the lakeshore methodology and continue to provide technical support for related projects.
- The Ministry of Environment contributed financially, provided boat support for the field component, and provided up-to-date kokanee spawning data.
- The BC Conservation Foundation provided the boat operator who was invaluable for locating historic kokanee shore-spawning locations.
- The City of Kelowna Environment Division contributed financially and provided the services of their Watershed Coordinators to collect data for the field component.
- The City of Kelowna Parks and Recreation Division provided backup equipment for the project.
- The District of Lake Country contributed financially and provided the services of their Planning Technician to give local expertise and knowledge during the field component of the project.

We would also like to extend a special note of appreciation to the Real Estate Foundation of British Columbia for their generous financial contribution and continued support.

This project would not have been possible without the assistance of the following agencies and staff:

- BC Conservation Foundation - Nick Ipatowich.
- City of Kelowna - Mark Watt, Tracy Guidi, Michelle Kam and Fred Schaad.
- District of Lake Country - Mike Reiley and Paul Wolanski.
- Fisheries and Oceans Canada - Adrian Wall, Brad Mason, Michael Crowe, and Bruce Runciman.
- Ministry of Environment - Steve Matthews and Andrew Wilson.
- Regional District of Central Okanagan - Ken Arcuri, Jason Johnson, and Rhodri (Hodge) Keogh.
- Community Mapping Network.

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Financial and In-kind Contributions	Regional District of Central Okanagan The Real Estate Foundation of BC City of Kelowna District of Lake Country Ministry of Environment BC Conservation Foundation Fisheries and Oceans Canada
Recommended Citation	Regional District of Central Okanagan, 2005. Okanagan Lake Foreshore Inventory and Mapping: Volume I. Kelowna, BC.

ACRONYMS & ABBREVIATIONS



DL	Disturbance Level
GIS	Geographic Information System
GPS	Global Positioning System
Lake Country	District of Lake Country
NMEA	National Marine Electronics Association
North Westside	RDCO North Westside OCP Area
RDCO	Regional District of Central Okanagan
OCP	Official Community Plan
SHIM	Sensitive Habitat Inventory and Mapping
SEI	Sensitive Ecosystem Inventory
The City	City of Kelowna
TRIM	Terrain Resource Information Mapping
Westside	RDCO Westside OCP Area
MoE	Ministry of Environment

DEFINITIONS



Beach Grooming	The removal of native coarse substrate materials within the foreshore, usually to promote or maintain recreational use of the area.
Carrying Capacity	The capacity of a lake to accommodate recreational use (e.g., boating, skiing, bathing) and residential occupation of the foreshore and adjacent upland areas without excessive overcrowding, pollution, and consequent danger to human health and safety.
Continuous Retaining Wall	A retaining wall that is contiguous over adjacent property boundaries and is counted as one retaining wall.
Discontinuous Retaining Wall	A retaining wall that is confined to a single property.
Disturbance Level	A subjective measurement, categorized as Low, Medium, or High, of the overall health of the foreshore. Disturbance level is based on visual observations of the foreshore and upland areas according to disturbance, beach grooming, and presence of retaining walls, docks, groynes, and marinas.
Foreshore	The part of a shore that lies between the highest and lowest watermarks.
Marine Railways	Railway tracks used to lift boats in and out of the water or to adjacent boat houses.
NMEA Output	The information transmitted from a marine electronic device to a computer or to other equipment. The National Marine Electronics Association has developed a specification that defines the interface between various pieces of marine electronic equipment.
Segment	Linear section of lake foreshore and adjacent upland area that has similar characteristics, including shore type, substrate, riparian vegetation, land use, modifications, and density of development.
Upland	The terrestrial area adjacent to the foreshore.



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**CENTRAL
OKANAGAN LAKE
FORESHORE INVENTORY
AND MAPPING**

PART I
STATE OF THE FORESHORE

REPORT PREPARED BY Regional District of Central Okanagan Planning Services Department
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A PROJECT FUNDED BY Regional District of Central Okanagan, The Real Estate Foundation,
The City of Kelowna, Ministry of Environment and The District of Lake Country.



The Okanagan Valley has long been the focal point of southern British Columbia for residents and tourists. The uniqueness of the landscape, mild climate, and scenic nature have made it a place of social, recreational, economic, and environmental importance. Of particular importance, and the focus of this report, is the link between the aquatic and terrestrial environments along Okanagan Lake. The foreshore – the part of the shore between the high and low watermarks – has significant biological, ecological, and social significance to residents of the Okanagan Basin (human and otherwise) and is extremely sensitive to disturbance. Foreshore ecosystems function upon intricate relationships to provide living space for permanent and transitory species and to support primary production and food webs (Batelle, 2001). Many provincially listed threatened and endangered species rely on these ecosystems throughout the Okanagan Valley (BC Species and Ecosystems explorer, 2005). The ability of these ecosystems to maintain function is often determined by their relative stability and resiliency to disturbance (Smith, 1992).

Historically, the long-term effects of foreshore disturbance were not well understood, resulting in inadequate protection, a cumulative loss of foreshore habitats, and ultimately, public and agency frustration over management of the foreshore. There are numerous reasons for such widespread frustration: the difficult task of coordinating a large-scale effort in managing resources over multiple jurisdictions and agencies; lack of inter-agency cooperation and program integration; limited funding resources; and limited consequences for foreshore degradation. These challenges often lead to further frustration by landowners, developers, and government staff alike. Foreshore ecosystems in the Okanagan continue to be the subject of development pressure, which further compromises ecosystem functions. The lack of comprehensive information on foreshore ecosystem relationships makes foreshore management difficult.

The Central Okanagan has become the most heavily urbanized area in mainland British Columbia outside the Lower Mainland. A steady influx of people is straining the capacity of land and water resources to meet human demand throughout the valley, with the greatest pressures being experienced in urban centres along Okanagan Lake. Degradation of water quality and declining water quantity throughout the Okanagan basin have been attributed to increased urbanization (and agricultural land use), but there is little likelihood of reprieve as the population continues to grow. Some of the areas most sensitive to urbanization are those located along the foreshore of Okanagan Lake. Red-listed ecosystems such as the black cottonwood–water birch plant association (BC Species and Ecosystems Explorer, 2005) support a wide variety of threatened and endangered species, such as the yellow breasted chat, and are often critical to the completion of species' life cycles.

Definition of Foreshore

The foreshore is defined here as the part of the shore that lies between the highest and lowest watermarks on a given water body.

Problem Statement

Problem Statement cont'd

A coordinated approach is critical if foreshore ecosystems are to be preserved for future generations.

Background to the Foreshore Inventory & Mapping Project

Regionally, foreshore degradation on Okanagan Lake is difficult to manage. In general, only high priority foreshore modifications and disturbances are investigated by governing agencies because of a lack of coordinated inter-governmental foreshore protection policies and reduced staffing and funding levels for enforcing violations. Public education has long been a priority in the mandates of resource managers at all levels of government, yet public awareness, understanding, and involvement in foreshore protection issues are persistently low. In addition, incentives for foreshore protection are also lacking.

One of the greatest challenges to changing past practices is found in the varying degree of scientific information and expertise that resides in agencies responsible for foreshore management. Where information does exist, it is often limited in detail, scope, availability, and comprehensiveness, making it exceedingly difficult for resource managers to make educated, informed decisions on a local scale. It has become apparent that a coordinated approach is critical if foreshore ecosystems are to be preserved for future generations.

In response to the continual increase in foreshore development along Okanagan Lake and to address the current lack of foreshore data, the Regional District of Central Okanagan (RDCO) initiated the Central Okanagan Lake Foreshore Inventory and Mapping Project in 2004.

The geographic area of the project was defined by the RDCO boundaries, within which the priority areas of partner agencies were inventoried and mapped. Thus, the study area included priority areas of the RDCO, the City of Kelowna, the District of Lake Country, and the Ministry of Environment (Figure 1, Study Area Map on following page). The priorities of MoE include the historic and recent occurrences of kokanee shore-spawning locations on Okanagan Lake. The north end of the lake, and the southern basin were not included in the study area.

The RDCO Planning Services Department is turning its focus toward the development of regulations, guidelines, education, and other management tools to protect habitats and species in settlement areas. For example, recent development has prompted the RDCO to identify aquatic and terrestrial development permit areas.

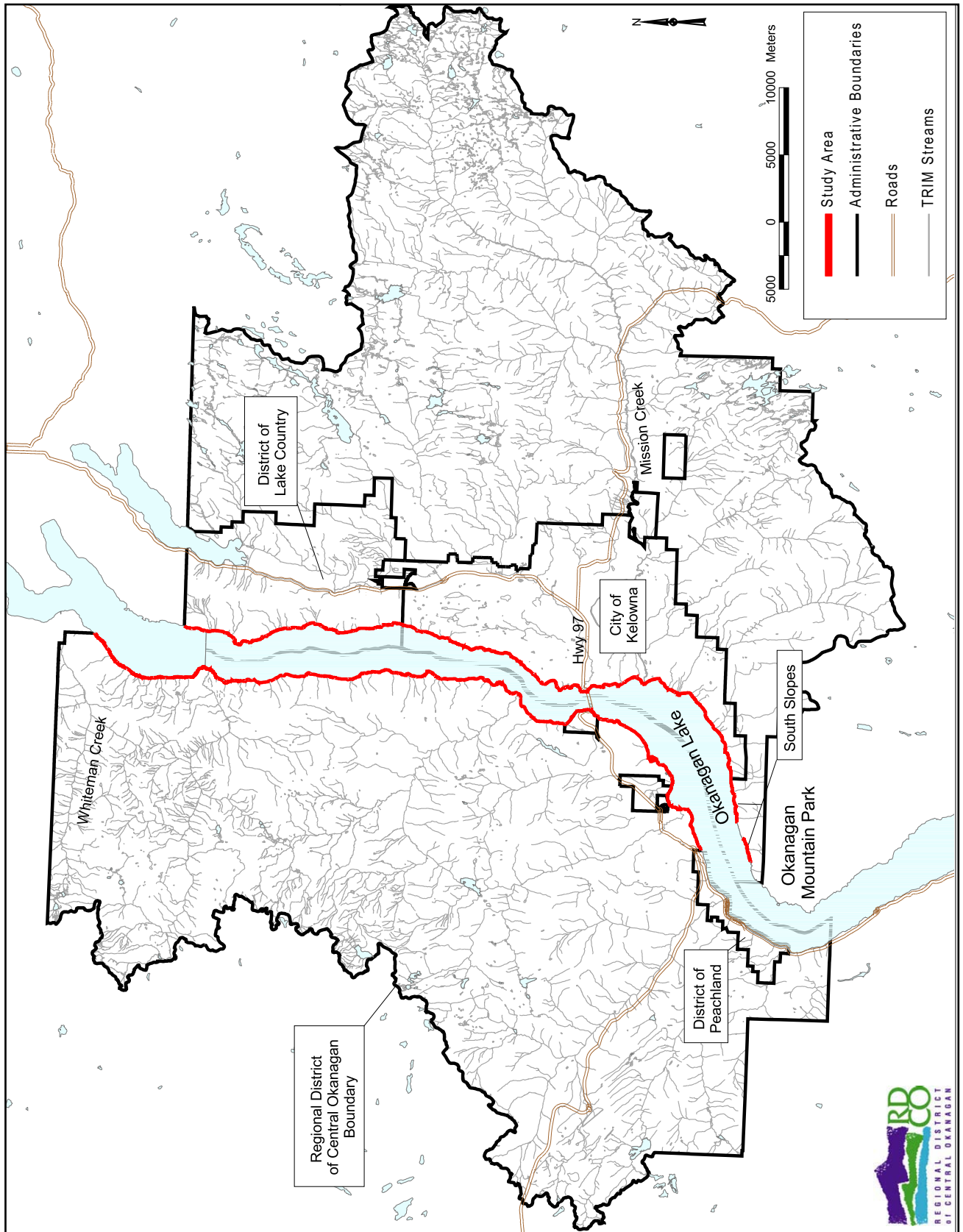
The goal of these areas is to protect sensitive habitats by requiring developers to follow specified policies and guidelines when working within the development permit areas (RDCO, 2004). The development permit areas were delineated based on the Sensitive Habitat Inventory and Mapping (SHIM) (Mason and Knight, 2001) and Sensitive Ecosystem Inventory (SEI) (Iverson and Cadrin, 2003), projects undertaken by the RDCO.

The SHIM mapping has been successful in accurately documenting sensitive habitats throughout the Central Okanagan, but it focused largely on stream and riparian corridors, whereas the SEI mapping documents sensitive terrestrial habitats. To augment the SHIM project, provide further information for refining the development permit areas, and to better manage foreshore habitats, the RDCO began applying SHIM methodologies to lakes.

Beginning in 2002, the RDCO was instrumental in developing Foreshore Inventory and Mapping methodology with the aid of Fisheries and Oceans Canada. This methodology was first used on Osoyoos Lake and has been under revision following similar projects on Christina and Kootenay lakes.

Figure 1.

Overview of Study Area



Purpose of the Foreshore Mapping & Inventory Project

The Central Okanagan Foreshore Inventory and Mapping Project is intended to address objectives established by regional strategies on the basis of scientific evaluations and site-specific data compiled through the project. A number of local, regional, provincial, and federal documents were reviewed during this inventory, including but not limited to the following:

- Regional Growth Management Strategy
- Okanagan Lake Action Plan
- Okanagan Shuswap Land Resource Management Plan

The objectives found in these strategies are the foundation of the project and will guide the discussion and recommendations sections at the end of this document.

The purpose of the Central Okanagan Lake Foreshore Inventory and Mapping project is to provide baseline information for future decision-making about development of the central Okanagan Lake foreshore. The project is intended to help partnering agencies identify the ecological condition of the foreshore, evaluate resource values, and explore conservation and restoration opportunities associated with lakeshore habitats. The information will be useful for local, regional, provincial, and federal organizations when addressing development issues related to foreshore sensitivity.

The project will also provide agencies with an easily accessible inventory of land use, shore type, existing riparian condition, and anthropogenic alterations along central Okanagan Lake. It will aid in developing land use policies, regulations, and standards and is intended to increase long-term environmental planning capabilities for the protection of aquatic and riparian habitat within existing local government land use planning programs. The project will serve as a benchmark for regulatory agencies by documenting current foreshore condition, and it will also provide evidence for regulatory investigations and will assess objectives set out in foreshore protection initiatives.

Objectives of the Foreshore Mapping & Inventory Project

The objectives of this project are to:

- provide an overview of foreshore habitat condition on central Okanagan Lake;
- inventory foreshore morphology, land use, riparian condition, and anthropogenic alterations on central Okanagan Lake;
- obtain spatially accurate digital video of the shoreline of central Okanagan Lake, made available through a Geographic Information System (GIS);
- develop an easily accessible GIS database on the ecological integrity of the central Okanagan Lake foreshore;
- collect information that will aid in prioritizing critical areas for conservation and/or protection;
- make the information available to planners, politicians, and other key referring agencies that review applications for land development approval.



Study Area

The study area includes 121 km of central Okanagan Lake foreshore within the RDCO in the Southern Interior of British Columbia. The area encompasses both sides of Okanagan Lake from Okanagan Mountain Provincial Park (to the south) to the RDCO boundary (to the north) (Figure 1, opposite). The study area includes the administrative boundaries of the District of Lake Country (Lake Country), the City of Kelowna (City), the RDCO Westside OCP Area (Westside), the RDCO North Westside OCP Area (North Westside), and an additional 7.5 km section of shoreline on the South Slopes between Okanagan Mountain Provincial Park and the City boundary. Data were also collected for Tsinstikeptum First Nations lands I.R. #9 and I.R. #10; however, these are not summarized as part of the results.

Throughout the study area, segments of 100-2600 m were identified according to foreshore morphology. The inventory and mapping results from these segments are summarized in Part I of the report for each of five administrative areas (RDCO Westside OCP Area, RDCO North Westside OCP area, RDCO South Slopes, District of Lake Country and City of Kelowna). Part III includes a detailed description of each segment and provides a summary of the ecological and social importance of specific segments of the foreshore.

Note: The segments are based on shoreline morphology and may straddle administrative boundaries.



City of Kelowna (right) and Westside OCP area (left) comprise almost half of the study area.

Photo: B. Magnan

Field assessments were conducted on June 22, 23, 24, and 25, 2004 aboard the Nerka K (MoE – Okanagan Lake Action Plan sampling boat). The survey team followed the shoreline from an optimal distance of 60 m and at a speed of 4 knots. The entire shoreline was recorded using digital video. A GPS unit was used to delineate foreshore segments, which are contiguous sections of shoreline that are determined by similar foreshore characteristics including land use designation adjacent to the foreshore, shore type, foreshore condition and modifications, and disturbance level (see Tables 1-5, on the following pages, for detailed descriptions). All of the information collected was input into the final database via field cards and the GPS unit.

There are no land use definitions consistent across all jurisdictions in the study area. The land uses that were recorded for this project (Table 1) were obtained from local zoning bylaw maps and cross-referenced into the database. Land use designations determine the type of activity that may occur on the land, with each designation having different effects on the land.

Field Assessment

Table 1.

Land use adjacent to the foreshore

Land Use Designation	Purpose
Institutional	To accommodate administrative, institutional, and service uses.
Crown	To accommodate forest and resource management uses on large parcels that are generally within the Forest Land Reserve.
Industrial	To accommodate industrial activities.
Agricultural	To accommodate agricultural operations and related activities on parcels that are usually located on the Agricultural Land Reserve.
Commercial	To accommodate a mix of commercial, retail, recreation, and service uses primarily intended for Town Centre areas.
Park	To accommodate active recreation, community oriented cultural centres, and some associated uses.
Urban Residential	To accommodate varied density residential use with some associated uses.
Rural	To accommodate agricultural and rural uses on parcels that are 0.5 ha or greater and located outside the Agricultural Land Reserve.

Table 2.

Predominant shore types as defined by the Resources Inventory Committee (1999a)

Shore Type	Description
Cliff/Bluff	Adjacent to steeper slopes, usually indicating a steep-sided lake basin or sudden drop-off.
Sand Beach	Often associated with alluvial fans or other shoreline deposition areas.
Gravel Beach	Often associated with low gradient foreshore, coves with pockets of riparian vegetation among steeper hillsides, or alluvial fans. Often associated with low gradient foreshore, coves with pockets of riparian vegetation among steeper hillsides, or alluvial fans.
Vegetated Shoreline	Characters 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.
Wetland	Characteristic of wide littoral zones with fine substrates promoting abundant emergent vegetation such as sedges, reeds, and cattails.



Cliff/bluff



Vegetated Shore



Sand Beach



Low Rocky Shore



Wetland



Gravel beach

Table 2.

Examples of predominant shore types.

Photos: T. Cashin

Condition	Description
Natural	Shoreline is unmodified.
Disturbed	Foreshore has been modified through human alteration.

Table 3.

Foreshore Conditions

Table 4.

Foreshore modifications

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 Railways	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.

As a method of qualifying the overall health of the foreshore, each segment was assigned a value describing disturbance level (DL). The DL is a qualitative measurement of the overall health of the foreshore and can be categorized as Low, Medium, or High (Table 5). The DL is based on visual observations during the assessment, including attributes from the database such as percent disturbed, retaining wall number and type, docks per kilometre, groynes per kilometre, beach grooming, and presence of marinas.

Table 5.

Disturbance level

Disturbance Level	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.
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.



Disturbance Level: High



Disturbance Level: Medium



Disturbance Level: Low

Table 5.

Examples of Disturbance Levels

Photos: T. Cashin

The report is presented in three parts. Part I contains an overall summary of results for the study area and individual summaries for each of the five administrative areas. Individual data were not summarized for Tsinstikeptum I.R. #9 and I.R. #10. Part II contains a case study highlighting the relationship between existing kokanee spawning locations and the foreshore data collected as a part of this project. Part III contains technical methods, technical recommendations, and detailed descriptions of each segment.

Presentation of Results

Appendices contain the following information:

- Appendix A: A key to the field headings in the Arcview foreshore database.
- Appendix B: A hard copy of the database.
- Appendix C: Video documentation of the shoreline (on DVD).
- Appendix D: Photo documentation, Arcview shapefiles for the foreshore and kokanee spawning databases, and field site cards for each segment (all on CD-ROM).
- Appendix E: Foreshore summary maps showing segment locations and characteristics.
- Appendix F: Summary map of kokanee spawning locations.
- Appendix G: Data tables with details for all figures presented in Part I.

Notes to the Data User

The information in this report is intended to provide an overview of the state of the foreshore of central Okanagan Lake within the RDCO boundaries. To use the information appropriately, it is important to recognize the conditions under which the data were collected and the situations in which the information is intended to be applied. The data are intended to aid in the management of foreshore ecosystems on a broad scale and do not preclude the need for site-specific visits to detail or clarify the information contained herein. The following describes the conditions under which the dataset was compiled. The user should understand these conditions when determining the applicability of the dataset to specific circumstances.

- The data were collected from a boat. Percentages (e.g., % disturbed) were based on visual observations of field personnel and are estimates rather than direct measurements. For example, a number like 80% disturbed is an estimated percentile rather than a physical measurement of the length of disturbed foreshore within the segment.
- Segment breaks have been interpolated from GPS locations onto existing Terrain and Resource Information Management (TRIM) line work with the aid of local cadastral and land use maps. Segment break locations are applicable at a large scale only, and may require further refinement at smaller scales.
- Associated maps are intended to be used only at the scale provided (Appendix E and F). See digital shapefile data for more detailed information and accurate delineation of segments (Appendix D).
- The video component of this project was linked to a coordinate system to the best available accuracy as budgeted by time and monetary constraints. The conditions in which the video was taken must be taken into account in order to assess the accuracy of the latitude and longitude information associated with the video files (See Technical Methodology section in Part III).



Video documentation of the shoreline was captured for the entire study area and includes GPS coordinates, heading, speed, date and time.

Photo: C. McKillican



Physical Characteristics of the Study Area

In total, 121,886 m of foreshore were surveyed and divided into 165 contiguous segments. Less than half of the total foreshore length is in natural condition and more than half is disturbed (Table 6). North Westside and City of Kelowna each have over 35,000 m of foreshore, with natural conditions occurring on two-thirds of North Westside’s foreshore and on one third of City of Kelowna’s foreshore (Figure 2). Westside has just over 20,000 m of foreshore, approximately one-third of which remains in natural condition. District of Lake Country has nearly 18,000 m of foreshore, of which just over half is natural. The South Slopes and Tsinstikeptum areas each have slightly less than 5,000 m in total. Over 80% of the South Slopes foreshore is natural, while only 2% of Tsinstikeptum foreshore remains in natural condition (Figure 2).

Foreshore	length (m)	% of total
Disturbed	63,837	52
Natural	58,049	48
Total foreshore	121,886	100

Table 6.

Total disturbed and natural shoreline for the Central Okanagan.

Land use on areas adjacent to the foreshore is primarily rural, with park and urban residential each accounting for 20% (Figure 3). The remaining land uses are commercial, agricultural, industrial, Crown, and institutional, each occupying <10% of adjacent lands.

Shore type is divided among gravel beaches, which represent one-third of the foreshore, and cliff/bluff, sand beach, and vegetated shore, each representing one-fifth of the foreshore (Figure 4). Low rocky shore makes up the bulk of the remaining foreshore, with wetland accounting for <1%. Throughout the study area, there are nearly 700 retaining walls and over 1,000 docks for a frequency of nearly 10 docks/km (Figure 5). Additional foreshore modifications include 125 groynes, 64 boat launches, 46 marine railways, and 8 marinas.

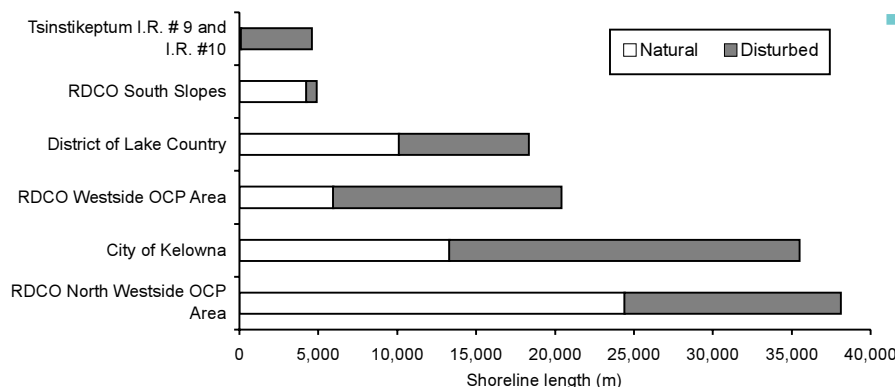


Figure 2.

The length of natural and disturbed foreshore in each administrative area.

Figure 3.

The land use on areas adjacent to the foreshore for the study area.

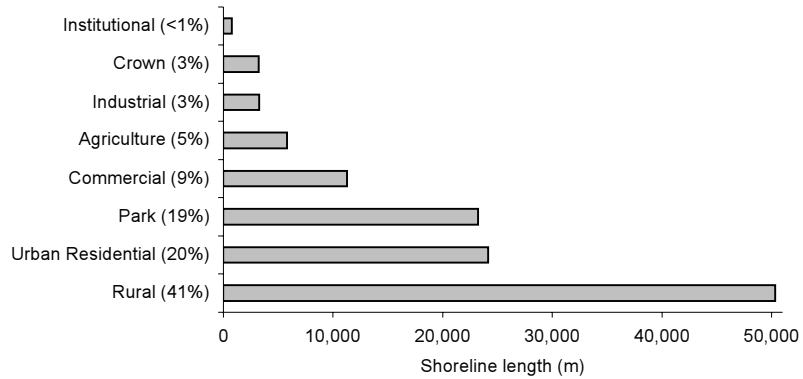


Figure 4.

The length of each primary shore type in the study area.

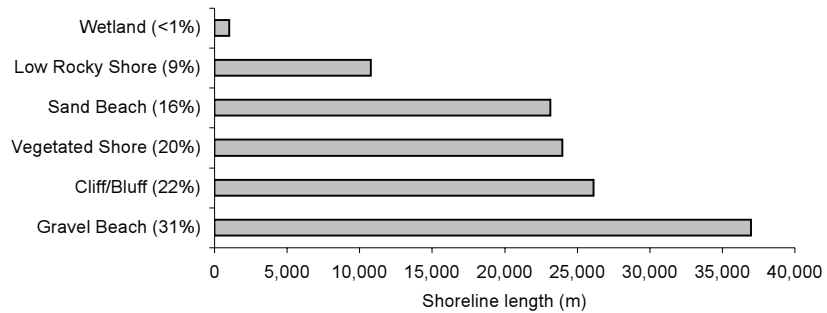
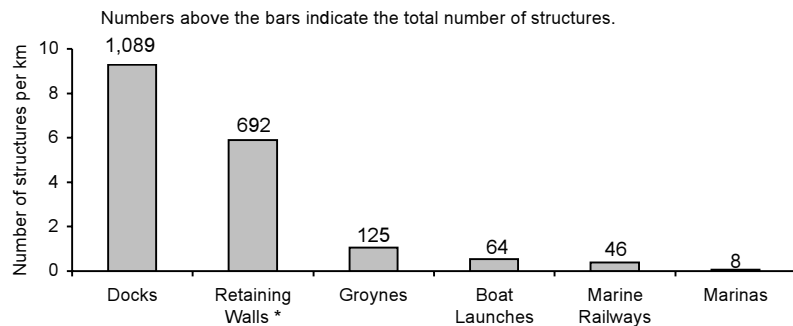


Figure 5.

Modifications along the foreshore of the study area.



* Retaining walls per km is not accurate representation as length of retaining wall was not determined.

The RDCO South Slopes area is located on the south side of Okanagan Lake between Okanagan Mountain Provincial Park and the City of Kelowna boundary.

Only three segments were surveyed in the South Slopes for a total of 4,909 m. Shorelines in this area remain primarily natural as access is limited to the privately owned large holdings that make up most of the area. The majority of land use is rural, with some agriculture occurring on flatter sites (Figure 6), accounting for most of the area’s disturbance. The South Slopes area is characterized by rocky outcrops and cliff/bluff extending into the lake, with gravel and sand beaches in small coves and alluvial fans (Figure 7). The majority of disturbance has occurred on gravel beaches (generally alluvial fans) where slopes are more suitable for building. In addition, this area was substantially affected by the Okanagan Mountain Park fire in 2003, which resulted in loss of most of the vegetation. Few modifications exist in this area as most of the foreshore remains undeveloped (Figure 8). The entire length of the South Slopes area was categorized as low disturbance level (Figure 9).

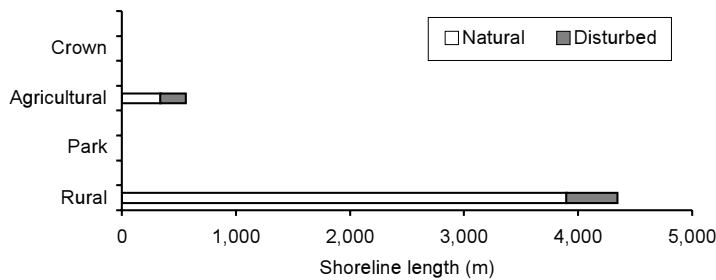


Figure 6.

The land use on areas adjacent to the foreshore in RDCO South Slopes.

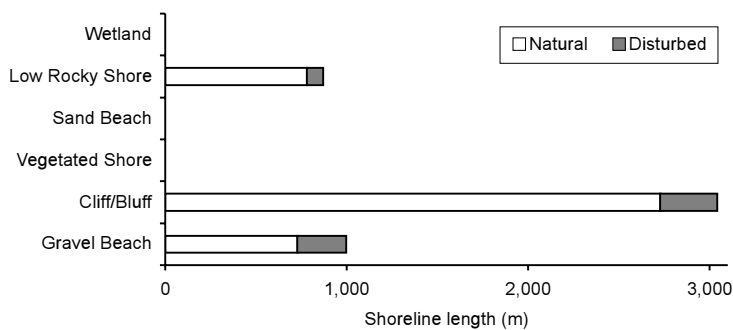


Figure 7.

The length of each primary shore type in RDCO South Slopes.

Figure 8.

Modifications along the foreshore in RDCO South Slopes.

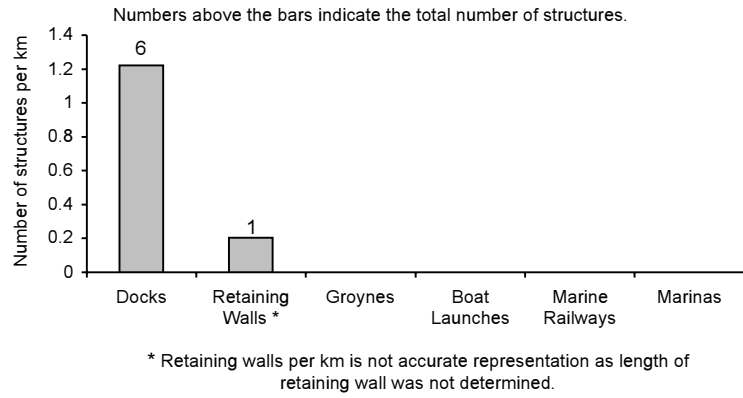
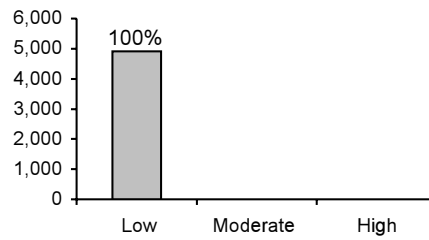


Figure 9.

The disturbance level of foreshore and upland areas in RDCO South Slopes.



Representative foreshore of Area 1 South Slopes

Photo: T. Cashin

The City of Kelowna area is bordered by the RDCO South Slopes to the south-west and the District of Lake Country to the north.

In the City of Kelowna, 52 segments were identified along a total surveyed shoreline of 35,505 m, and 63% of this was found to be disturbed. The majority of land along the City of Kelowna foreshore is considered rural, with urban residential and park also well represented (Figure 10). Disturbance within these land uses has occurred primarily in residential and park areas; however, those locations with commercial, industrial, and institutional land uses are completely disturbed (Figure 10).

Most of the foreshore within the City of Kelowna is sand beach, coinciding with the large alluvial fan of Mission Creek (Figure 11). The fan is bordered by steep hillsides and rocky slopes to the south and cliff/bluffs to the north. The cliff/bluff foreshore remains largely undisturbed since most of it falls within Knox Mountain Park. Areas comprised of sand beach are almost entirely disturbed, and as seen in other locations, they are easily developed due to gentle grades and easily disturbed soils (Figure 11). Numerous modifications have been made to the foreshore area, including the building of 392 docks, 241 retaining walls, and 4 marinas (Figure 12). Nearly 60% of the City's foreshore was categorized as having a high disturbance level (Figure 13).

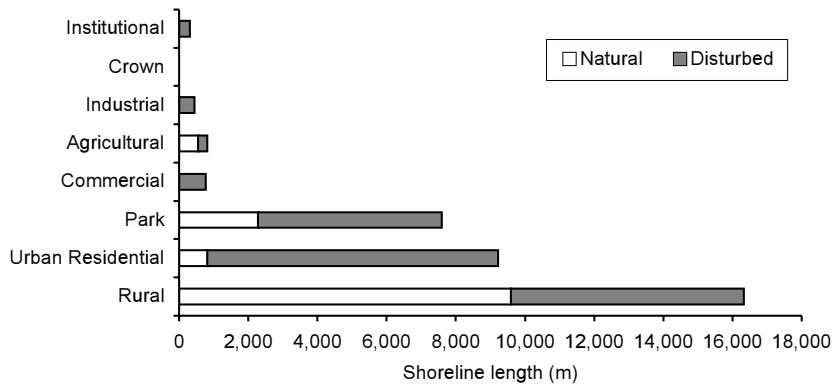


Figure 10.

The land use on areas adjacent to the foreshore in the City of Kelowna.

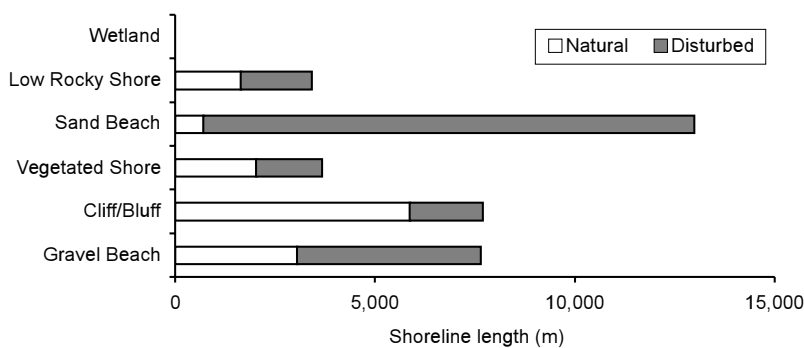


Figure 11.

The length of each primary shore type in the City of Kelowna.

Figure 12.

Modification along the foreshore in the City of Kelowna.

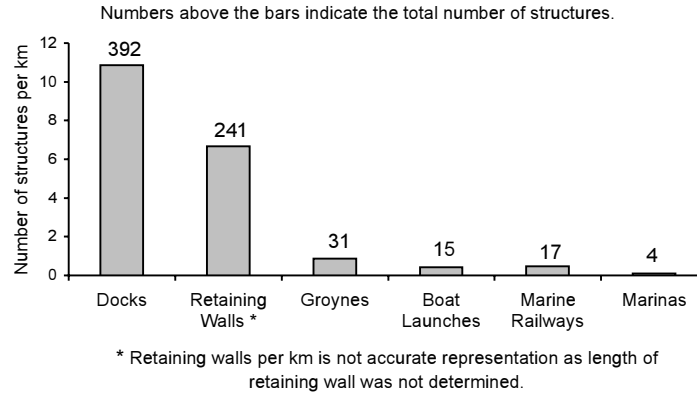
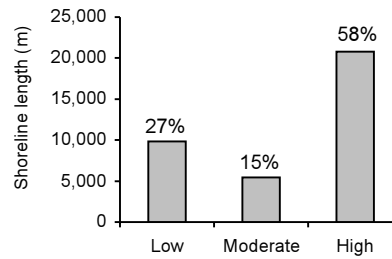


Figure 13.

The disturbance level of foreshore and upland areas in the City of Kelowna.



Typical marina and associated development in Areas 2—City of Kelowna.

Photo: T. Cashin

AREA 3
**District of Lake
 Country**

The District of Lake Country is located immediately north of the City of Kelowna and is bordered by the North Okanagan Regional District to the north.

Thirty-one segments were surveyed over a shoreline length of 18,344 m; 45% of this was identified as disturbed. Land use within this area is primarily rural, with additional lands being Crown, urban residential, agricultural, and park (Figure 14). Almost 20% of the area is classified as Crown land, which is foreshore area that falls within a road right-of-way and remains undisturbed. Most disturbance in Lake Country occurs primarily in association with rural, urban residential, and agricultural land uses.

Shore types in Lake Country were found to be primarily gravel beach and vegetated shore, with some cliff/bluff and smaller amounts of low, rocky shore (Figure 15). Nearly 60% of the gravel beach habitat has been disturbed through development, while other shore types are disturbed to a much lesser extent. Modifications to the foreshore include 203 docks, 103 retaining walls, 6 groynes, 10 boat launches, 13 marine railways, and 1 marina (Figure 16). The disturbance level was assessed as being fairly equally split among low, moderate, and high categories (Figure 17).

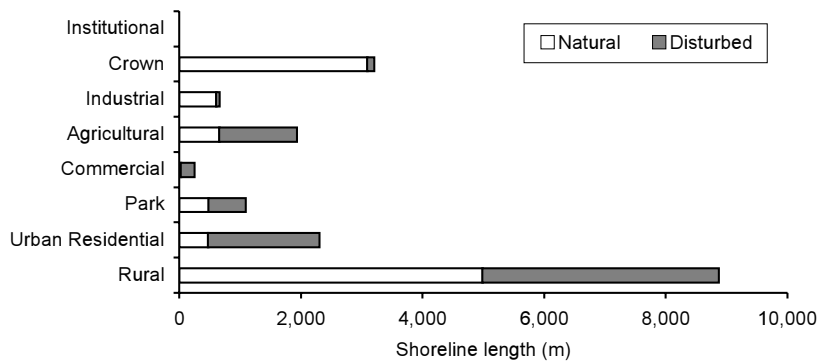


Figure 14.

The land use on areas adjacent to the foreshore in the District of Lake Country.

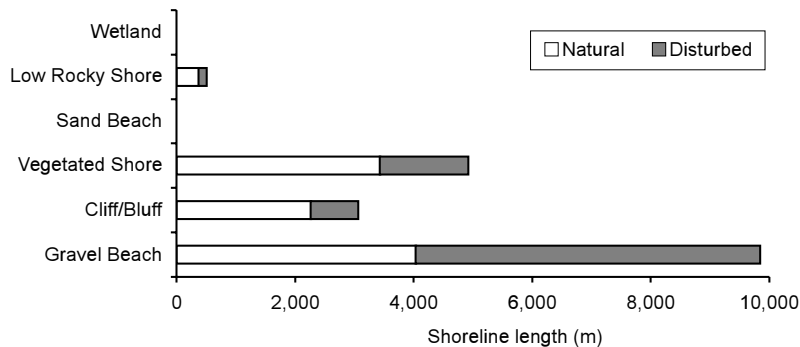


Figure 15.

The length of each primary shore type in the District of Lake Country.

Figure 16.

Modifications along the foreshore in the District of Lake Country.

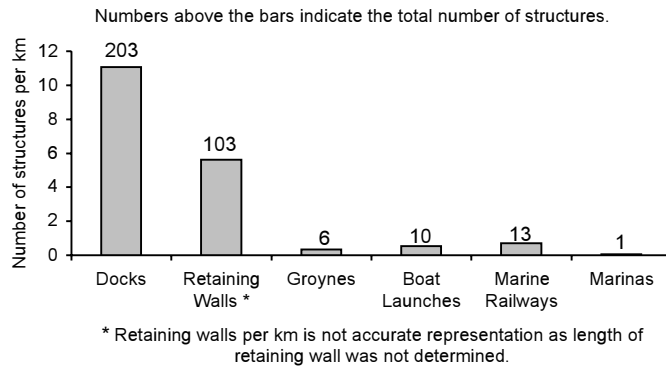
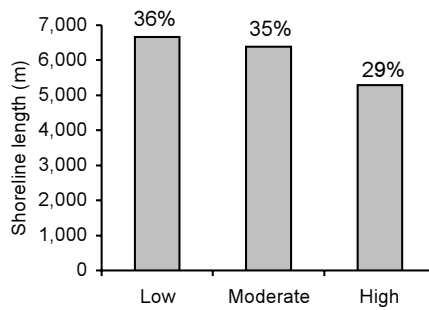


Figure 17.

The disturbance level of foreshore and upland areas in the District of Lake Country.



Typical shoreline morphology and disturbance in Area 3—District of Lake Country.

Photo: T. Cashin

RDCO North Westside OCP Area

The North Westside OCP Area is located on the west side of Okanagan Lake and is bordered by the North Okanagan Regional District to the north and Bear Creek to the south.

Fifty-two segments were surveyed in North Westside over a shoreline length of 38,116 m; 36% of this was disturbed. Land use is primarily rural and park, with some urban residential and commercial lands also represented (Figure 18). Disturbance was found to occur primarily on foreshore areas associated with rural, urban residential, and commercial land uses. Institutional and industrial land uses occurred adjacent to only a small length of shoreline but they were both 100% disturbed. The North Westside area has many steep hillsides and rock bluffs that extend into the lake, and as a result, development activities occur mainly on flatter sites such as the alluvial fans of Shorts and Whiteman creeks and on low gradient hillsides. Some residential development has occurred on benchlands atop steep bluffs, which provide building sites that have limited potential impact on the foreshore.

Shore type is evenly distributed between cliff/bluff, gravel beach, and vegetated shoreline, with smaller amounts of low rocky shore and sand beach (Figure 19). Most of the cliff/bluff and vegetated shores remain natural throughout North Westside, but two-thirds of gravel beach foreshore areas are disturbed, which is largely associated with development of alluvial fans and small coves throughout the area. Modifications such as docks, retaining walls, and groynes (Figure 20) are found primarily in residential areas, but are also found in areas with rural, commercial, and institutional land use. Half of North Westside was characterized as low disturbance level, with 28% moderate and 22% high disturbance (Figure 21).

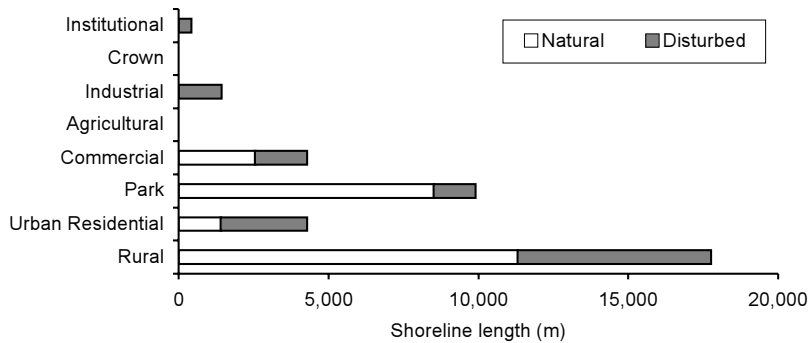


Figure 18.

The land use on areas adjacent to the foreshore in the RDCO North Westside OCP area.

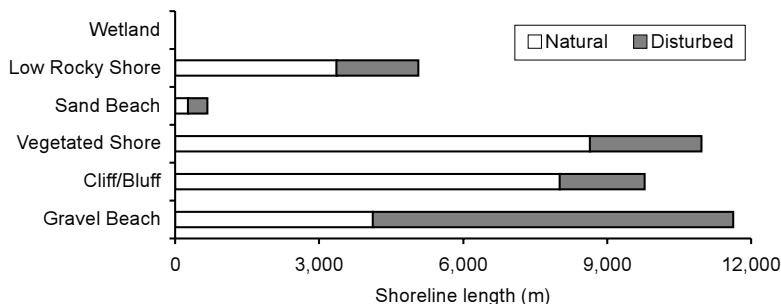


Figure 19.

The length of each primary shore type in the RDCO North Westside OCP area.

Figure 20.

Modification along the foreshore in the RDCO North Westside OCP area.

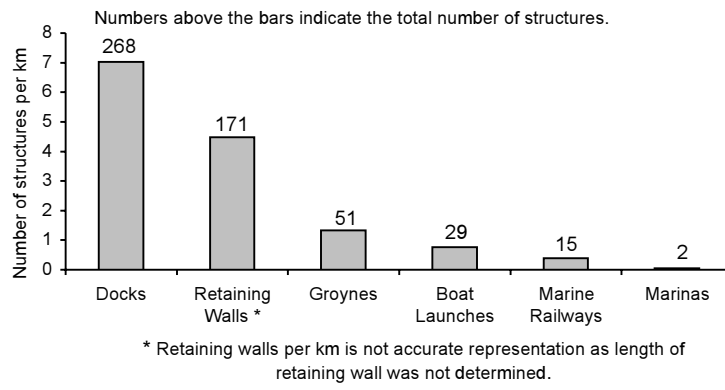
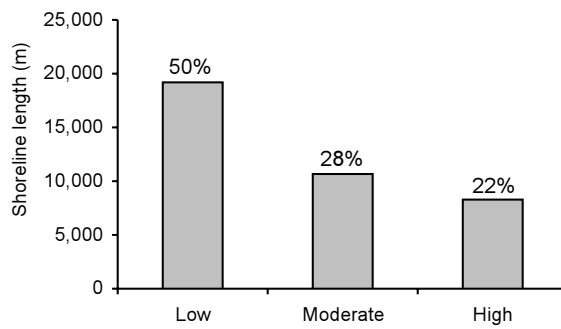


Figure 21.

The disturbance level of foreshore and upland areas in the RDCO North Westside OCP area.



Typical foreshore in Area 4-North Westside OCP area.

Photo: T. Cashin

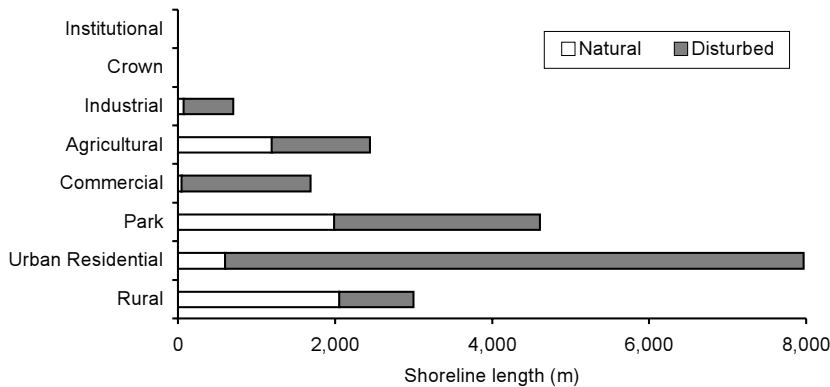
**RDCO Westside
OCP Area**

The Westside OCP Area is located on the west side of Okanagan Lake across from the City of Kelowna. It is bordered to the north by the North Westside OCP area and to the south by the District of Peachland.

In total, 20,420 m of shoreline in 23 segments were assessed in Westside. Of this length, 14,480 m or 71% was disturbed. Urban residential is the dominant land use in this area, with park, rural, agricultural, and commercial also well represented (Figure 22). Large portions of alluvial fans in Westside have been used for residential development or agriculture in the past; recent pressures on these areas include commercial resort development. Most urban residential and commercial lands are associated with disturbed foreshore, and over half of the foreshore adjacent to park lands is also disturbed. Rural lands have less disturbed foreshore.

Foreshore type is dominated by gravel beach, sand beach, and vegetated shore, corresponding with the alluvial fans of McDougall and Powers creeks (Figure 23). The low gradient alluvial fans are situated between cliff/bluff to the south and steep hillsides promoting low rocky shores to the north. The majority of the cliff/bluff remains natural, while gravel beach, sand beach, and low rocky shore habitats are heavily disturbed. Most foreshore modifications occur in segments zoned residential and include docks, retaining walls, beach grooming, and riparian clearing (Figure 24). The majority of shoreline was categorized as having a high disturbance level (Figure 25).

Figure 22.



The land use on areas adjacent to the foreshore in the RDCO Westside OCP area.

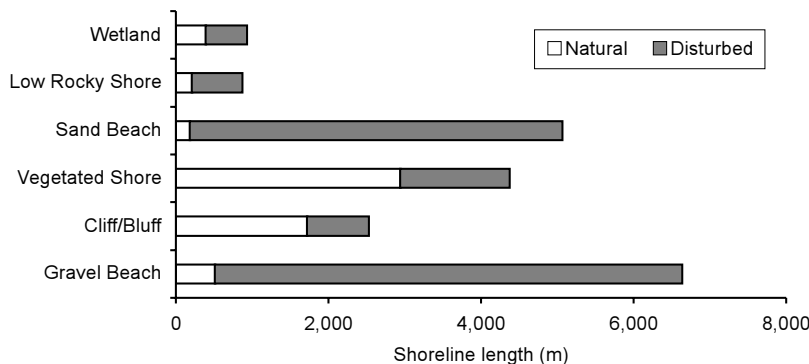


Figure 23.

The length of each primary shore type in the RDCO Westside OCP area.

Figure 24.

Modifications along the foreshore in the RDCO Westside OCP area.

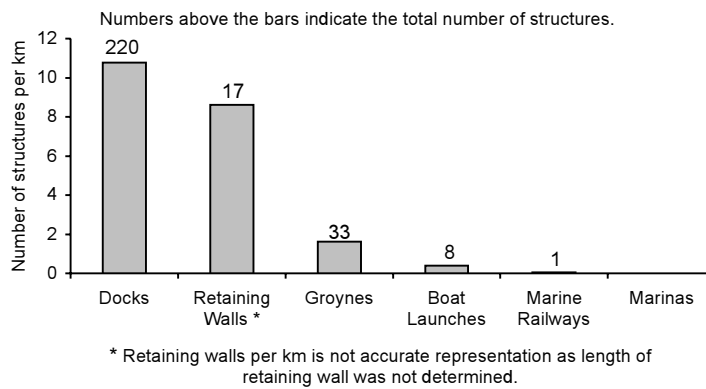
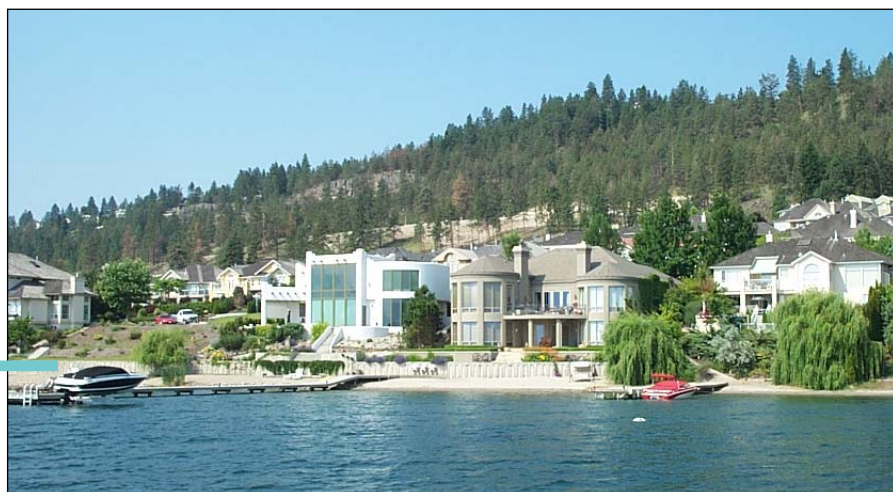
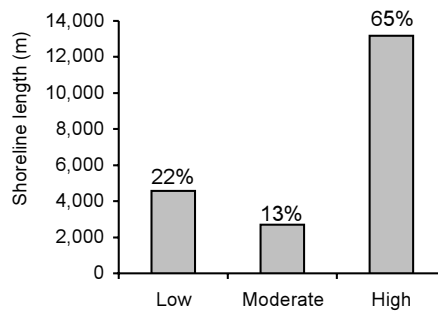


Figure 25.

The disturbance level of foreshore and upland areas in the RDCO Westside OCP area.



Typical foreshore modification and disturbance in Area 5—Westside OCP Area.

Photo: T. Cashin



State of the Foreshore of Central Okanagan Lake

The foreshore (and adjacent upland areas) of central Okanagan Lake have undergone substantial alteration. Over half of the lake foreshore area studied has been disturbed through anthropogenic alterations, which have been directed largely by topography. Areas found to have the highest impacts from development generally exhibit gentle gradients with fine substrate materials that are easily moved during development activities. These areas mostly include gravel and sand beaches, such as those found on alluvial fans. Areas that are less easily disturbed, such as cliff/bluffs, pose access and development constraints that lead to more site-specific impacts to the foreshore, such as blasting and filling.

Land use that occurs on upland areas adjacent to the foreshore has a great impact on the type and intensity of foreshore alterations. Residential and urban development, agriculture, parks, and commercial uses of upland areas have had the highest impact on the integrity of the foreshore in the central Okanagan. Land uses such as industrial and institutional were found to promote exceptionally high impact activities, although their incidence is low relative to other land uses. In the North Westside and Westside areas and in the City of Kelowna, percent disturbed values averaged over 90% for both institutional and industrial land uses. A similar relationship was observed with commercial land uses. While disturbance on rural land use areas was considerably lower than other land use types, these areas constituted nearly half (40%) of the foreshore within the study area. As these areas have the potential for future subdivision and, therefore, increased foreshore impacts, it is imperative that foreshore protection issues associated with land use are adequately addressed by local and regional government planning and approval processes.

Foreshore modifications include lake infilling, beach grooming, shoreline armouring, construction of foreshore structures (groynes, retaining walls, docks, boat houses, and marine railways), riparian vegetation removal, modification of the land base (blasting and moving of material for roads or development activities), and importing substrate materials (usually for recreational purposes). Such activities were found to be similar for adjacent properties throughout the study area, especially in areas zoned as urban/residential.

Neighbours tend to conduct similar activities that cause foreshore impacts; where one resident had built a house immediately adjacent to the foreshore, others appeared to do the same. This also occurred with foreshore modifications such as docks, retaining walls, groynes, and imported materials. Such activities pose a special challenge to regulatory agencies when dealing with precedence, consistency, and the manner in which development and redevelopment are viewed or managed.

For example, property owners are often granted accretion rights through Land and Water BC for accreted land adjacent to Okanagan Lake, even though the accretion occurred as a result of a man-made structure such as a groyne. This is contrary to Regional policy, which states:

Retain land currently in public ownership located next to water (such as streams and shorelines) and waterbodies (lakes and reservoirs) in public ownership (RDCO, 2004)

State of the Foreshore of Central Okanagan Lake cont'd

The mandates of Provincial agencies often permit activities that are contrary to regional or local government policy, such as the reconstruction of damaged retaining walls within the high water mark, thereby setting precedent throughout the Central Okanagan.

Foreshore modifications may impact environmental, social, economic, and commercial values; however, it is often difficult to determine the threshold beyond which significant impacts occur. The cumulative effects of these impacts are not easily measured, but could be examined by determining carrying capacity. The carrying capacity of a lake is defined as a lake's ability to accommodate recreational use (e.g., boating, skiing, bathing) and residential occupation of the foreshore and adjacent upland areas without excessive overcrowding, pollution, and consequent danger to human health and safety (adapted from NALMS, 2005).

Carrying capacity has many connotations including biological, ecological, and social and is an approach by which growth and development may be balanced with retention of social and environmental values. Carrying capacity is not easily measured and has not been addressed in this study; however, determining carrying capacity may be useful in assessing cumulative loss of foreshore habitats resulting from human disturbance. A measure of successive impacts that ultimately tip the balance of ecological stasis would be of great value in foreshore management.

Regional Protection

Despite many foreshore impacts revealed by this project, half of the foreshore within the study area remains undisturbed. The bulk of the undisturbed foreshore is in the South Slopes, North Westside, District of Lake Country, and outlying areas of the City of Kelowna. These areas present a unique challenge to governing agencies responsible for balancing unprecedented growth with environmental protection. They are key to preserving the remaining intact ecosystems that exist along Okanagan Lake.

Intact ecosystems have biological, social, and economic value; the cost of protecting such areas may be low compared to the cost of restoring them (Battelle et al., 2001). In addition, the effectiveness of restoration is often unclear. For example, most foreshore restoration efforts on Okanagan Lake are recent and have not been monitored for long-term effectiveness. Challenges are especially formidable when dealing with foreshore protection issues in areas where long-term visions have not been established, such as those areas without an Official Community Plan to guide development.

The foreshore of Knox Mountain Park (photo centre) in the City of Kelowna remains undisturbed.

Photo: B. Magnan



On the contrary, foreshore protection can be equally as challenging in areas where long-term visions have been established. As identified, parks within the study area constitute almost 20% of the foreshore. Park management strategies vary greatly throughout the Central Okanagan and are dictated by the mandates of the overseeing agencies. Park classifications fall into a continuum from Regional or Provincial parks (with little disturbance), where natural features are maintained for the general public, to parks that are categorized as community, neighbourhood, linear, athletic, or waterfront parks, where management differs greatly between each designation but most of the parks are geared toward recreation and unimpeded public access.

A clear understanding of regional strategies may guide future decisions and promote a more coordinated approach to foreshore management among regulatory agencies. The information presented in this report is consistent with the management initiatives set forth in a number of regional strategies, including the Regional Growth Management Strategy, the Okanagan Lake Action Plan, and the Okanagan Shuswap Land Resource Management Plan. These strategies are key to establishing a regional vision and common goals while considering provincial interests (RDCO, 2002). Action items from these documents include:

1. Planning for development by first knowing what to protect and then developing and using management tools to achieve the desired level of protection (*RDCO Regional Growth Strategy* – RDCO, 2002);
2. Managing water resources to ensure their long-term health and sustainability (*RDCO Regional Growth Strategy* – RDCO, 2002);
3. Developing protection and restoration plans for shore-spawning habitats and implementing effective shoreline protection and preservation activities (*Okanagan Lake Action Plan* – MWLAP, 2004); and
4. Conducting inventories of the known salmon watersheds for locations of critical habitat (*Okanagan Shuswap Land Resource Management Plan* – FRBC, 2001).

Action items

Using guidance from the regional strategies together with information gained from this inventory, we can begin to identify and prioritize critical habitat areas on central Okanagan Lake. A case study example of this is included in Part II of this report where we analyze kokanee shore-spawning data alongside the foreshore condition data. Subsequent efforts should concentrate on protecting critical habitats using tools available in a regional planning environment.

These tools include regional policies, foreshore plans, and foreshore development guidelines, all of which should be examined and updated to include science-based policy direction for conservation planning. This direction should be intent on achieving a higher quality of development that preserves the integrity of upland areas and maintains environmental attributes of the foreshore while facilitating human use. Other potential tools include public education, which can be used to curtail the loss of critical habitat on private property, and expanding partnerships, which can increase local government's ability to adapt to increasing development pressure.



The foreshore of central Okanagan Lake is dominated by gravel beach, sand beach, cliff/bluff, and vegetated shore types. Over half of the foreshore of central Okanagan Lake has been disturbed by anthropogenic alterations. Historical disturbance has resulted in changes to all shore types and particularly in a loss of the majority of wetland habitats. Land use adjacent to the foreshore is dominated by rural activities, with moderate amounts of both urban residential and park space. Most of the disturbance can be characterized by the removal of native riparian vegetation and primary modifications including docks, retaining walls, beach grooming activities, and groynes.

In light of the cumulative foreshore impacts presented, efforts to restore and enhance previously disturbed sites and protect remaining natural areas on central Okanagan Lake should be put forth collectively by all levels of government. The results of this inventory are intended to increase the effectiveness and coordination of foreshore management activities on Okanagan Lake, leading to improved ecosystem structure and function and better integration of human use with environmental protection. The dissemination of this material will help promote a coordinated ecosystem-based approach that is essential to successful foreshore management. In order to adequately address foreshore protection issues, it is important to examine the way residents and stewards view foreshore ecosystems. The key to protection is our ability to recognize and acknowledge our influence on these systems and the role they play in the health and vitality of Okanagan Lake (Battelle, 2001). Preservation of these ecosystems is critical in maintaining the environmental, social, and economic values that have long drawn people to the Okanagan region.



Foreshore modifications include lake infilling, removal of riparian vegetation, dock structures and blasting of parent foreshore material.

Photo: T. Cashin



Decisions regarding the management of the Okanagan Lake foreshore zone should be based on the best available science and should reflect policies set out in regional strategies and guidelines as well as those of senior levels of government. Based on the current state of the foreshore, measures must be taken to conserve areas that contribute to maintaining and restoring sensitive foreshore ecosystems and to preserving the ecological integrity of Okanagan Lake.

Regional and local governments possess a variety of means to ensure development is sensitive to environmental values. These include Official Community Plans, zoning, and bylaws and are useful in many situations, provided the baseline information on which decisions are made is both current and accurate. The following provides action items that local governments may use to achieve a higher level of habitat protection. Included are specific recommendations that pertain to the management of Okanagan Lake.

- Set objectives, which should consider shore type and disturbance level for the management of Okanagan Lake.
- Address specific zoning of the foreshore of Okanagan Lake.
- Include regulations and guidelines for new development, re-development, and management of existing development.
- Designate protection of critical areas in policies.
- Explore a memorandum of understanding with all levels of government regarding foreshore management roles and responsibilities.
- Develop jointly with all partnering agencies.
- Consider lakeshore development guidelines being developed elsewhere (e.g., Lindros Project Development, Urban Systems, 2004).

ACTION #1

Develop a foreshore protection plan.

- Examine carrying capacity to determine the impact of foreshore modifications and activities on shore zone ecosystems.
- Gather more information to determine a method of quantifying carrying capacity.

ACTION #2

Determine carrying capacity.

ACTION #3

Identify critical areas for protection, restoration, and enhancement.

- Use the information presented in this report to help identify critical habitat areas on central Okanagan Lake (e.g., kokanee shore-spawning locations).
- Identify additional critical habitat areas for species other than kokanee through further analysis and future addition to the project database (e.g., migration and rearing areas for juvenile fish).
- Identify critical areas on the remainder of Okanagan Lake through a subsequent inventory, and compile the information with the current database.

ACTION #4

Protect critical and natural areas.

- Protect fish spawning areas (including historic kokanee spawning areas that have habitat and features conducive to shore spawning) and adjacent upland areas.
- Protect undeveloped areas adjacent to the foreshore. This is especially important when dealing with ecosystems that are threatened or endangered. Foreshore types characterized as vegetated shore are especially vulnerable since they occur infrequently on Okanagan Lake and likely contain plant communities that are provincially listed as “at risk.”
- Protect substrates from alteration. Beach grooming, lake infilling, importation of sand, armouring, and dredging all have the potential to negatively impact substrate materials.
- Pursue agreements between local governments and provincial agencies about foreshore management. “Head lease” agreements give one party control over the management of the foreshore and have been obtained by local governments such as the District of Peachland. This will reduce difficulties in coordinating inter-agency management strategies.

ACTION #5

Address modifications.

- Restore or enhance foreshore areas affected by past modifications, such as armouring, infilling, beach grooming, etc., if restoration or enhancement is likely to benefit habitat quality.
- Prevent or mitigate further modifications to foreshore areas where they are likely to reduce habitat quality. For example, in kokanee spawning areas, modifications should not disrupt wind and wave action.
- Make technical guidance available to agencies and the public regarding alternatives to traditional shoreline modifications such as armouring. Such guidelines should be developed in conjunction with senior government agencies to ensure consistency with regulatory requirements and resource management objectives.
- Inventory the foreshore of both the north and south of Okanagan Lake and compile the information with the current database.

- Develop and produce indicators, actions, and timelines.
- Initiate a detailed habitat monitoring program on Okanagan Lake.
- Develop a coordinated enforcement protocol with all levels of government to respond to foreshore habitat impacts.
- Compare results from a monitoring program to the original inventory data to determine compliance with best management practices and effectiveness of protection activities.

ACTION #6

Monitor habitat losses and gains to measure success.

- Provide federal, provincial, and local jurisdictions with inventory data.
- Provide partnering agencies with inventory data.
- Make the inventory data available to the public via the Internet through continued partnership with the Community Mapping Network.

ACTION #7

Make inventory data and habitat information available.

- Determine fisheries sensitive zones for a variety of fish species on Okanagan Lake.
- Conduct a detailed study to examine the relationship between current kokanee spawning locations and the level of foreshore disturbance along Okanagan Lake (a preliminary analysis of these data is included in Part II of this report).
- Conduct a detailed study to examine the relationship between upland spring locations and kokanee spawning areas.
- Obtain more detailed information to determine critical spawning areas for shore-spawning kokanee along Okanagan Lake.
- Conduct a detailed study to identify critical habitats for other aquatic species and life stages.

ACTION #8

Identify further challenges and opportunities.



- Andrusak et al., 2002. *Okanagan Lake Action Plan Year 5 (2000) Report*. Ministry of Environment (formerly Ministry of Water, Land and Air Protection), Penticton, BC.
- Anonymous, 1996. *Channel Assessment Procedure Guidebook*. BC Ministry of Forests and BC Ministry of Environment, Lands and Parks, Victoria, BC.
- Battelle Marine Sciences Laboratory et al., 2001. *Reconnaissance Assessment of the State of the Nearshore Ecosystem: Eastern Shore of Central Puget Sound, Including Vashon and Maury Islands (WRIAs 8 and 9)*. King County Department of Natural Resources, Seattle, Washington.
- BC Species and Ecosystems Explorer, 2005 – Government of British Columbia, Ministry of Sustainable Resource Management and Water, Land and Air Protection. (Accessed January, 2005).
<http://srmapps.gov.bc.ca/apps/eswp/search.do>
- City of Kelowna, 1997. *Lake Okanagan Shore Zone Plan*. Planning Services and Development Department, Kelowna, BC.
- City of Kelowna, 2003. Zoning Bylaw no. 8000. Kelowna, BC.
- City of Kelowna, 2003. *City of Kelowna Official Community Plan*. Kelowna, BC.
- District of Lake Country, 2001. *District of Lake Country Official Community Plan*. Winfield, BC.
- Dobson Engineering Ltd, 2000. *Water Resources in the Central Okanagan – A Discussion Paper Within the Growth Management Strategy – Final Report*. Regional District of Central Okanagan. Kelowna, BC.
- FRBC (Forest Renewal BC), 2001. *Okanagan–Shuswap Land and Resource Management Plan*.
- Hatfield Consultants Ltd, 1996. *Shoreline Inventory and Fisheries Sensitivity Classification of Main Arm Shuswap Lake*. Department of Fisheries and Oceans, Kamloops, BC.
- Iverson and Cadrin, 2003. *Sensitive Ecosystem Inventory: Central Okanagan 2000-2001*.
- Lindros Project Development, Urban Systems, 2004. Lakeshore development guidelines. Draft. Thompson Nicola Regional District, Kamloops, BC.

References cont'd

- Mason, B. and R. Knight, 2001. *Sensitive Habitat Inventory and Mapping*. Community Mapping Network. Vancouver, BC. 315pp + viii. M. Johannes, Editor.
- Ministry of Water, Land and Air Protection, 2004. *Okanagan Lake Action Plan. Summary of Priority Activities*. Penticton, BC.
- NALMS (North American Lake Management Society), 2005. http://www.nalms.org/glossary/lkword_c.htm
- RDCO (Regional District of Central Okanagan), 2002. *Regional Growth Strategy - Environmental Protection Discussion Paper*. Kelowna, BC.
- RDCO (Regional District of Central Okanagan), 2004. *Westside Official Community Plan*. Bylaw 1050. Planning Services Department, Kelowna, BC.
- RDCO (Regional District of Central Okanagan), 1997. *Lakeview Official Community Plan*. Regional District of Central Okanagan, Kelowna, BC.
- Resources Inventory Committee, 1999a. Reconnaissance (1:20,000) *Fish and Fish Habitat Inventory: Lake Survey Form Field Guide; Errata #3* (March, 2004). BC Ministry of Fisheries – Fisheries Inventory Section, Victoria, BC.
- Resources Inventory Committee 1999b. *Overview Fish and Fish Habitat Inventory Methodology*. BC Ministry of Fisheries – Fisheries Inventory Section, Victoria, BC.
- Roed, Murray A, 1995. *Geology of the Kelowna Area and Origin of the Okanagan Valley, British Columbia*. Kelowna Geology Committee, Kelowna BC.
- Smith, Robert L., 1992. *Elements of Ecology. Third Edition*. Harper Collins Publishers Inc., New York.
- True Consulting Group, 1999. *North Westside Official Community Plan*. Regional District of Central Okanagan, Kelowna, BC.
- Urban Systems, 1997. *Westbank Official Community Plan*. Regional District of Central Okanagan, Kelowna, BC.
- Woodroffe, J., 1990. *Foreshore Plan – Regional District of Central Okanagan*. Woodroffe Consulting, City and Regional Planning, Victoria, BC.