Foreshore Integrated Management Planning Methods

Foreshore Inventory and Mapping

Foreshore Habitat Sensitivity Index

Foreshore Development Guide

Prepared For:

Living Lakes Canada

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ACRONYMS

Post 2020 FIMP Methods Update	Pre-2020 FIMHP Methods Update	Acronym
CDC		Conservation Data Centre
CMN	CMN	Community Mapping Network
DFO	DFO	Fisheries and Oceans Canada
EKILMP	EKILMP	East Kootenay Integrated Lake Management Partnership
FDG	SMG	Foreshore Development Guide/Shoreline Management Documents
FHSI	AHI	Foreshore Habitat Sensitivity Index/Aquatic Habitat Index
FHSI Category		Foreshore Habitat Sensitivity Index Category
FHSI Criteria or Criterion		Foreshore Habitat Sensitivity Index Criteria
FHSI Ecological Rank		Foreshore Habitat Sensitivity Index Ecological Rank or output
FIM	FIM	Foreshore Inventory and Mapping
FIMP		Foreshore Integrated Management Planning
FISS		Fisheries Information Summary System maps
GIS		Geographic Information System
GPS		Geographic Positioning System
HWM		High Water Mark
KLP	KLP	Kootenay Lake Partnership
LiDAR		Light Detection and Ranging
LLC		Living Lakes Canada
MFLNRORD	MFLNRORD	Provincial Ministry of Forests, Lands, Natural Resource Operations and Rural Development
QA/QC		Quality Assurance/Quality Control
QEP		Qualified Environmental Professional
SEI		Sensitive Ecosystem Inventories
SHIM	SHIM	Sensitive Habitat Inventory and Mapping
TEK		Traditional Ecological Knowledge
TEM		Terrestrial Ecosystem Mapping
TRIM		Terrain Resource Information Management Enhanced Topographic map data
ZOS		Zone of Sensitivity

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Appendix A – First Nations Traditional Ecological Knowledge was written by Bruce Mac Donald, John Cathro, and Ryan Cloutier.

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1.0 INTRODUCTION

For the purposes of this methodology, the shoreline (or foreshore) is defined as the area from the edge of pelagic regions (or the upper layers of open water/limnetic areas) of the lake to an area up to 50 m past the high water mark (HWM) in the upland/riparian zone. Lake foreshores in British Columbia (BC) have been inventoried, mapped, assessed, and guidelines have been developed by various government and community group partnerships over the past 15 years (see summary of lakes surveyed in Schleppe et al. 2019, Schleppe and Mason 2009). Throughout that time, the draft Foreshore Inventory and Mapping protocol (Version 2.6, Schleppe and Mason 2009), and various versions of aquatic habitat indices and foreshore guidance documents have been applied on a lake-specific basis. These mapping and assessment protocols have been collectively built from all areas around BC, with key contributors from the Okanagan and Kootenay regions. In recent years, selected lakes in Alberta and Manitoba have also been mapped using the BC methods.

Development pressures on lakes around the world continue to increase. Coupled with this, associated risks from these development pressures are also increasing as more lakeside habitats urbanize. Living Lakes Canada (LLC), through its lake foreshore work in BC, Alberta and Manitoba, recognized a need to standardize the lake foreshore mapping, assessment and guidance protocols. Consequently, LLC applied for and received funding from Fisheries and Oceans Canada's (DFO) Canada Nature Fund for Aquatic Species at Risk (CNFASAR) as well as other partners, to formalize the general approach and standardize the protocols for mapping, assessment and guidance for small and large lakes in the Columbia River basin.

This methodology, called Foreshore Integrated Management Planning (FIMP), documents and summarizes development-related impacts to the foreshore and provides landowners, land use managers, and agencies with data necessary to make informed land use decisions. The general approach and protocols were designed to be easily adapted across lakes in BC and throughout Canada.

1.1 Foreshore Integrated Management Planning (FIMP) Process

Foreshore Integrated Management Planning (FIMP) is a process intended to help agencies; non-profit organizations; local, provincial and federal governments; and landowners understand lake foreshore habitat values and the prospective risks from proposed shore-altering activities for surveyed lakes. This process has been developed to be adaptable to available financial resources, development pressures, lake size, lake ecology and other variables. Foreshore Integrated Management Planning specifically allows the rate of change to be determined if data from previous surveys are used. Using rates of change, risks to key shoreline areas can be easily determined, facilitating informed land use decisions. This process provides the public and government agencies with the important information necessary to make key decisions regarding foreshore development and conservation. The methods herein are intended to help standardize the mapping and assessment of lakes and provide a framework for more consistent application of the approval process for shoreline development at a local, provincial and federal level.

The FIMP process follows three general steps:

1. Shoreline inventories following the Foreshore Inventory and Mapping (FIM) protocol are undertaken and mapped. The standardized methods for undertaking this work are found in Section 2.0.

2. Shoreline habitat sensitivities are determined using a ranking index called the Foreshore Habitat Sensitivity Index (FHSI). The index is a simple, cost-effective method to approximate shoreline values and is developed using assessments, inventories and professional opinions. The index is intended to identify areas of greatest sensitivity to change from shoreline urbanization. The FHSI development protocol is found in Section 3.0. Former iterations of this index (e.g., Aquatic Habitat Index) are referenced in this document to clarify the evolution of the previously named habitat indices.
3. The Foreshore Development Guide (FDG) is prepared to identify risks posed by different shore-altering activities to inform land use decisions on the lake foreshore. The FDG provides background information regarding the risks to riparian, foreshore, and aquatic fish and wildlife habitats from various land use changes or foreshore activities. The FDG is intended to help mitigate or eliminate the negative impacts to sensitive habitats from the various developments. The protocol for preparing a FDG is found in Section 6.0.

1.2 Incorporation of First Nations Traditional Ecological Knowledge

Incorporation of First Nations Traditional Ecological Knowledge (TEK) into FIMP allows integration of data that may not be readily available to assessors, but is well known to First Nation communities and elders and may be complementary to other data inventories. Inclusion of TEK in FIMP is largely focused on integration of important environmental and biological values that can or should be included. It is important to observe that numerous other First Nations cultural or archaeological values may also be present. Inclusion of these other values can occur in collaboration with FIMP data collection but it is noted that these values should be managed independently from the FIM and FHSI processes if they may not be biologically based or if the data is culturally sensitive.

While FIMP does not require inclusion of TEK, there are numerous benefits. Appendix A summarizes the methods and defines several different mechanisms for inclusion of First Nations TEK into FIMP. Additionally, incorporation of TEK is also referenced below, where applicable, to help integrate these different data streams into the FIMP process.

1.3 Assessor Qualifications

It is recommended that Qualified Environmental Professionals (QEP) supervise the FIMP methodology outlined herein. The QEP may rely upon government agency staff or volunteers who are knowledgeable but not recognized professionals to provide advice and assistance. An individual may serve as a QEP for the purposes of conducting this assessment if they meet the following three requirements (adapted from RARP 2019):

1. The individual is one of the following professionals:
    i. an applied technologist or technician, or
    ii. a professional biologist.
2. The individual is registered and in good standing in British Columbia with the appropriate professional association constituted under an Act for the individual's profession.

3. When carrying out that part of the assessment, the individual is acting:
    i. within the individual's area of expertise,
    ii. within the scope of professional practice for the individual's profession, and
    iii. under the code of ethics of the appropriate professional association and is subject to disciplinary action by that professional association.

It is recommended that assessors have the appropriate level of experience and expertise, as judged by the lead QEP (see also Section 2.4). It is extremely beneficial for field crews to ensure that a complement of different skill sets is present during the survey(s) including fisheries, wildlife and GIS experience, for example. Individuals should also be trained in basic first aid and relevant safety protocols. This includes meeting the minimum standards under applicable legislation and having navigational certifications from Transport Canada (e.g., small vessel operator's proficiency). Recommendations for field crew members and division of tasks is provided in Section 2.4.1.

1.4 FIMP Working Groups

Foreshore Integrated Management Planning is best accomplished through the establishment of a working group. For example, the Kootenay Lake Partnership is a working group including different levels of government and non-profit partners. The group helps facilitate FIMP by defining each of the designated partners' roles and responsibilities and by establishing a group that can help complete the key steps of FIMP. The working groups often rely upon the work of QEPs to help complete FIM and FHSI and help develop FDG datasets and documents. Working groups are important for dissemination of information and FIMP products to, and liaison with, lakeshore property owners, interest groups and the general public.

2.0 FORESHORE INVENTORY AND MAPPING (FIM)

2.1 Overview

Foreshore Inventory and Mapping (FIM) is a field-based assessment of the lake foreshore intended to provide a summary of shoreline conditions using a geographic information system (GIS). The methods closely resemble the Sensitive Habitat Inventory and Mapping (SHIM) methods (Mason and Knight 2001), developed for mapping smaller streams and watercourses. The FIM concepts are like other land-based spatial mapping initiatives such as Terrestrial Ecosystem Mapping (TEM) and Sensitive Ecosystem Inventories (SEI), where habitat data for a particular point, line or polygon are collected. For FIM, the lake foreshore and riparian areas are the primary features assessed.

The intent of FIM is to catalogue and describe land use (e.g., residential development), shoreline modifications (e.g., retaining walls, docks, marinas) and biophysical attributes (e.g., shoreline vegetation cover, substrates, large woody debris and aquatic vegetation) within the foreshore area. Information collected allows resource managers at all levels of government to incorporate the information into a variety of land use planning documents such as Official Community Plans or Shoreline Management Plans. This data is also used in the FHSI analysis (Section 2.6.1) and incorporated into the FDG (Section 6.0).

The FIM procedure is typically completed in a four-step process as follows:

1. *Pre-Field Assessment* – Background information and base maps are prepared. Preliminary shoreline segment breaks and survey timing are also determined (Section 2.2).
2. *Video Documentation of the Lake Foreshore* – A video is collected for the entire lake foreshore. The video is stamped with GPS coordinates that can be used to cross-reference shoreline feature locations and help determine the location for shoreline segment breaks. Shoreline video documentation is not a mandatory part of a FIM process but useful if budgets allow (Section 2.3).
3. *Field Assessment* – A field assessment is conducted to collect the biophysical and habitat attribute data. During this stage, data is entered into a locational data dictionary for all applicable fields and geo-referenced[1] still photographs are taken to characterize each shoreline segment and its attributes. Baseline maps and preliminary segment breaks are also confirmed and updated (Section 2.4.2). Additional fish and wildlife surveys may also be conducted during this step, particularly if Step 2 (FHSI) of FIMP is planned (see Section 3.0).
4. *Reporting and Data Analysis* – Field data is transferred to a computer (e.g., Excel forms), reviewed, corrected and analyzed. Review and data correction acts as a quality assurance process and is a very important step in the FIM component of FIMP. Relevant data is summarized and transferred to the shoreline map. Segment breaks are adjusted so that they occur where intended from the field assessment. Any additional survey information collected (e.g., fish and wildlife) is also incorporated, where applicable (Section 2.5 and 2.6).

2.2 Pre-Field Assessment

During the pre-field assessment, assessors should gather as much background information as possible, prepare a baseline field map, determine preliminary segment breaks and determine the appropriate timing to conduct the survey. The pre-field assessment will help guide the field data collection to ensure that all necessary information is acquired.

It is difficult to infer missing data during post-processing and it is extremely costly to mobilize field crews to collect what was forgotten or misidentified. On larger lakes, it may be necessary to divide the lake into smaller regions and vary the level of detail to focus effort in areas with the greatest shoreline development.

2.2.1 Background Information Collection

The following background information should be gathered, if possible:

1. *Aerial Imagery* – Obtain the most recent digital (GIS) aerial imagery of the entire shoreline. Aerial imagery (including orthophotos) provides a large-scale, high-elevation overview of the lake and is valuable to help determine segment breaks, assess land uses and to help locate important features such as stream mouths. Imagery is available for most areas of the province and imagery selected should be as high resolution as possible to allow for digitization of important foreshore

[1] Georeferenced means that the photos have a latitude and longitude (or other position identifier) stamped to them where they are taken.

attributes or modifications. Image sources are highly variable, and it is likely there are free and commercial imagery sources available for most GIS platforms.

2. *Topography* – Obtain any topographic information for the shoreline. Topographic information is available for almost all areas of the province in the form of TRIM map sheets and can be obtained digitally via GIS files from provincial (e.g., BC data catalogues), federal or local authorities. This information can help assessors determine reach breaks and assess slope. If available, the digital elevation models from LiDAR data could also be used.
3. *Cadastral* – Obtain local cadastral information for private holdings that occur along the foreshore. This information is typically available digitally (GIS or AutoCAD files) from the local government, First Nations' offices or regional districts.
4. *Regional Boundaries* – Obtain jurisdiction and zoning information from municipalities, First Nations and Regional Districts. This information can help assessors determine land uses and segment breaks. In most instances, this information is available digitally (GIS files) but may also be available as map sheets from the local jurisdiction.
5. *Provincial & Conservational Boundaries* – Obtain boundaries for any provincial parks, conservations areas or other known features. In BC, most of this information is available from the Land and Data Warehouse provided by the Integrated Land Management Bureau and is likely available in other provinces and jurisdictions.
6. *Fisheries & Wildlife* – Background information should be reviewed to determine fish and wildlife presence for the survey area. Inventories for fish, mammals, herptiles, waterfowl, sensitive or endangered ecosystems, etc. are examples of background information that should be obtained. Information for Species at Risk (SAR) should also be obtained. Most of this data is available via GIS from provincial or federal databases and can be incorporated into field maps for reference. For example, there are numerous SAR management plans that identify critical habitat for species that could be loaded and incorporated into field maps for FIM. This data can, for example, help to determine the appropriate survey timing. Also, this information is very useful for Step 2 of FIMP (see Section 3.0). If inventory information is not available, future inventory surveys may be required.

2.2.2 Baseline Field Map Preparation

Once the background information above has been collected, assessors should prepare baseline field maps in GIS software. Baseline field maps will allow assessors to provide a pre-field assessment of the foreshore, and should depict all relevant information in an organized way to streamline and support the field data collection process. Baseline field maps should include key information from above (e.g., cadastral, government, conservation boundaries). The maps should include the preliminary shoreline segment breaks (see below). Additionally, the maps should depict marsh/wetland habitats and stream mouths. Often the locations of these features are not spatially accurate on TRIM maps. Matching map grid sheets to local government sheets is recommended. The baseline field maps are used to record field observations (e.g., modifications, high water mark, key habitat areas and aquatic vegetation), which can later be digitized into a GIS dataset.

2.2.3 Preliminary Shoreline Segment Breaks

Baseline field maps should be reviewed to determine preliminary shoreline segment breaks that can be verified during the field survey. A shoreline segment break is where the shoreline linear extent is divided up into smaller sections, based on the presence of similar biophysical attributes. A segment break is similar to a habitat reach break used to inventory stream systems (e.g., Johnston and Slaney 1996).

Shoreline segment breaks should be made by using the following criteria:

1. *Shore Type* (Section 2.4.2.2). For example, significant landform changes from cliff/bluff to a sandy shoreline would warrant a segment break.
2. *Land Use* (Section 2.4.2.4). For example, changes from multi-family residential development to single-family development could warrant a segment break because of the change in density associated with the developments. In general, land use changes are often accompanied by stark changes in riparian conditions making them obvious.
3. *Riparian Vegetation* (Section 2.4.2.6). Typically, riparian vegetation changes are associated with changes in land use but can also be due to differences in property management, etc. Significant differences in vegetation cover could warrant a segment break, such as changes from a coniferous forest to an agricultural area.
4. *Stream Mouths and Wetlands* (Section 2.4.2.3). Stream mouths or confluences are extremely important shore types and should be given their own segment designation to delineate important aquatic and wildlife values.
5. Other unique habitat types that are evident on aerial imagery may also warrant their own segments.

Preliminary shoreline segment breaks should be delineated so that they are a minimum length of 50 m. This can be done using GIS or even by directly measuring and marking the paper field maps. However, segments smaller than this threshold can be delineated for unique and/or high-value habitats (see below). The location to start the field assessment (e.g., Segment 1) should also be considered in the pre-field stage and be based on logistical factors such as boat access points or lake size, noting that segment numbers can always be revised during post-data processing.

It is important that high-value habitats are separated into their own shoreline segments to support the FHSI assessment (Section 3.0). When its unclear whether a shoreline area should be divided up into multiple segments, err on the side of splitting out unique, high-value features and habitats because, if required, they can be more easily amalgamated during the post-processing office assessment. It is more difficult to split a shoreline segment into multiple segments after the field assessment is complete because there are other features collected that are attributed to that segment that may not be spatially delineated (e.g., shoreline modifications such as docks, groynes and retaining walls). When in doubt, split it out!

2.2.4 Determine Field Survey Timing

The appropriate survey timing can be determined based on background information collected and the objectives of the survey. If there are specific fish and wildlife (including SAR) values that need to be inventoried, then it may be prudent to capture specific life history periods like spawning, migration or nesting timing. It may be important to conduct the survey during low and/or high water to capture different habitat attributes and identify activities and shoreline modifications that might influence specific areas. Additional surveys (e.g., heron nesting and kokanee spawning) can also be conducted during the appropriate timing window once the general field survey is completed. Note, this data can be added to the shoreline segments for later FHSI analyses if a review of all segments has been undertaken in a consistent manner.

2.2.5 FIM Technology

There are numerous different technologies that can be used during the FIM assessment. The technology selected should allow the user to collect and enter field data in an efficient and consistent manner that is compatible with the FIM field assessment. The following is a brief list of useful technologies and their respective utility for conducting the FIM assessment:

1. *Drones* – Drones can be used to collect low-elevation digital imagery. Drone imagery is useful to document key foreshore areas during the field assessment. The following are different types of drone imagery that may be useful:
    i. Vertical – Vertical imagery is very similar to aerial photos and has the same advantages as aerial imagery.
    ii. Oblique – Oblique still photos are thought to be useful for observing shoreline modifications and riparian conditions. If taken at lower water levels, substrate data may also be collected. These photos are very similar to still photographs taken from a boat (Section 2.4.3).
    iii. Video – Drone video, whether oblique or vertical, provides a similar advantage to still photos taken using a drone.
2. *Videography* – See Section 2.3.
3. *LiDAR* – LiDAR provides a very high-resolution data set that can be used for a variety of different purposes. LiDAR provides a very accurate summary of foreshore elevation data. Further, this data could be used to capture both tree and shrub canopy cover or a variety of other useful features. A full investigation of the use of LiDAR is not provided in these methods.
4. *Field Data Collection* – The following is a list of field data collection devises that may be used to document and collect field data:
    i. Trimble GPS – This is the default technology that has been traditionally used to conduct the FIM field assessment. The FIM data dictionary is uploaded prior to the field assessment and contains all the required fields to allow users to enter data consistently and efficiently. The Trimble unit or similar types of field collection devices are extremely rugged and field ready. However, some Trimble units do not allow users to easily edit data collection criteria or review previous field assessment data without a laptop.

ii. Tablet – A tablet is a useful tool when paired with software such as Avenza © and baseline field maps to digitize important habitat or polygons. It also allows photos to be embedded directly into the segment and be labelled by the segment number for easier reference post-processing.

iii. Laptop – A laptop is useful to use when lookup of other data is required using Excel, especially when conducting FIM for the second time (Section 2.7). However, a laptop is not as field rugged as the other devices listed above.

2.3 Video Documentation

Video documentation can assist in classifying land use and features of the lake foreshore. As mentioned previously, it is not a mandatory step for FIM but it can be useful for detecting change over time as a result of development (e.g., new modifications) or natural disturbance. Depending on the lake, it may be appropriate to capture video at a particular elevation such as high or low water. For example, if video is captured during high water, the number of retaining walls that become submerged or partially submerged can be enumerated.

The following is a guide for recording geo-referenced lake shoreline video. Video equipment and recording methods are constantly being improved. However, the tools are only as good as the operator, so nothing replaces training, personal experience and practice. There are several models and set-up options for recording video so use the following only as a guide. In addition to video recording equipment, the selection of a boat is also important. If possible, choose a boat that is stable under windy conditions and that has a small draft to avoid grounding when navigating near the shore. The boat must also safely and comfortably carry a crew of three, including the boat operator. An appropriate power supply such as a car or RV battery should be used with a power inverter to ensure there is adequate power for all the recording equipment. Video is often best collected independent of FIM data collection.

Almost any digital video camera with analog output can be used. However, users must become familiar with the video camera controls prior to going into the field. The video should be recorded no more than 50 m from the shoreline if possible. One to two homes should be in the view of the video, where applicable. Do not use the digital zoom and try not to use the optical zoom if possible, otherwise the video will become blurry especially in rough conditions. The video should be recorded on dry, calm days if possible. A general rule is that the larger the waves, the poorer the quality of the resulting video. Other considerations include:

- good image stabilization
- analog output (mandatory)
- durability for use in the field conditions
- easy-to-use and -reach buttons
- a lens shroud to protect from direct sunlight
- a polarized lens
- an excellent tripod with easy-to-use controls
- tape or hard drive storage media
- use of gimbal device to stabilize images

Use a suitable video recorder that stamps or geo-references the output. In addition, a GPS trackline should be recorded at the same time using one-second intervals. This will allow synchronization of the video with the GPS trackline for each shoreline segment. Using a video player to view the stamped video as it is being recorded is an important safeguard to ensure the quality of the final video recording. An example of a video recording set-up is provided in Figure 1. Video files should be post-processed to edit and remove any unwanted frames using appropriate video editing software. A sample video image with embedded coordinates can be seen in Figure 2.

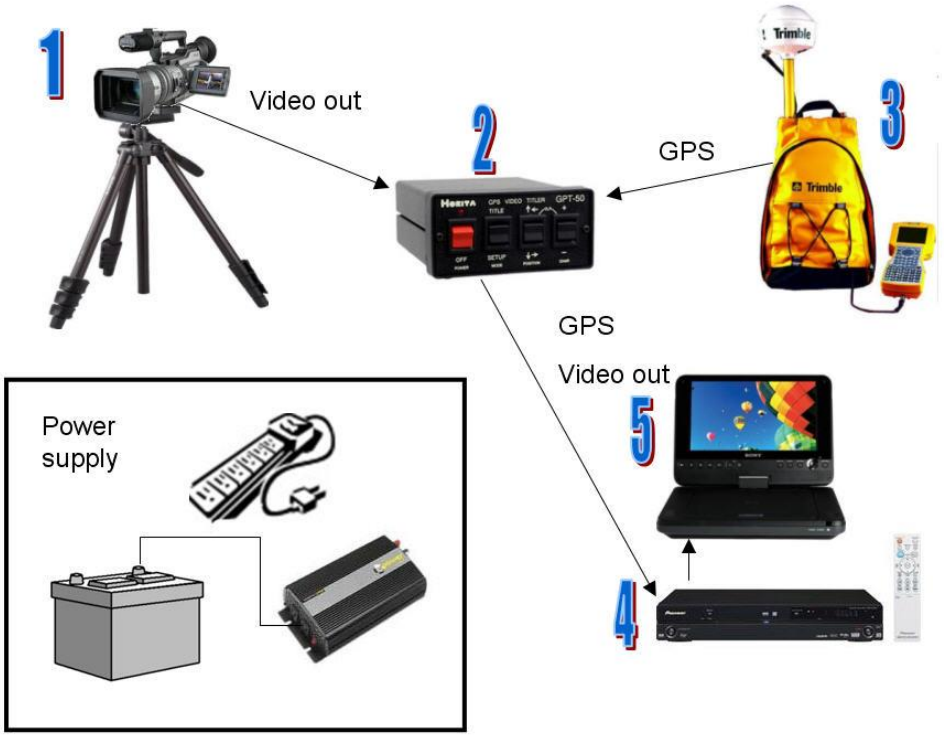


Figure 1. Video documentation set-up. 1) Digital video camera, 2) GPS stamper unit, 3) GPS data logger and receiver, 4) Digital video recorder, 5) Digital video player.

Figure 2. Sample video with boat heading, coordinates, date and time.

2.4 Field Assessment

The field assessment is conducted by boat along the shoreline of the lake. It is recommended that the boat be driven slowly while maintaining a safe distance from the shoreline, where practical. Field assessors should be stationed on the boat for best viewing of the features they are responsible for. There should be enough room for assessors to move around safely to ensure accurate field data collection. Base maps should also be on hand to verify preliminary segment breaks and verify and mark data on aerial imagery or on tablets as required.

Start the survey at a convenient location at the beginning of a segment break. Record general lake characteristics (Section 2.4.2.1), number the shoreline segment (Section 2.4.2.2) and work around the lake sequentially to collect all data fields possible (Section 2.4.2). Take photographs as required to represent each segment and additional features (Section 2.4.3). Only collect data viewed perpendicular to the direction travelled.

The entire field assessment may require several days to complete depending on lake size and will be influenced by lake size and feature complexity, access, field crew and weather conditions. For larger lakes, it may not be possible to sequentially survey the lake. In these cases, care should be taken to make sure that all portions of the lake are surveyed. Also, storms and weather may preclude survey and field crews may need to be highly adaptable during data collection, sometimes alternating sides or areas of lakes that are more safely surveyed. Assessors should review daily weather reports when conducting surveys.

Further details for the FIM field assessment are provided below, including crew and additional equipment requirements as well as data collection methods and specific data entry fields.

2.4.1 Crew & Additional Equipment Requirements

A minimum field crew size of three (including the boat operator) is required. However, a crew of four is recommended to collect shoreline field data and reduce fatigue and stress. At least one of the field crew members must be a QEP (Section 1.3) with relevant qualifications and skills who would be the designated field lead. The field lead must be familiar with the FIMP methods (Section 1.3 & 2.0), data processing and accuracy requirements (Section 5.1) to guide the field assessment. The QEP leading the assessment must be able to direct other crew members and divide up tasks effectively.

There are many data fields that require data to be counted and some interpretation/judgement will be required. Field assessors should be given specific tasks that they oversee and tasks should be assigned based upon the knowledge of the assessor. For example, one assessor would be responsible to enter electronic data, take all photographs and record paper notes. A second assessor would be responsible for feature inventory such as counting docks, retaining walls, large woody debris or stick nests. A third assessor would have the base map and call out segment breaks, determine the HWM, littoral zone, classify substrates and vegetation classes for each segment. It is preferred that assessors focus on specific tasks throughout the duration of the field assessment. This helps minimize the influences of observer bias in the dataset and ensures consistency.

The following is a list of recommended field equipment to use when conducting the FIM field assessment:

1. Baseline field maps (Section 2.2.2)
2. GPS unit and corresponding data dictionary or other compatible technology (with a backup if available)
3. Digital camera (preferably with GPS and time stamp)
4. Waterproof field paper for recording field notes
5. Data sheets on waterproof paper (in case GPS unit fails)
6. Binoculars for viewing shore substrates and other features
7. Thumb counters (4 to 8) for field enumeration of features
8. Required safety equipment (e.g., life vests, first aid kit, boat safety kit etc.)
9. Site-specific safety plan

Backup supplies such as camera batteries, chargers, replacement cords and extra memory cards are useful to bring in the field. Other equipment such as an Ekman dredge may also be helpful for classifying substrate types (Section 2.4.2.5).

2.4.2 Data Collection Methods & Data Entry Fields

The following sections provide detailed field data collection methods and data entry fields to help make field surveys easier. A tabular data entry field summary is provided in Appendix B. Mandatory data entry fields are provided in ***bold*** text and noted in the appendix table.

2.4.2.1 Lake Reference

The Lake Reference section is intended to provide background information regarding the lake that is being assessed, field conditions during the assessment and the crew completing the assessment.

1. ***Lake Name*** – The official name of the lake (gazette or common name) being surveyed from provincially sourced website.
2. *Lake Reference* – The local (alias) regional name for the lake. Examples include "Arms" like Seymour, North or West.
3. *Lake Level* – The current level or elevation of gauged lakes on the date of the assessment. This field should be left blank if the lake level is unknown or if the lake is not gauged. On gauged lakes, lake level is typically the geodetic level (i.e., above sea level) of the lake the day the assessment was completed. However, each gauging station will be benchmarked to a certain level and this standard should be used. This will help people utilizing data understand at what water level the data was collected. Real-time water level and flow data can be found for some lakes in BC at the Environment Canada Hydrometric Data website: https://wateroffice.ec.gc.ca/mainmenu/real_time_data_index_e.html.
4. ***High Water Mark (HWM)*** – The HWM is usually considered the mean maximum water elevation of the lake over a 2- to 5-year period using staff gauge measurements (MoE 2009). If this information is not available, the shoreline should be examined for evidence of the high water mark.

   There are many signs that can be used to determine the high water mark. A water level that is often reached will leave a mark in the lichens on a rock face. Wave action will also clean away some weathering debris so there may be a band that is relatively plain with a few excursions above it that are faintly visible. If there are no clear indicators on the rocks, then examine tree trunks for evidence such as ice damage, which is usually clearly visible. If the survey is conducted shortly after freshet in an area where trees are releasing pollen, then mud, needle or pollen lines may be visible to indicate the high water level. Other indicators include: driftwood berms; driftwood or floating grasses caught in shrubs; small wave-cut benches in side slopes; erosion under trees (where extreme shade has kept the ground bare); small scars on the forest floor; markings on other hard surfaces (e.g., retaining walls); as well as differences in vegetation, especially ferns, mosses, graminoids and herbaceous plants.

   If known, document if it is a normal, subnormal or above normal water year. The purpose of the HWM field is to ensure that the data for the FIM, FHSI and FDG are placed as close to the approximate HWM as possible. *This field is often determined either during the pre-field planning process or is determined during the post-field data collection processing period. FIM does not provide the legal boundaries for properties but focuses on habitat values in the foreshore area.*
5. *Secchi Depth* – Measure the Secchi depth using a Secchi disk (or similar device) to the point where the white line is no longer visible when lowered from the shaded side of a vessel and that point where it reappears upon raising it. The depth of this point is recorded from the water surface to the disk. This measurement should be made at midday as the results are more variable at dawn and dusk. Secchi depths vary depending upon the time of year measured and productivity of a lake, particularly in lakes with increased particulate matter (e.g., algae).

6. ***Organization*** – Identify all the organizations present that are completing the work. Organizations include government, non-profit organization or companies that are responsible for collection of the field data.
7. ***Date and Time*** – Identify the date and time field assessment is completed. Some GPS units may enter this information automatically.
8. ***Crew*** – Field crew completing the assessment. Assessors should enter the initials of all crew members present in the field.
9. *Weather* – Weather is a categorical field and includes: Light Rain, Heavy Rain, Snow/Sleet, Overcast, Clear, Partly Cloudy, and Other. This field should be filled in with the most appropriate weather observed throughout the day. If the Other category is chosen, field assessors should make relevant notes in the Comments field.
10. *Air and Water Temperature* – Temperature (˚C) measured during the start of the assessment. Water temperatures will vary in the water column, around the lake and throughout the day. Typically, temperature is taken off of the depth sounder on the vessel or measured in the first 1 m depth.
11. *Jurisdiction* – The jurisdiction field is to identify the governmental entity that has predominant governance over the shore segment being assessed. Typically, this would be a local government, regional district or a First Nations band. In some cases, the shoreline may occur along Crown land or within a provincial park. A segment break is not required with a change in jurisdiction.
12. *Regional District* – The Regional District electoral area (or other regional political division such as municipality or county) is a defined area within a jurisdiction. A segment break is not required with a change in jurisdiction.
13. *Comments* – The Comments field allows assessors to enter applicable information that is not included in the lake reference data fields above.

2.4.2.2 Segment Class

The Segment Class section is intended to provide a summary of the dominant land uses, shore types, and other characteristics of each shoreline segment.

1. ***Segment Number*** – The shoreline segment number is a field that identifies the segment. The shoreline segment is the fundamental unit of FIM and each segment is characterized by attributes (e.g., land use, shore type and vegetation) that are similar. Typically, shoreline segments begin at 1 and numbers continue sequentially until the entire shoreline has been mapped. However, in some instances, segments may begin at another number, particularly in cases where only portions of a lake are mapped at various time periods. Shoreline segments should generally have similar land use, shore type, vegetation and substrates. The minimum length of a shoreline segment is 50 m and there is no maximum length. It is possible to delineate shorter shoreline segments where unique features or high-value habitats are observed (Section 2.2.3). It is acceptable to break preliminary shoreline segments determined during the pre-field assessment (Section 2.2.3) into additional segments because the resolution of aerial imagery is at a small scale and may not depict features that are only observable on the ground. Generally, assessors will create more segments in densely developed areas due to changes in vegetation cover and land use than they will under more natural conditions where shorelines tend to be more similar for longer stretches. Shoreline segment densities tend to be greatest in urbanized areas and less in areas of Crown land.
2. ***Shore Type*** – Shore type is a categorical field that describes the predominant shore type that occurs along the length of the shoreline segment (i.e., the highest percentage of the linear shoreline length). Shore types include Cliff/Bluff, Rocky Shore, Gravel, Sand, Stream Mouth, Wetland and Other. If Other is selected, comments should be included to describe the shore type observed. Definitions for each of these shore types are found in Section 2.4.2.3.
3. ***Shore Type Modifier*** – The shore type modifier field is used to describe significant activities that influence the shoreline. This categorical field includes: Log Yard, Small Marina (6–20 slips), Large Marina (greater than 20 slips), Railway, Roadway, Utility Corridor (hydro, gas, fibre-optic), None and Other. If Other is selected, the Comments field should be used to identify the modifier. If the field is left blank or None is chosen then there is no shoreline modifier.
    i. *Log Yard* – A log yard is an area where logs are temporarily stored until they are moved to a lumber mill. Log yards typically have large log breakwaters, log booms and associated loading/unloading facilities.
    ii. *Large and Small Marina* – A marina is any type of location where boats are moored. A boat slip is where each boat is moored and each finger of a dock may be used to moor two boats (i.e., one on each side). Marinas can either be on pile-supported or floating structures. Marinas may have associated breakwaters, fuelling stations and boat launches, for example. Also, marinas can be associated with commercial or multi-family dwellings. A small marina is defined as having 6–20 slips, whereas a large marina has >20 slips.

iii. *Railway* – Railways constructed within shoreline segments are another shore modifier. Railways should only be considered a modifier when they are having a detrimental impact on the shoreline, which typically occurs when the railway is within 10 to 25 m of the HWM and there are no private holdings between the railway and the shoreline. Decommissioned railways can be considered a railway shoreline modifier.

iv. *Roadway* – The roadway modifier identifies shore segments where a roadway occurs directly adjacent to the shoreline. Roadways should only be considered a modifier when they have a detrimental impact on the shoreline. This typically occurs when the road is within 10 to 25 m of the HWM and there are no private holdings between the roadway and the shoreline. Boat launch access roads are not considered a roadway shoreline modifier.

4. ***Slope*** – Slope is a categorical field that determines the slope or gradient of the shoreline segment. Categories include Low (less than 5%), Medium (5–20%), Steep (20–60%), Very Steep (>60%) and Bench. A Bench is a shoreline with a flat area typically greater than 15 horizontal metres between a typically steep or very steep section rising from the water and another steep or very steep section above the flat area. On bluff shore types, where the shoreline rises sharply and then flattens, the categorical statement should describe the steep portion of the shoreline (i.e., do not use bench).

5. ***Land Use*** – Land Use is a categorical field that is used to describe the predominant land use observed along the segment in an area of up to 50 m within the Vegetation Band zones (Section 2.4.2.6.) Categories include: Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single-Family, Rural and Urban Park. Land use can be determined based upon a combination of field observation, review of zoning and bylaw maps, and air photo interpretation. Refer to detailed definitions of the land use types in Section 2.4.2.4.

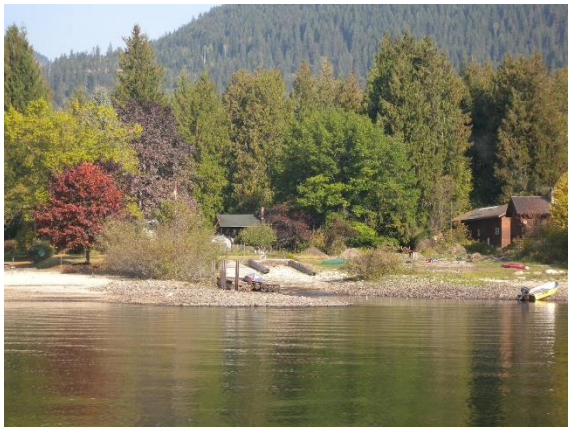
6. ***Level of Impact*** – Level of Impact is a categorical field that is used to describe the general disturbance that is observed along the shoreline and is largely based upon the percentage of the shoreline that is natural or disturbed as discussed below. Disturbances are considered to be any anthropogenic influence that has altered the shoreline including substrates, vegetation or the shoreline itself (e.g., retaining walls). Level of Impact is considered by both looking at the length of the shoreline segment and the depth of the foreshore zone area assessed. In more rural settings, typically the assessment area is greater (i.e., up to 50 m) and in more developed shorelines the assessment area is less (i.e., up to 30 m). In cases of roadways or railways, one should generally consider the location of the rail or roadway along the segment (i.e., how far back is it set, is there lake infill etc.). To determine Level of Impact, aerial imagery interpretation is recommended. Level of Impact categories include High (>50%), Medium (10–50%), Low (<10%) or None and should be largely based upon the percentage disturbed for the segment discussed below. Consistency of determination is very important and assessors should use the same criteria to determine the level of impact. The *Level of Impact* is defined as follows:

    i. *None* – Segments that are completely natural with no disturbance or impacts.

    ii. *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 very few or no shoreline modifications.

The photos above are examples of shorelines with None (left) and Low (right) level of impact.

iii. *Medium* – Segments that show medium 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 most of the foreshore segment.

The photos above are examples of shorelines with Medium level of impact.

iv. *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. Shoreline modifications are extensive and likely continuous or include many docks. Generally, residential development is high intensity. Modifications often impact most of the foreshore.


The photos above are examples of shorelines with High level of impact.

7. *Livestock Access* – Livestock access is a categorical field that is used to determine whether livestock, such as cattle, have access to the foreshore. This is usually determined during the pre-field assessment or during post-processing office analysis. Field observations may be made but confirmation should also be made using land-based maps. Choices include Yes, No or blank. If the field is left blank, one should assume that cattle do not have access.

8. ***Disturbed*** – The disturbed field allows assessors to enter the percent of the shoreline that is disturbed by anthropogenic influence. This is a measurement of the approximate length and depth (i.e., up to 50 m) of the shoreline segment that has been disturbed. Assessors should use a combination of field observations and aerial imagery to determine the percentage disturbed using 5% increments. Generally, the percentage disturbed should correspond to the Level of Impact (i.e., a high percentage of disturbance should translate into a High Level of Impact). The summation of the Percent Disturbed and the Percent Natural should equal 100%. If baseline field maps are available, use of a scale ruler can help assessors determine the percentage that has been disturbed. Although this field is somewhat qualitative, assessors should do their best to be consistent and to be as quantitative as possible.
9. ***Natural*** – The Natural field is the percent of the shoreline segment that is natural. This is a measurement of the approximate length and depth (i.e., up to 50 m) of the foreshore that remains in a natural condition. Assessors should use a combination of field observations and aerial imagery to determine the Percent Natural using 5% increments. Generally, the Percent Natural should correspond to the Level of Impact. The summation of the Percent Disturbed and the Percent Natural should equal 100%. If baseline field maps are available, use of a scale ruler can help assessors determine the percentage that has been disturbed. Although this field is somewhat qualitative, assessors should do their best to be consistent and to be as quantitative as possible.

The remaining fields included in the FIM database (i.e., Photo, Tape, Video and comments) are provided in Appendix A. These fields do not have any specific methodology, are not mandatory and are for information purposes.

2.4.2.3 Shore Type

The Shore Type section is intended to provide a summary of the different shore types that may occur over the entire shoreline segment. In many cases, one shore type will be predominant in a segment, with other shore types occurring to a smaller extent. Examples of this include rocky shorelines with intermittent gravel beaches in depositional areas. The shore type section allows assessors to enter in the approximate percentage of the shoreline segment that is occupied by the different shore types.

For all categories it is important to remember that the major landform is the definitive feature and not the foreshore fringe (see photo examples below).

When determining the percent of a segment that a shore type occupies, assessors should utilize whatever data is available to them such as aerial photos. The baseline field map prepared during the pre-field assessment can be used to determine the approximate percentage. If field maps are not available, assessors should use best judgement to estimate the percentages. It is important that consensus is generally achieved between assessors. As segment lengths become longer, it becomes more difficult to estimate the shore type percentage. Sometimes dividing a long segment into subsections and averaging the scores can be helpful to keep track. Given this, an assessor should be cognizant of the distance travelled, boat speed and other factors when judging the percentage of the segment. A hand-held GPS and field maps are helpful for this purpose. *When a specific shore type is present in amounts less than 5% but it is difficult to determine the percent value to assign it, then an amount of 1% can be used.*

The following is a summary of data fields and methods for this section of the data dictionary.

1. ***Cliff/Bluff*** – The Cliff/Bluff field allows assessors to enter the percent of the segment, based upon the shoreline segment length, that is a cliff or bluff shore type. A cliff shore type is typically very steep with substantial vertical elements that are greater than 70º or 75%. A bluff shore type is typically steep or very steep and then flat for a substantial distance, typically formed by the fast recession of water levels during glacial periods. Bluff substrates tend to consist mostly of silts and clays.

The photos above are examples of Cliff shoreline (left) and Bluff shoreline (right).

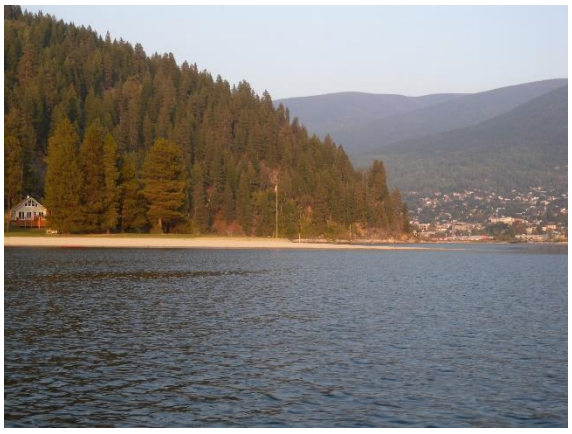
2. ***Rocky*** – The Rocky shoreline field allows assessors to enter the percentage of the segment that is rocky, based upon the shore segment length. Rocky shores consist mostly of boulders and bedrock, with components of large cobble and some gravels. These shores tend to occur on steeper shorelines. Percentages of bedrock versus cobble/boulder substrates can vary considerably, yet still be considered Rocky shoreline.

The photos above are examples of typical Rocky shorelines.

3. ***Gravel*** – The Gravel shore type field contains the percentage of the segment, based upon the shore segment length, that is a Gravel beach. Gravel beach shorelines tend to occur on Low or Medium slopes and substrates are predominantly gravels and cobbles. These shore types may also contain small percentages of boulders and/or bedrock. Often, gravel beaches and rocky shorelines occur along one segment, with Gravel shore types occurring in depositional areas (i.e., in bays) and Rocky shores (i.e., at points) occurring in erosion areas.


The photos above show typical Gravel shores. Notice that substrates consist mostly of gravels and cobbles. Gravel shore types may also have boulders and periodic patches of bedrock in some instances.

4. ***Sand*** – The Sand shore type field contains the percentage of the shoreline, based upon the shore segment length, that is a sand beach. Sand beach shorelines tend to occur within low gradient areas and are predominated by sands and small gravels. These shore types may also contain some gravel shoreline areas in places that are more exposed to wind and wave action (e.g., points).




The photos above show typical Sandy shore types.

5. ***Stream Mouth*** – The Stream Mouth field contains the percentage of the shoreline, based upon the shore segment length, that is a stream mouth or confluence. A stream mouth is defined as the space where there is a confluence between a lake and a stream or a river, and the stream has direct influence on sediment movements and deposition or is part of the active floodplain or alluvial fan. Typically, the stream mouth segment is larger for rivers and smaller for creeks and includes the associated floodplains for the river system.

   A point location (i.e., nested point site) is added for stream mouths where the length along the shoreline is less than 50 m. A separate segment should be created for stream mouths where the length along the shoreline is greater than 50 m. Size can be adjusted based on aerial photographs (Section 2.2.3) and/or during GIS processing (Section 5.0). The photo on the left below shows a stream mouth that, if its size is only within the extent of the photo, would likely be added as a point location. The photo on the right shows a segment that is entirely Stream Mouth (i.e., area where the stream meets the lake and the sediments mobilized and deposited by the stream are greater than 50 m length). The Stream Mouth segment lengths may be greater than those shown in the photos if the site is a complex floodplain association typical of larger river deltas. Fish presence and runs of salmonids are often deciding factors when differentiating between an independent segment or an embedded stream point location.

The photos above are Stream Mouth examples.

6. ***Wetland*** – The Wetland shore type field contains the percentage of the shoreline, based upon the shore segment length, which is a shore marsh wetland. A wetland segment typically occurs on low gradient sites; the littoral zone is wide and shallow; substrates are predominantly silts, organics or clays; and there is emergent vegetation present. *Wetlands of British Columbia* (MacKenzie and Moran 2004) defines a shore marsh as a seasonally or permanently flooded non-tidal mineral wetland that is dominated by emergent grass-like vegetation. MacKenzie and Moran (2004) provide descriptions of some of the wetland shore types that may be observed along lake shorelines.

   Wetlands that span greater than 50 m along the segment should be designated as their own segment. Wetlands that span less than 50 m along the segment should be added as a point location with description added in comments. For segments with large shore wetlands or emergent vegetation, Littoral Zone bands can be used to provide a more accurate description of the area (Section 2.4.2.6).


The photos above are examples of Wetland shore type. Notice the significant amounts of emergent vegetation. *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004) provides specific classifications for the different types of wetlands that occur.

7. *Other* – The Other shore type field allows assessors to enter in shore types that do not fit into one of the general categories above. If the Other shore type field is used, assessors should add comments to describe the shore type and provide justification for use of this field. Examples of other shore types may include constructed boat access canals or other shoreline segments that are highly modified. This field is usually used to describe areas of very high urbanization where the historic shore type is no longer readily apparent.
8. *Shore Type Comments* – The Comments field allows assessors to enter applicable information that is not included in the shore type data fields above.

2.4.2.4 Land Use

The Land Use section allows assessors to provide more detail regarding existing land uses. Land use categories have been created to generally correspond with a broad range of local government zoning bylaws. Other categories have been created to correspond with provincial, non-profit and federal government land use types (e.g., natural areas parks, conservations areas etc.). In many cases, shoreline segments will have only one land use type. However, in some instances, land uses may slightly vary along a segment and the differences do not warrant creation of a new shoreline segment. Use the land use percentage based upon the shore segment length the different land uses occupy.

During the field assessments, scaled aerial imagery can be used to determine the approximate percentage. If field maps are not available, assessors should use best judgement to estimate the percentages. As segment lengths become longer, it becomes more difficult to estimate the percentage of a segment a particular shore type occupies. Given this, an assessor should be cognizant of the distance travelled, boat speed and other factors when judging the percentage of the segment. Land Use is assigned to the area from the HWM to 50 m upland.

1. ***Agriculture*** – The Agriculture land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for crop-based agricultural or as active livestock range lands (i.e., extensive holding areas, large numbers of cattle etc.). Livestock pastures that are not active rangelands (i.e., a few cows or horses) are typically considered a Rural land use and not an Agriculture land use (see Rural). These lands are typically part of the Agricultural Land Reserve or a provincial range tenure.
2. ***Commercial*** – The Commercial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for commercial purposes. Commercial purposes include anything that is operated as a business such as retail, hotels, food establishments, marinas with fuel, stores and can also include campsites used for recreation and RV pads etc. Commercial areas tend to occur along highly impacted shorelines. Where feasible, significant commercial areas should be part of one segment because the land use on these shore types has a different assortment of potential impacts. Commercially zoned areas that are not yet to be constructed may also warrant their own segment.
3. ***Conservation*** – The Conservation land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for conservation of critical or important habitats. Examples of Conservation shorelines include lands held by the Land Conservancy, biological reserves etc. Conservation lands cannot occur on privately held shorelines unless conservation covenants or other agreements are in place to protect areas in perpetuity.
4. ***Forestry*** – The Forestry land use field is the percentage of the shoreline, based upon the shore segment length, where there is visible evidence of impacts of past or present forestry operations. These areas are typically Crown lands that are part of active cut blocks or forestry operations. Log yards are considered an industrial land use and are not considered a Forestry land use because they tend to have associated industrial infrastructure.
5. ***Industrial*** – The Industrial land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for industrial purposes. Examples of industrial purposes include log yards, processing facilities, lumber mills etc. These shorelines are typically heavily impacted by infrastructure, impervious surfaces, buildings etc.
6. ***Institutional*** – The Institutional land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for institutional purposes. Examples of Institutional land uses include schools, public libraries etc.
7. ***Multi-Family Residential*** – The Multi-Family Residential land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for multi-family residences. Multi-family developments are typically condominiums, apartments, or town homes.
8. ***Natural Areas*** – The Natural Areas land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly undisturbed Crown lands. These areas do not occur in provincial or federal parklands and cannot be privately held.

9. ***Park*** – The Park land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly natural area parklands. These park areas can be provincial, federal or local government parks. These parks tend to be relatively undisturbed and natural. They differ from urban parks (discussed below), which are used intensively for recreational purposes (e.g., public beaches).
10. ***Rural*** – The Rural land use field is the percentage of the shoreline, based upon the shore segment length, which is predominantly used for rural purposes. These shorelines are typically large lots, private estates or hobby farms. If the home is on a parcel of at least one hectare or more (varies depending on zoning bylaws) and more than 50% of the land is vacant then likely the land use can be designated as Rural. Properties that supply their own heating source, water or septic systems are also more likely to be considered rural. Differentiation between Rural and Single-Family land use can be difficult when lots are narrow but deep (i.e., buildings appear dense on the shoreline but extend quite far back). When doubt exists between a Rural and Single-Family land use designation (see below), assessors should be consistent in their judgements and refer back to local government zoning or bylaws to help decide on the appropriate land use type.
11. ***Single-Family Residential*** – The Single-Family Residential land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used for single-family residential purposes. Typically, single-family residential occurs in more densely developed areas. However, seasonal use cottages or cabins can often be considered single-family residential areas if the dwellings have associated outbuildings, docks and other features consistent with more densely developed areas. In areas where there are numerous seasonal use cabins and cottages, assessors should consider this single-family residential if lots have smaller lake frontages and land uses and buildings are consistent with single-family types of development. If lake frontages for seasonal use cabins and cottages are quite large, the land use would be considered rural. The differentiation between Rural and Single-Family in these cases can be difficult and assessors should be consistent in their determination.
12. ***Transportation*** – Transportation land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used as a transportation corridor. Examples of this land use include public roads or railways directly adjacent to the shoreline; sometimes fill into the lake is even present. Shorelines dominated by this land use tend to have limited riparian vegetation in locations of fill but can maintain larger buffers if initial road or rail construction was set back from the watercourse. This land use type may not extend the 50 m upland as is required for the other land use categories.
13. ***Urban Park*** – The Urban Park land use field is the percentage of the shoreline, based upon the shore segments length, which is predominantly used as an urban park. Examples of this land use include public beaches, picnic areas etc. Shorelines dominated by this land use tend to have limited riparian vegetation and contain extensive areas of turf in the understory.

14. ***Utility Corridor*** – Utility Corridor land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used as a transmission corridor. Examples of this land use includes gas, hydro and fibre-optic. Shorelines dominated by this land use tend to have limited riparian vegetation in locations of fill but can maintain larger buffers if initially constructed with a setback. This land use type may not extend the 50 m upland as is required for the other land use categories.
15. *Land Use Comments* – The Comments field allows assessors to enter applicable information that is not included in the land use data fields above.

2.4.2.5 Substrates

The Substrate section allows assessors to enter detailed information regarding Foreshore and Littoral Zone Substrates. Substrates are important for a variety of reasons and can influence primary productivity. When describing substrates, assessors should describe the *representative distribution* of substrates along the shoreline segment. It is acknowledged that substrates are variable along segments with many areas having concentrations of coarse or fine materials. Thus, this section provides a description of the general distribution of substrates and may not be representative of micro-sites that occur along the segment.

When assessing substrates, the entire shore segment should be considered. In many cases, small amounts of a substrate type may be observed (e.g., one small bedrock outcrop along a gravel shoreline). In these cases, a value of 1% should be used to acknowledge the presence of this substrate type along the shoreline segment. As segment lengths become longer, it becomes more difficult to estimate the percentage of a segment that the substrate type occupies. Given this, an assessor should be cognizant of the distance travelled, boat speed and other factors when judging the percentage of the segment. Typically, dominant substrates are described in 5% increments and 1% or 2% increments are used for less prevalent substrates along a segment.

Foreshore Substrates

Foreshore substrates occur from the edge of the approximate low water mark (LWM) to the HWM and are best viewed at low water levels because more of the foreshore is visible. However, often assessments do not coincide with these periods. Thus, binoculars are extremely helpful to estimate substrates along a shoreline. In addition, polarized sunglasses are helpful to see substrates that are underwater, and assess particle size to appropriately fill in data fields. Underwater observation with mask and snorkel may be necessary in some conditions.

Assessors should also exit the vessel and visually inspect foreshore substrates within representative areas of the shoreline segment as required. The data fields allow assessors to enter in detailed information for highly visible shorelines and summary information for less visible shorelines. For example, gravels can be entered more generally as Gravels or subdivided into Fine Gravels and/or Coarse Gravels. Presence can be indicated by using a value of 1%, whereas none would be left blank or with a 0.

The following are descriptions of the different Substrate type fields and definitions applicable for Foreshore and Littoral Substrates. The substrate definitions below are derived from the SHIM manual (Mason and Knight 2001) and Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures (RIC 2001).

1. ***Marl*** – The Marl substrate field is the relative percentage of marl occurring along the shoreline segment. Marl is a substrate that is typically white in colour, associated with clear lakes and consists of loose clay, precipitated calcium carbonate, mollusk/invertebrate shells and other impurities. Marl substrates would often be associated with fines, mud or organics depending upon the lake. *Foreshore areas are not likely to have marl, but this field has been left in to be consistent with the Littoral Substrate suite of fields.*
2. ***Mud*** – The Mud substrate field is the relative percentage of mud occurring along the shoreline segment. Mud is a substrate that is typically dark in colour and consists of a mixture of silts, clays and finely decayed organic material that is not typically discernable.
3. ***Organic*** – The Organic substrate field is the relative percentage of organic materials that occur along the shoreline segment. Organic substrates are typically associated with wetland sites and consist of detritus material that is identifiable to some extent (e.g., sticks, leaves etc.). Organics generally do not form a large proportion of the substrates unless the shore segment is an extremely productive wetland.
4. ***Fine*** – The Fine substrate field is the relative percentage of fines that occur along the shoreline. Fines consist of silts and clays and these substrates are typically less than 0.06 mm in size. Fines are differentiated from mud because there is little to no organic content.
5. ***Sand*** – The Sand substrates field is the relative percentage of sands that occur along the shoreline segment. Sands are any particle that contains granular particles visible to the naked eye. These particles are typically 0.06 to 2 mm in size.
6. ***Gravel*** – The Gravel substrates field is the relative percentage of gravels that occur along the shoreline segment. Gravels are particles that range from 2 mm to approximately 64 mm. Thus, they are the size of a ladybug to the size of a tennis ball or orange. *This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine or coarse gravels are present (see below).*
7. ***Fine Gravel*** – The Fine Gravel substrates field is the relative percentage of fine gravels that occur along the shoreline segment. Fine gravels are particles that are 2 mm to approximately 16 mm or the size of a ladybug to the size of a grape. This field should only be used when assessors have good visibility and can confidently identify fine gravels. *If this field is used, the general Gravel category (above) should not be used.*
8. ***Coarse Gravel*** – The Coarse Gravel substrates field is the relative percentage of coarse gravels that occur along the shoreline segment. Coarse gravels are particles that are 16 mm to approximately 64 mm or the size of a grape to the size of a tennis ball or orange. This field should only be used when assessors have good visibility and can confidently identify coarse gravels. *If this field is used, the general Gravel category (above) should not be used.*
9. ***Cobble*** – The Cobble substrates field is the relative percentage of cobbles that occur along the shoreline segment. Cobbles are particles that are 64 to 256 mm in size (tennis ball to basketball). *This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine or coarse cobble substrates are present (see below).*

10. ***Fine Cobble*** – The Fine Cobble substrates field is the relative percentage of fine cobbles that occur along the shoreline segment. Fine cobbles are particles that are 64 to 128 mm in size (tennis ball to coconut). This field should only be used when assessors have good visibility and can confidently identify fine cobbles. *If this field is used, the general Cobble category should not be used.*
11. ***Coarse Cobble*** – The Coarse Cobble substrates field is the relative percentage of course cobbles that occur along the shoreline segment. Coarse cobbles are particles that are 128 to 256 mm in size (coconut to basketball). This field should only be used when assessors have good visibility and can confidently identify coarse cobbles. *If this field is used, the general Cobble category should not be used.*
12. ***Boulder*** – The Boulder substrates field is the relative percentage of boulders that occur along the shoreline segment. Boulders are particles that are greater than 256 mm in size (bigger than a basketball). These substrates cannot typically be lifted by one person as they are too heavy.
13. ***Bedrock*** – The Bedrock substrates field is the relative percentage of bedrock that occurs along the shoreline segment. Bedrock is considered any rock where blocks are larger than 4 m or is a solid, unweathered underlying rock.
14. *Substrate Embeddedness* – Embeddedness as a categorical field is the approximate embeddedness of substrates along the shoreline segment. Embeddedness is a measure of the degree to which boulders, cobbles and other large materials are covered by fine sediments. Categories for embeddedness include None (0%), Low (0 to 25%), Medium (25–75%), High (>75%) or Unknown. When assessors are unclear of the embeddedness they should either complete actual field measurements of a representative subsample of substrates throughout the shoreline segment or leave the field as unknown.
15. *Substrate Shape* – Shape is a categorical field that is the shape of larger particles such as cobble or boulders along the shoreline segment. Angular shapes refer to naturally occurring angular rock material that has not been substantially weathered. Blast rock refers to angular blast rock materials, such as riprap. Smooth materials are rocks that are generally rounded. This field should be used to describe the predominant substrates that occur along the shoreline (e.g., if 85% of the substrates are round and smooth and 10% are blast rock, the field should be used to describe the 85%).
16. *Substrate Comments* – The Comments field allows assessors to enter applicable information that is not included in the substrates data field above.

Littoral Substrates

Littoral substrates occur within the areas below the Low Water Mark (LWM) to a point where light penetration to the bottom no longer occurs; this varies but is usually around a depth of 6 m at the LWM. As with Foreshore Substrates, visual inspection of underwater substrates using a variety of different means should be considered when classifying littoral substrates. Ekman dredges can also be used but visual inspection is preferred. Substrate categories for the littoral zone are defined as listed above under Foreshore Substrates. Littoral Substrates are differentiated by the three letter "LIT" in front of the substrate category (e.g., LIT_FINES; Appendix A). Classification of Littoral Substrates along each shoreline segment is *not* a mandatory field. *If multiple bands of substrates are needed, they can be added as additional layers. A depth field could be added to accommodate marking the slope length of the assessed area as needed. This adaptation of the method would be used in a larger, managed reservoir and should be identified in the pre-field inventory.*

2.4.2.6 Vegetation Bands (B1 and B2)

The Vegetation Bands sections describe foreshore vegetation that occurs within 50 m of the HWM, or the nearest continuous band of riparian vegetation. There are two distinctive vegetation zones that should be inventoried: Vegetation Band 1 and Vegetation Band 2 (Figure 3). These vegetation bands exist adjacent to lakes and are representative of riparian habitat. The zones are differentiated between riparian and upland vegetation types such as coniferous forest. The vegetation bands often reflect how moisture regime transitions from riparian to drier upland areas. For example, in many wetlands, there is a wide band of emergent shrubs and willows and then a riparian zone beyond the wetland features.

Often, in floodplain areas, the HWM may be higher in elevation than the nearest band of shrub-like riparian vegetation. In this case, the nearest band of riparian is described as Vegetation Band 1 and the secondary forested areas are described as Vegetation Band 2. In the cases of large floodplains, the bands of vegetation are more complicated and should be supported by aerial imagery. The approximate width of the bands considered is the sum of Vegetation Band 1 and 2. In these highly complex areas, mapping vegetation with polygons in GIS is often preferred. *Wetland features such as cattail marshes are a Shore Type (see Section 2.4.2.3).*

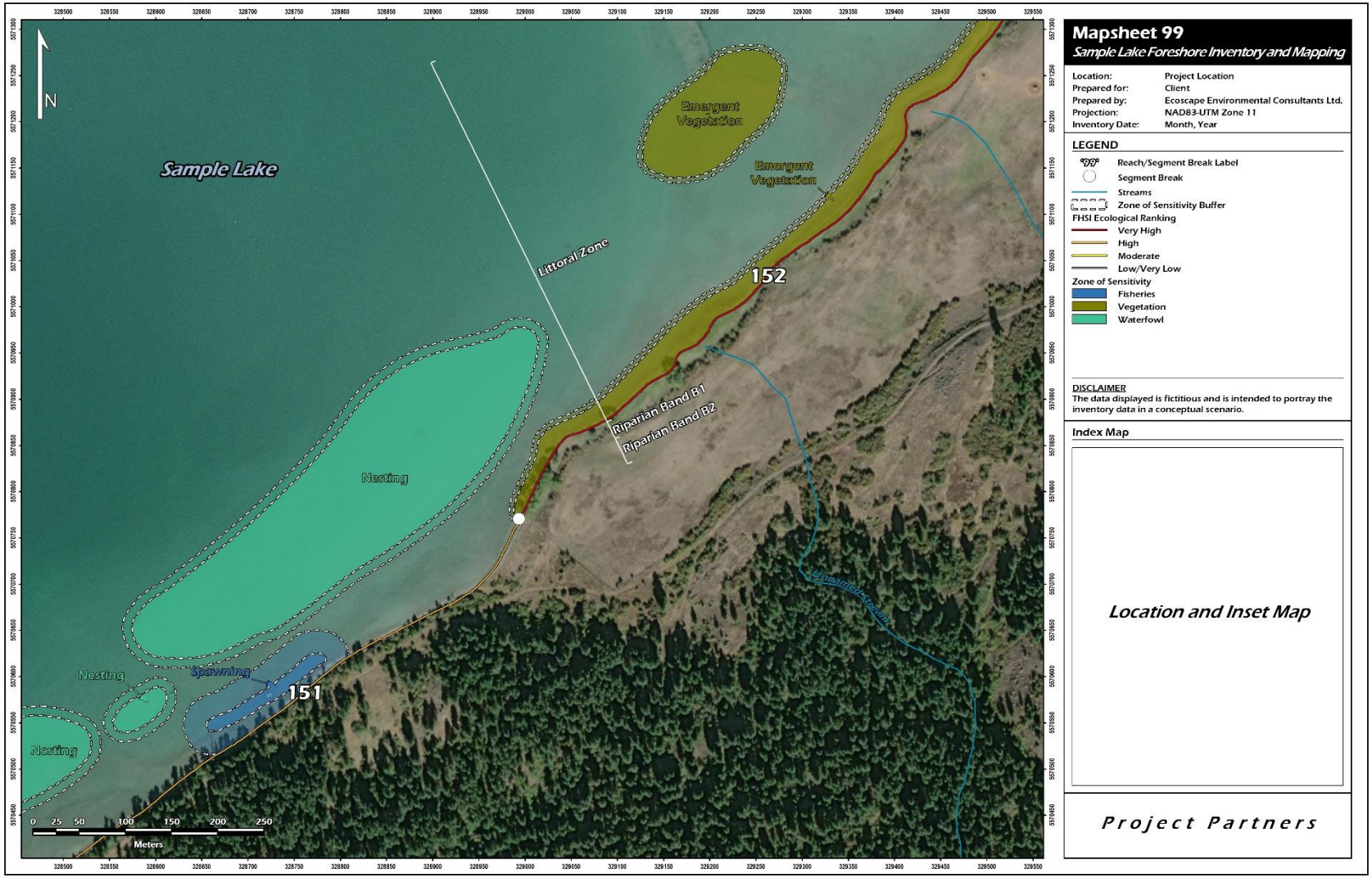


Figure 3. Diagram representing vegetation bands, highlighting mapping convention for complex shorelines.

In highly urbanized or impacted areas, it is often difficult to define a clear vegetation band. In these cases, it is generally preferred to limit the assessment to the first row of development, which often results in describing only one vegetation band. In other cases, shorelines may not contain two distinctive bands of vegetation. In these circumstances, assessors should only describe the shoreline with one vegetation band, leaving the second band blank. The Comments field is a useful section that allows assessors to describe exactly what is being described. Also, the bandwidth fields (discussed below) are helpful because they give an indication of the width of the vegetation band.

Vegetation bands can be extremely variable along a segment. Assessors should focus on the primary or dominant vegetation observed along the segment and people utilizing the data must understand that this overview inventory cannot describe every micro-site that may exist. When assessing the different bands, assessors should consider both the linear length and depth of the bands and critically evaluate if the complexities of the riparian vegetation warrant additional segments. The intent is to describe a representative section of the shoreline segment.

The following sections describe all fields that may occur in Vegetation Bands 1 and 2.

1. ***Vegetation Class*** – This is a description of the predominant vegetation class present in Vegetation Band 1 or 2. Categories a) through f) are from Ministry of Environment TEM standards (MoE 1998) and the categories g) through j) are largely derived from the SHIM Module 4 (Mason and Knight 2001).
    a. The *Coniferous* Class occurs where tree cover is at least 20% of the shore zone area and at least 75% of the trees are coniferous.
    b. The *Broadleaf* Class occurs where the tree cover is at least 20% and at least 75% of the trees are broadleaf or deciduous.
    c. The *Mixed Forest* Class occurs where tree cover is at least 20% and there are no more than 75% coniferous trees or broadleaf trees.
    d. The *Shrubs* Class occurs where tree coverage is less than 10% and shrubs cover at least 20%. Shrubs are defined as multi-stemmed woody perennial plants.
    e. The *Herbs/Grasses* Class occurs where there is less than 10% tree coverage, less than 20% shrub coverage and greater than 20% herbs/grasses coverage.
    f. The *Exposed Soil* Class occurs where recent disturbance, either anthropogenic or natural, has occurred and mineral soils are exposed and vegetation cover is less than 5%.
    g. The *Landscape/Lawn* Class refers to urbanized areas where most natural vegetation has been replaced by at least 30% coverage of ornamental trees, shrubs, and other vegetation. This class also includes areas where turf grasses cover at least 30% of the area.
    h. The *Natural Wetland* Class occurs where shore marshes dominate the shore zone area and they have not been significantly influenced by human disturbance.
    i. The *Disturbed Wetland* Class occurs where shore marshes predominate the shore zone area and they have experienced significant disturbance (i.e., greater than 30%).

j. The *Row Crops* Class occurs in agricultural areas where crops are growing. If sites are agricultural, but are not used for row crops (e.g., pasture lands), they should be described as Herbs/Grasses and comments should be used to indicate the agricultural nature of the shore segment.

k. *Unvegetated Sites* occur where there is less than 5% vegetation cover and at least 50% of the vegetation cover is mosses or lichens. Unvegetated sites tend to occur on rocky, exposed shorelines.

2. ***Vegetation Stage*** – This is a description of the structural stage of the dominant vegetation in Vegetation Band 1 or 2. Categories are largely derived from the SHIM Module 3 and the Standard for Terrestrial Ecosystem Mapping in British Columbia (MoE 1998). On highly developed shorelines, assessors should attempt to describe the structural stage of the dominant vegetation type observed.

   i. *Sparse* describes sites that are in the primary or secondary stages of succession, with vegetation consisting mostly of lichens and mosses, the total shrub coverage is less than 20% and tree coverage is less than 10%.

   ii. *Grass/Herb* describes sites where shore zones are dominated by grasses and herbs as a result of persistent disturbance of natural conditions (e.g., grasslands).

   iii. *Low Shrubs* describes sites that are dominated by shrubby vegetation less than 2 m in height.

   iv. *Tall Shrubs* is dominated by vegetation that is 2 to 10 m in height and seedlings and advance regeneration may be present.

   v. *Pole/Sapling* describes sites that contain trees greater than 10 m in height, typically densely stocked and there is little evidence of self-thinning or differentiation of the canopy into layers.

   vi. *Young Forest* describes sites that are typically less than 40 years old (but could be as great as 50 to 80 years depending upon the forest community), self-thinning is evident and the forest canopy has begun to differentiate into distinct layers.

   vii. *Mature Forest* describes sites that are typically 40 to 80 years old (but could be as high as 140 years) and the understory is well developed with a second cycle of shade trees.

   viii. *Old Forest* describes sites that are typically greater than 80 years old and the stands are structurally complex. Old Forests contain abundant coarse woody debris at varying stages of decay. Old Forests are at least 80 years in age but may be as old as 250 years and should be considered relative to the forest community assessors are in.

3. ***Shrub Cover*** – Shrub Cover describes shrub coverage within the shore zone. Shrubs are defined as multi-stemmed woody perennial plants. Sparse sites have less than 10% shrub coverage. Medium shrub coverage occurs on sites that have between 10 to 50% coverage. Abundant shrub coverage occurs on sites that have greater than 50% shrub coverage.

4. ***Tree Cover*** – The Tree Cover categorically describes tree coverage within the shore zone. Sparse sites have less than 10% tree coverage. Medium tree coverage occurs on sites that have between 10 to 50% coverage. Abundant tree coverage occurs on sites that have greater than 50% tree coverage.

5. ***Distribution*** – The Distribution field is used to describe the continuous nature of the vegetation band along the entire shoreline segment. Categories include Continuous and Patchy (i.e., for sites where the dominant vegetation band occurs in patches along the segment). An example of a patchy distribution is a shoreline segment where most areas are extensively landscaped, except for a few shore lots which remain relatively natural. In this case, the dominant landscaped area would be described and comments would be used to identify residual natural areas.
6. ***Bandwidth*** – The Vegetation Band 1 bandwidth field is used to provide an estimate of the approximate width of the band being described in metres. In cases where bandwidth varies along the segment, a representative width should be used to describe the shoreline segment. The intent of this field is to provide a general description of the width of the vegetation band that is being described. If more detail is required, vegetation mapping may be necessary.
7. *Overhanging Vegetation* – The Overhanging Vegetation field is used to describe the percentage of the shore segment length that contains significant overhanging vegetation. Overhanging vegetation should be considered as if the lake level was at the HWM. This is usually difficult to determine in the field and should be considered during post-processing as a GIS exercise (Section 2.6).
8. *Comments* – The Comments field allows assessors to enter applicable information that is not included in the data fields above.

2.4.2.7 Littoral Zone (LZ) Bands

The Littoral Zone section includes biophysical information about the littoral zone within the shoreline segment. Aerial imagery is extremely helpful for determining the width of this zone. In large reservoirs, there is often a need to describe the different areas of the drawdown and this suite of data can be used.

As many littoral bands as needed can be added, where GIS polygon mapping of the shoreline is likely better than FIM field data for complex drawdown zones. The data for the littoral zone is also summarized by different broad categories of data that may occur in each band, such as aquatic vegetation, substrate or large woody debris (Figure 3). It is likely there is only one Littoral Zone band in lakes that are not highly managed (i.e., reservoirs).

1. Littoral Zone Band# – The Littoral Zone Band# field allows the user to identify and add in bands as required. *In more natural lakes there will be only one.* Users can enter one but should also assume that a Null infers only one littoral zone band.
2. *Littoral Zone* – The Littoral Zone category provides a general classification of the littoral zone width. Wide littoral zones are greater than 50 m. Medium littoral zones are 10 to 50 m in width and narrow littoral zones are less than 10 m wide.
3. *Littoral Zone Width* – The Littoral Zone Width field allows assessors to enter the average littoral width of the segment in metres. This field can be determined using air photo interpretation or field measurements. Typically, the field is rounded to the nearest 5 m as the number is intended to be representative of the segment. In cases of large drawdowns and multiple bands, the width is the approximate slope distance of the band being described.

4. *Drawdown Zone Slope* – Drawdown Zone Slope is a categorical determination of the predominant slope of shoreline. Categories include Low (less than 5%), Medium (5–20%), Steep (>20–60%), Very Steep (>60%) and Bench. A bench is a shoreline that drops and holds constant before dropping again, typically occurring on steep or very steep areas where shallow benches less than 15 horizontal metres are present before the slope becomes steep or very steep again. Bench is typically only used for lakes that are not highly managed because in lakes with large drawdowns it is likely that each "band" would be described with its own zone.
5. *Comments* – The Comments field allows assessors to enter applicable information for the Drawdown Zone and the Littoral Zone separately.

Aquatic Vegetation

The Aquatic Vegetation field is used to describe the percentage of the shoreline that contains emergent, submergent and floating aquatic vegetation. Note that each subcategory of Aquatic Vegetation is estimated relative to the entire shoreline segment length and independent of each other. This means that the total of all four vegetation subcategories (i.e., overhanging, submergent, emergent and floating) can exceed 100%. Presence can be indicated by using a value of 1%, whereas 0 can be used for none.

Wherever possible, aquatic vegetation should be mapped using polygons in GIS (Section 5.2). There are numerous other types of mapping that can be used to describe wetland areas and FIM mapping is intended to be a simple, quick classification of vegetation and not a detailed mapping exercise.

1. *Overhanging Vegetation* – The Overhanging Vegetation field is used to describe the percentage of the shoreline segment length that contains significant overhanging vegetation. Overhanging vegetation should be considered as if the lake was at full pool or the mean annual high water mark. Overhanging vegetation often includes things like large Pacific willows overhanging the shore or areas with extensive low flood bench and shrubs submerged during high water.
2. *Aquatic Vegetation* – Use the Aquatic Vegetation field to describe the percentage of the shoreline that contains emergent, submergent and floating aquatic vegetation. This field is the combined length of all aquatic vegetation types along the segment, not considering overlapping areas.
3. *Submergent Vegetation* – The Submergent Vegetation field is used to describe the percentage of the shoreline segment that contains submergent vegetation. Submergent vegetation includes species such as milfoil, *Potamogeton* spp. etc.
4. *Submergent Vegetation Presence* – The Submergent Vegetation Presence field is used to indicate whether submergent vegetation is present along the segment. This field should be used when assessors cannot determine the percentage of the segment but are aware it is present.
5. *Emergent Vegetation* – The Emergent Vegetation field is used to describe the percentage of the shoreline segment that contains emergent vegetation. Emergent vegetation includes species such as cattails, bulrushes, sedges, willow and cottonwood on floodplains, grasses etc.

6. *Emergent Vegetation Presence* – The Emergent Vegetation Presence field is used to indicate whether emergent vegetation is present along the segment. This field should be used when assessors cannot determine the percentage of the segment but are aware it is present.
7. *Floating Vegetation* – The Floating Vegetation field is used to describe the percentage of the shoreline segment that contains floating vegetation. Floating vegetation includes species such as pond lilies, duckweed, water hyacinth etc.
8. *Floating Vegetation Presence* – The Floating Vegetation Presence field is used to indicate whether floating vegetation is present along the segment. This field should be used when assessors cannot determine the percentage of the segment but are aware it is present.
9. *Aquatic Vegetation Comments* – The Comments field allows assessors to enter applicable information that is not included in the data fields above.

Large Woody Debris (LWD)

Wood helps stabilize shorelines and provides habitat for salmonids and other species. It provides refuge for juvenile and adult fish, provides food sources and habitat for aquatic insects and wildlife along shorelines and helps stabilize shorelines by reducing excessive erosion.

The LWD field allows assessors to indicate the presence of LWD along the shoreline segment either as a categorical description or a total count. Only significant pieces of LWD that are contributing to fish habitat should be counted.

LWD is defined as wood within the foreshore with a diameter equal to or greater than 10 cm over a length greater than 2 m (definition adapted from Johnston and Slaney 1996).

1. *Large Woody Debris* – The Large Woody Debris (LWD) presence field allows assessors to indicate whether LWD is present along the shoreline segment. Categories include less than 5 Pieces, 6 to 25 Pieces and greater than 25 Pieces.
2. *Large Woody Debris Number* – The LWD count field allows assessors to enter the total number of LWD pieces counted along the shore segment.
3. *Littoral Large Woody Debris* – This field is used to describe the quantity of large woody debris (LWD) observed in the littoral zone. This is a separate count from the overall foreshore LWD found in the segment (see below).
4. *Large Woody Debris Clusters* – The LWD cluster field allows assessors to inventory any notable clusters of wood that are present along the shoreline segment. Clusters can be added as locational data and a total count can be made along each shoreline segment. The number of pieces of LWD that are necessary to make it a cluster is up to the assessor and the assessor should consider the significance of the feature to shoreline habitat. All LWD clusters can also be mapped with GIS; this is more important on lakes that are more devoid of woody features.
5. *Large Woody Debris Comments* – The Comments field allows assessors to enter applicable information that is not included in the data fields above.

2.4.2.8 Shoreline Modifications

The shoreline modifications section allows assessors to enter a summary of all the different types of shoreline modifications that may occur along the shore segment. Most of the categories described in this section are features or structures that are counted. However, some of the fields require assessors to pay attention to the percentage of the segment that shoreline modifications occupy. As mentioned above, assessors need to be cognizant of boat speed, distance travelled and the relationship of these to the feature in question. The use of aerial imagery to estimate and scale shoreline length to determine the percentage is extremely beneficial and improves the accuracy of measurements. All shoreline modifications can also be mapped using GIS as point features, where applicable.

All fields are optional and selection is based on the lake being surveyed. When conducting a FIM for a second time, assessors need to provide a clear summary of how former FIM v. 2.6 data were merged to this version of FIM (refer to Section 2.7).

1. *Retaining Walls* – The Retaining Wall count field is the total number of retaining walls occurring along the segment. Retaining walls should only be counted if they are within 15 m of the HWM. Retaining walls must have a vertical element that is greater than 30 cm and must be retaining earth to some degree. On steep-sloping sites, more than one retaining wall may be present (i.e., the property is tiered); each retaining wall is counted. For shorelines with long, continuous retaining walls, each unique parcel or property where the wall occurs should be counted as 1 wall per property. While construction may have occurred at the same time, each property is considered to have a retaining wall. Assessors must be consistent in the counts they undertake and when reconducting a FIM it may be necessary to "calibrate" to the previous data collector's opinion or judgements (see Section 2.7 for further information on "calibrate").


The photos above are examples of retaining walls.

2. *Percent Retaining Walls* – The Percent Retaining Wall field indicates the approximate percentage of the shoreline segment length where retaining walls occur.
3. *Docks* – The Docks count field is the total number of pile-supported or floating docks that occur along the segment that are attached to the shoreline. A dock has less than 6 boat slips. Each structure that touches the shoreline counts as one dock. Properties may have more than one dock present and each different structure is

considered a separate dock. Removable docks (if identifiable) can be inventoried separately using the Other category field if required as these have different impact implications.

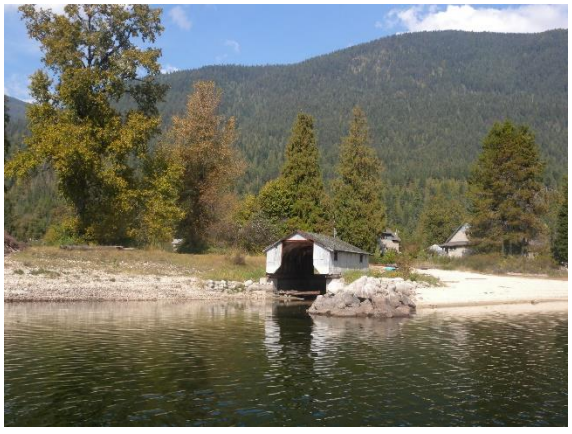
The photos above are examples of floating (top) and pile-supported docks (bottom).

4. *Docks per Kilometre* – The Docks per Kilometre field is determined during post-processing. This field is calculated by dividing the total number of docks observed by the total length of the shore segment.
5. *Dock-Groyne* – The number of docks that have groynes underneath them. These include large rock crib docks or piles or large boulder/rubble underneath a dock structure. This feature is counted separate or independent from the total number of docks, meaning there can be both a dock, a groyne and a “Dock-Groyne.” This distinction is important because there is a difference between each of these as it relates to Crown lands and associated leases, tenures or otherwise. This means it is possible to count some things in different categories twice (i.e., one dock and one dock-groyne). Assessors must be consistent in the counts they undertake and when reconducting a FIM it may be necessary to “calibrate” the previous data collector (see Section 2.7 for further information on “calibrate”).

6. *Swim Float or Dock* – The number of swim floats or swim docks observed. Swim floats or docks are floating structures that are not mooring boats, which are anchored adjacent to swimming areas for recreational play. They vary in size and each separate structure is counted.

The photo above provides an example of swim floats (red) used to delineate a swimming area along a sandy shore type.

7. *Floating Boat House* – A Floating Boat House count field is used to count boat houses that occur along the segments over the water that are either floating or directly accessible from the shore. Floating Boat Houses are structures that are specifically designed to house boats or watercraft with four walls that are overtop of the water. Boat Houses can either be located on land with floating access directly to the house by boat or as structures over the water. Field assessors should track the different types.



The photos above are examples of Floating (left) and shore access (right) Land boat houses.

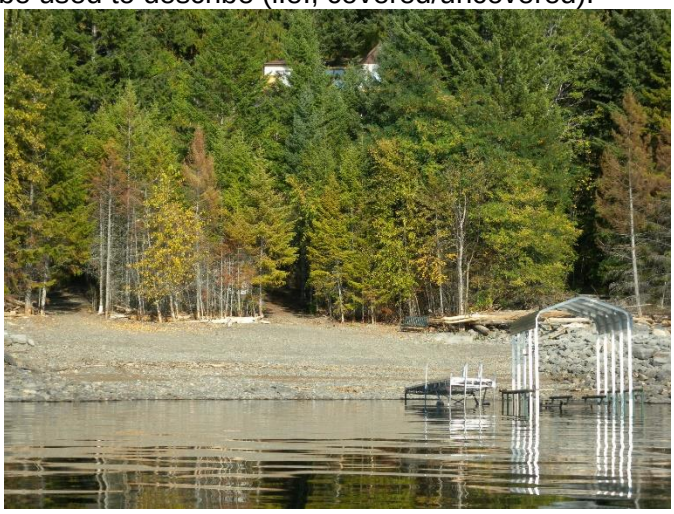
8. *Land Boat House* – The Land Boat House count field is used to count boat houses that occur along the segment above the HWM. Boat Houses are structures that are specifically designed to house boats or watercraft with four walls and usually contain a concrete boat ramp or marine rail for access. Boat Houses must be located on land with access directly to the water. In some cases, a boat house could also be excavated below the HWM to allow the boat to drive in and out at any time.


The photos above are examples of lake-access boat houses with access provided by a concrete boat ramp (left) and marine rail (right).

9. *Boat Covers* – A Boat Cover is a count of all structures that cover boats along the shoreline that are not a boat house of some form. There are numerous different types of boat covers from simple four-post tarp systems to large more elaborate pile-supported pole systems that do not have four enclosed walls like a boat house. See photo example under boat rack/lift below.

The photo above is an example of a boat cover. A pile-supported dock is also depicted in the photo.

10. *Boat Rack/Lift* – The Boat Rack/Lift field is the total number of boat racks and lifts that occur along a shoreline segment. Point location of each needs to be added and comments can be used to describe (i.e., covered/uncovered).



The photo above is an example of a boat lift under a boat cover. A retractable dock is also depicted in the photo.

11. *Groynes* – The Groyne count field is used to count any structure that is perpendicular to the shoreline that is impacting regular sediment drift along the shoreline. Groynes can be constructed out of concrete, rock, piles, wood or other materials. Groynes must have some effect on the movement of sediment to be included in the groyne count. Rock lines that are too small to significantly impact sediment movement or are not permanent should not be counted as a groyne. Assessors must be consistent in the counts they undertake, and when reconducting a FIM it may be necessary to "calibrate" the previous data collector's judgement or opinion. In the field, there is a level of interpretation to determine if the groyne is influencing sediment movement patterns; hence the need to try and "calibrate" to the previous biases of the former assessor (see Section 2.7 for further information on "calibrate").

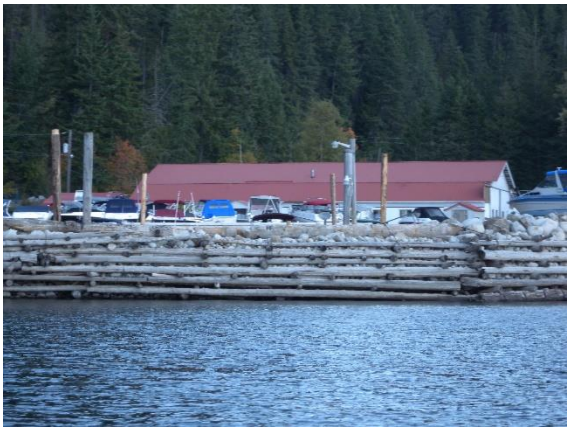

The photos above are examples of groynes constructed out of rock.

12. *Groynes per Kilometre* – The Groynes per Kilometre field is determined during post-processing of data. This field is calculated by dividing the total number of groynes observed by the total length of the shoreline segment.

13. *Boat Launch* – The Boat Launch count field is the total number of formal boat launches that were observed along the shoreline. Only permanent (i.e., formal) boat launches are counted (e.g., made of concrete or formalized gravel public launches). Do not count non-formal launches such as gravel beach areas that are used occasionally—that are ad hoc and not overly formalized. For instance, a narrow concrete pad with two strips would be counted as a launch but a gravel shoreline that is used once or twice a year would not typically be counted. However, gravel launches that are well used would be included in this category. Assessors should document criteria used to determine what constitutes a boat launch during the assessment for clarity. What constitutes a launch may differ by lake. For example, smaller lakes may only have a few gravel launches whereas larger lakes may have several different types of boat access from formal to gravel launches. Assessors must be consistent in the counts they undertake and when reconducting a FIM it may be necessary to "calibrate" the previous data collector (see Section 2.7 for further information on "calibrate").


The photos above are examples of boat launches.

14. *Boat Basin* – The Boat Basin field is the total number of areas within the Littoral Zone that have been modified to create a boat basin. A boat basin is an area that has been modified with large boulders, wood, concrete and other materials to build a protective bay area for boats. Point location of each needs to be added and comments can be used to describe. A marina could also be located within the boat basin. Marinas within a boat basin should also be inventoried as per the Marina field separately (see above).




The photos above are examples of boat basins.

15. *Percent Rail Modifier* – The Percent Rail Modifier field is used to describe the percentage of the linear segment length that contains railways near the shoreline. Only count railways if they are within 25 m of the HWM.


The photos above are examples of railways within 25 m of the high water mark that would be included under the rail modifier category.

16. *Percent Road Modifier* – The Percent Road Modifier field is used to describe the percentage of the linear segment length that contains a roadway near the shoreline. Only count roads if they are within 5 m of the HWM.


The photos above are examples of roadways within 5 m of the high water mark that would be included under the road modifier category.

17. *Marine Railways* – The Marine Railway count field is the total number of marine railways that occur along a shore segment. Marine Railways are a track system that is used to remove boats from a lake during the winter months. Only include marine railways if they are within 5 m of the HWM.


The photos above are examples of marine railways. A land boat house accessed by a marine railway is also depicted by the photo on the left.

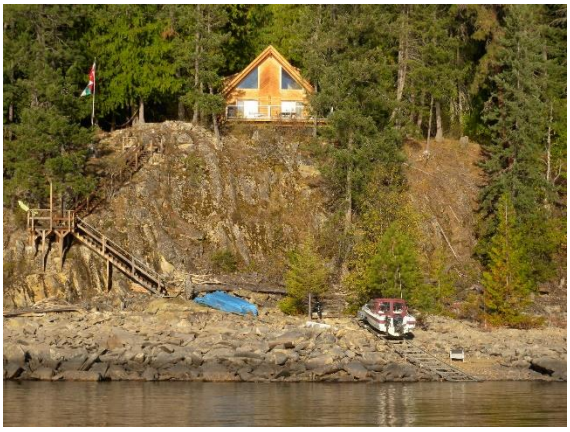
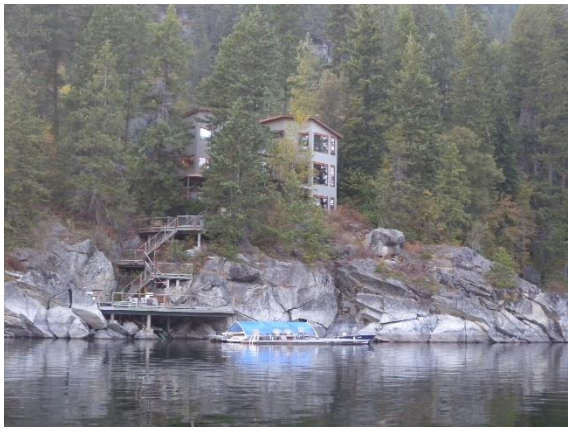
18. *Marinas* – The Marinas Field is the total number of large and small marinas that were documented along the shoreline. A small marina is any pile-supported or floating structure that has between 6 and 20 slips whereas a large marina has greater than 20 slips. A dock has less than 6 slips (see above). If budget allows, GIS mapping of the total cover of the marina is useful as a separate GIS mapping exercise (see Section 5.2).


The photos above are examples of marinas.

19. *Fences* – The Fences field is the total number of fences that occur along a shore segment. They should only be counted if they are within 15 m of the HWM.


The photos above are examples of fences within 15 m of the HWM.

20. *Stairs* – The Stairs field is the total number of stairs that occur along a shore segment. They should only be counted if they are within 15 m of the HWM.

The photos above are examples of stairs within 15 m of the HWM.

21. *Tram* – The tram field is the total number of electronic trams that occur along a shore segment. A tram is similar to an elevator but moves up and down the slope rather than vertically or horizontally and there are numerous different types and forms.

The photo above is an example of trams within 15 m of the HWM. These trams are aluminum framed and there are three in the photo.

22. *Mooring Buoys* – The Mooring Buoys field is the total number of mooring buoys that occur along a shore segment. Point location of each needs to be added.

The photos above are examples of mooring buoys.

23. *Buildings/Sheds* – The Buildings/Sheds field is the total number of small buildings and/or shed-like structures that are within Vegetation Band 1 (riparian zone).

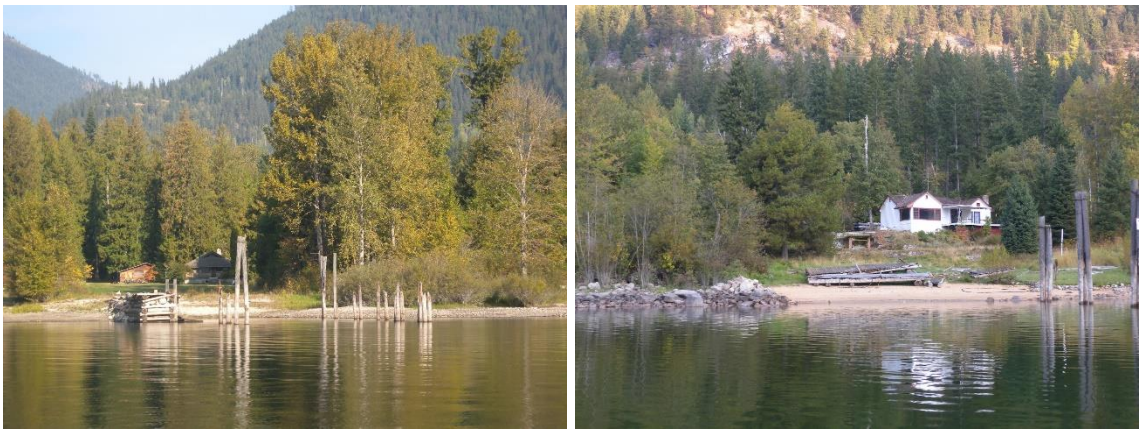

The photos above are examples of small buildings within 15 m of the HWM.

24. *Pumphouse* – The Pumphouse field is the total number of structures that have pipes and/or other features to pump/extract water. These can be within 15 m of the HWM or be within Vegetation Band 1 (riparian zone). This can often be mapped using GIS and confirmed using other provincial data that may exist for water withdrawals. Use the Buildings/Sheds field count if unknown.

The photo above is an example of a pumphouse.

25. *Pipes* – The pipes field is used to document the variety of different types of pipes that may enter or exit a lake. For instance, there could be deep water storm discharges of geothermal grids along a lake. Other examples include large water intake pipes. Single-family domestic intakes or water pipes are not counted in this field because the intent is to document large pipe networks existing or entering the lake. This field is used to count the total number of larger pipes observed in the water during the assessment.
26. *Ponds/Pools* – The Ponds/Pools field is the total number of anthropogenic ponds and/or pools that are visible along the shoreline segment. These typically occur in Vegetation Band 1.

27. *Pilings* – The Pilings field is the total number of pilings that occur within the littoral zone along a shoreline segment. Pilings are usually wood poles that are driven into littoral substrates that likely have most of their length underwater (depending on water levels).



The photos above are examples of pilings.

28. *Pile-Supported Structures* – The Pile-Supported Structures field is the total number of structures that are supported by piles that are not identified in another shoreline modifications category. These are often unique and are things like pile-supported restaurants as an example.
29. *Other* – Use the Other field for any other modification that does not fall under one of these categories. This is a field that can be defined by the assessor and used if needed. Null is assumed to mean zero in this field.
30. *Substrate Modification Presence* – The Substrate Modification Presence field is used to document whether substrate modification is occurring along the shoreline segment. Substrate modification includes any type of importation of sands, significant movement of natural substrates (e.g., to construct groynes) or earthworks.

The photos above are examples of Substrate Modification including imported sand (left) and movement of natural substrates to construct groynes and beaches (right).

31. *Percent Substrate Modification* – The Percent Substrate Modification field is the estimated percentage of the shoreline segment where substrate modification has occurred.
32. *Percent Erosion Protection* – The Percent Erosion Protection field is the estimated percentage of the segment where shoreline modifications for erosion protection have occurred. Examples of erosion protection include retaining walls, riprap shorelines, gabion baskets, rock or wood cribs, groynes and other similar structures that hold back sediment/soils to prevent erosion due to wave and/or wind action.

The photos above are examples of shoreline modifications for erosion protection including retaining walls (left) and groynes (right).

33. *Comments* – The Comments field allows assessors to enter applicable information that is not included in the data fields above.

2.4.2.9 Flora and Fauna

The Flora and Fauna sections contain specific information for flora and fauna observations and data along the shore segment. Significant features/values should be individually mapped as point or polygon data and comments used to describe further. If there are other features that are not listed here, then a separate tally can be made and added into the dataset afterwards. Null means that this field was not inventoried.

1. ***Veterans*** – The Veterans field is a categorical field to describe the number of veteran trees that occur along the shore segment. A veteran tree is a tree that is significantly older than the dominant forest cover and provides increased structural diversity. Categories include no, less than 5 trees, 5 to 25 trees and greater than 25 trees.
2. *Veterans Count* – The Veterans field is a count of all veteran trees.
3. ***Snags*** – The Snags field is a categorical field to describe the number of dead standing trees that occur along the shore segment. Snags are defined as dead standing trees that provide increased structural diversity. Categories include no, less than 5 trees, 5 to 25 trees and greater than 25 trees.
4. *Snags Count* – The Snags field is a count of all snag trees.
5. *Beaver Lodges* – The Beaver Lodges field is the number of beaver lodges observed along the shore segment. Point location of each needs to be added.
6. *Wildlife Dens* – The Wildlife Dens field is the total number observed along the shore segment.

7. *Wildlife Trails* – The Wildlife Trails field is the number of runs and trails observed along the shore segment.
8. *Mineral Licks* – The Mineral Lick field is the total number of mineral licks observed along the shore segment.
9. *Shellfish* – The Shellfish field can be used to inventory the total number of areas where shellfish such as mussels/mussel beds have been observed. A polygon or point location can also be added.
10. *Stick Nests* – The Stick Nests field is the total number of avian nests observed along a segment. Use the Comments field to describe species, where warranted.
11. *Other* – The Other field is the total number of any other flora/fauna features observed along the segment that is user-defined. Use the Other Comments field to describe further.
12. *Flora, Fauna and Other Comments* – These fields are important to note observations made. Examples of important observations are known spawning areas, osprey or other birds of prey nesting locations etc. Significant features should be individually mapped if possible, especially sensitive nesting areas etc.

2.4.3 Photographs

Still photo data collection is mandatory when undertaking a FIM field assessment. Since digital memory is now cost-effective, photograph inventory will allow the field team to document nearly the entire shoreline. On most lakes, the field team should attempt to collect at least one photograph per single-family residential property. This level of photograph detail allows users in the data post-processing to recreate new segments, if necessary, because the images allow documentation of the shoreline riparian conditions, substrates, shoreline modifications and land use.

Photographs should:

1. Be taken perpendicular to the shoreline whenever possible.
2. Include at least one photo of each single-family residential lot. In rural areas, numerous photos may be required.
3. Include the full riparian canopy and foreshore areas within the photo.
4. Take in all modifications on the shorelines if the entire shoreline area for a property cannot be documented in one photo.
5. Include GPS tagging—very important but not mandatory. This technology is now readily available on nearly all photo devices and is extremely useful to place the approximate location of where a photo was taken.
6. Be time stamped (mandatory). While the metadata for the photo may contain this data, a permanent stamp ensures that photo documentation provides permanent record for future reference that cannot be easily manipulated.

2.5 FIM Reporting

Reporting should focus on identification of key foreshore changes or alterations observed and data analysis should be used to corroborate observations.

2.6 FIM Data Analysis

Data analysis can be completed in numerous ways using the FIM database. Data analyses should focus on describing and interpreting the data to summarize the overall shoreline conditions. Most reports prepared to date generally include a suite of analyses that consider the modification counts and data as it relates to length of natural shoreline in different land uses or shore types. These analyses can be conducted for an entire lake or for specific segments, FIM categories or jurisdictions within a lake. The length of natural shoreline is determined by calculating the weighted average of the percentage of natural shoreline for each segment using the segment's length. The data can be presented using graphs, tables, figures and correlations.

The following is a standard suite of analyses that are often completed:

1. *Percentage of Natural and Disturbed Shoreline*. These data are presented as either a percentage or as length of shoreline and the data can be broken into subsets to present for different jurisdictions or regional areas as required.
2. *Percentage of Natural and Disturbed Shorelines for each Land Use Category*. These data are presented as either the percentage or shoreline length for each land use category, broken down by the shoreline disturbance.
3. *Percentage of Natural and Disturbed Shorelines for each Shore Type Category*. These data are presented as either the percentage or shoreline length for each shore type category, broken down by the shoreline disturbance.
4. *Modification Counts*. The total number of each type of modification is presented. These data can also be broken down by length of shoreline to present counts per kilometre of shoreline. Additional analyses may be considered by segment, ecological rank, shoreline modification distribution, etc.

2.6.1 Rate of Change Analysis

When FIM is repeated (see section 2.7), each of the FIM analyses can be completed for the first and second FIM (or third). Coupled with this, the specific rate of change can also be determined. For example, the percentage of natural shoreline could be graphed for the entire lake or specific segments for each assessment. The slope of the line between the two points would represent the rate of change.

As more assessments are conducted, this rate of change can be subsequently estimated using standard techniques to better understand key rates of change. Since the data is collected spatially, this analysis can be completed on a segment-by-segment basis, for any jurisdiction or management area or for the lake as a whole. Finally, this data can then be incorporated into key planning documents and used to set management targets that can be confirmed using subsequent data collection events. For instance, land use managers could set a target of reducing the rate of change to less than 0.5% (x time scale) of the shoreline for the whole lake. During the second, third or fourth FIM, this data could be used to determine if the management target was achieved, and further, determine spatially the specific lake areas where it was not achieved.

2.7 Updating FIM by Reconducting the Survey

Foreshore Inventory and Mapping is often used to monitor the rates of change (e.g., level of impact) along the foreshore of a lake. One way of monitoring or calculating the rate of change is to conduct a FIM for the second (or third or fourth) time, following the field assessment methods above.

Updating FIM provides a means to determine development impacts and potential loss of habitats that may be useful for future lake management. This also enables land use managers at all levels of government to understand where changes are occurring along a shoreline and may help determine how fast the shoreline is changing. Finally, the update may also help enable identification of important management targets, such as reducing the rate of change to 0% or planning for conservation areas.

The following steps are to be used when updating a FIM:

1. Review the GIS Dataset – Load all available data onto the most recent aerial imagery. It is assumed that the same general data acquisition processes will occur for a FIM conducted a second time compared to the first time (see Section 2.2).
2. Convert the FIM GIS dataset – Convert the previous FIM GIS dataset, as much as possible, to the most recent database version. In general, this will involve adding new data fields. Existing data fields may require reclassification depending upon the original FIM version, particularly if the original data collection event occurred prior to FIM database v. 2.6 (Schleppe and Mason 2009). Typically, a “rule set” can be developed that will allow the database and existing data to be scripted using GIS or software like ‘R’ into the most recent database version. The following is useful to ensure consistent data conversion:
    i. Fields that are added should contain data in the second FIM.
    ii. Fields that were not sampled during the first event should be left as either NAs or be estimated using photos, aerial imagery or by using other methods. Notes should be left in the Comments field or metadata for GIS to allow users to understand what fields were added in the second FIM and what was completed for fields where estimation or other tools were used.
3. Consolidate Mapping Attributes – Identify important mapping attributes such as aquatic vegetation, shoreline modifications or littoral zone substrates that were or were not mapped. Obtain this data, if available. Make a list of field data to be collected.
4. Review Segment Breaks – Conduct a review of the original segment breaks using the most recent cadastral and land use data from local government, where possible. This allows the assessor to identify whether any significant land use changes have occurred.

5. Identify New Segment Breaks – As per pre-field planning (Section 2.2.3), identify new segments breaks, where applicable.
    i. If new segment breaks are required, split the segment by adding a decimal point. For example, if Segment 15 was to be split into three, each segment would be labelled as 15.1, 15.2, and 15.3. This system allows segments to be split ad infinitum. Thus, in the future, if 15.1 requires splitting, it would be 15.11, 15.12 etc. It is assumed that all the original FIM datasets from each collection would be maintained allowing comparisons to the same stretches of shoreline over time.
    ii. Addition of new segment breaks may affect the Foreshore Habitat Sensitivity Index (see Section 3.0). Assessors can either update the index for the lake or elect to maintain the original index rank for all segments that were split if the FHSI is not revisited.
6. Review Original Sensitivity Indices – Conduct a review of the original sensitivity indices (e.g., AHI, FHSI) considering key parameters, previously mapped Zones of Sensitivity and other important habitat information (Section 3.0). Consider any new additional data that could be considered and develop protocols to map data for either the FHSI or as a Zone of Sensitivity. Adding new mapped features is important during the second (or subsequent) mapping initiatives to build upon previous assessments.
7. Finalize List of Data Collection Parameters – A list of the key FIM and FHSI information that needs to be collected should be finalized. The final list of data to be collected should optimize the available budgets and data needs for the lake in question, with focus on rare and endangered species, their habitats or other important biophysical data that are present. See also Pre-Field Assessment (Section 2.2) for relevant steps to follow during the second FIM assessment to help maximize data to be collected.
8. Data Collection – Follow steps outlined in Field Assessment (Section 2.4) for the second assessment.

It is important to note that updating FIM requires a thorough understanding of the FIM methods. There will be a requirement to analyze both the original and secondary FIM databases during this update and implement key measures of Section 5.0. This step is critical to ensure that estimates of change between the assessments are as accurate as possible and this is only possible through appropriate Quality Assurance/Quality Control (QA/QC). Key data fields (see below) should be identified during the pre-field assessment to ensure that appropriate QA/QC is in place that will address any changes identified (e.g., data fields, revised definitions of key parameters etc.). A detailed list of assumptions made with the dataset should be maintained and provided with the data as a deliverable.

Key data fields to consider as part of the QA/QC process that are typically reviewed and scrutinized include:

1. Natural/Disturbed – While not a perfect estimate, this field is typically used to relate shoreline impacts to the length of disturbed shoreline in analyses. This field is subject to observer bias, and as such, should be carefully considered by the field team. Discussions by the field team may be necessary to consider the previous assessment and the estimate. Observers may need to "calibrate" with previous assessors because there is often a difference in interpretation between the extent of disturbance along shoreline areas between assessment crews. This means that the second field team may determine a Percent Natural or Percent Disturbed estimate that is different from the previous assessment, which may need to be revised. The changes should generally be small and have an appropriate rationale based upon field observations. This ensures that estimates for rates of change are based upon the best available estimate of the disturbed shoreline areas. Recent habitat restoration plans or initiatives along the shoreline should also be considered, even if small. These can be acknowledged by using a placeholder of either 1% or 5% if the estimate is challenging to determine but known to be present (i.e., the exact measure of actual "distance" can be undertaken using aerial imagery to improve the estimate). The field team ultimately decides on the pre- and post-database that reflects their best judgement. The QEP then views pervious photos and confirms this during the QA/QC process (see Section 5.0)
2. For many of the shoreline modifications fields there are differences that may exist between observers between the most recent and previous surveys due to observer bias. The following is a series of steps to consider for shoreline modifications:
    i. During field collection, review the previous counts in the database for consistent use of shoreline modification.
    ii. Keep track of new or recent works using standard field queues such as water staining on rocks, retaining walls or concrete.
    iii. Compare the current inventory counts to the previous counts.
    iv. If discrepancies exist, inventory the feature as best as possible and leave for review during the field post-processing assessment as part of QA/QC (see Section 5.0).
    v. During post-processing, all photos from the previous assessment should be reviewed.
    vi. Once photos have been reviewed, a final decision should be made to determine the number of shoreline modifications in the previous and current assessments. When in doubt, assessors should assume that no change has occurred.

    The primary purpose of this data processing is to ensure that any analysis of change over time is as accurate as possible. This highlights why digitization of key modification features in GIS is useful because it allows assessors to both visualize the location of data points and count them. For example, the Boat House field has been amended to differentiate between floating and on-land boat houses and a clear statement on how data was amended needs to be provided.

3. Land use fields during a second FIM usually do not change much and should not require extensive amendments. Often, the changes are from Rural to a denser land use like Single-Family because of new subdivisions. The local or regional government should also be able to provide useful information regarding recent zoning changes to help inform these fields.
4. Riparian fields (i.e., Vegetation Band 1 and 2) do not normally change unless extensive shoreline works such as land clearing have occurred. Often, changes are very small, on a lot-by-lot basis. Since changes are small, these bands usually remain unchanged. However, change in these fields may occur in cases of extensive land clearing or significant changes in land use. Therefore, large changes in riparian bands should be identified during the second FIM survey (e.g., new subdivisions), whereas smaller changes may not need to be updated. It is noted that extensive land cover changes may warrant creation of a new segment, if the riparian habitat values have been significantly altered.
5. During a second FIM, it is usually an opportune time to increase the level of GIS mapping around a lake. In most cases, the previous data in combination with these methods and newer aerial imagery often allow much more detailed habitat mapping to occur. For example, aquatic vegetation mapping polygons can be added or GIS point files can be added for all docks, groynes and boat launches.

3.0 FORESHORE HABITAT SENSITIVITY INDEX

A Foreshore Habitat Sensitivity Index (FHSI) is a tool to assess the habitat value or environmental sensitivity of a shoreline segment. The output of FHSI analysis is referred to herein as the “FHSI Ecological Rank.” The antecedent index developed and applied to previous lakes in BC, Alberta and Manitoba was known as the Aquatic Habitat Index (AHI) (see summary in Schleppe et al. 2019). An index is a numerical or categorical scale used to compare variables with one another. Shoreline sensitivity indices have been used in many other lakes and a comparative summary of the different indices helped guide development of these methods (see summary of indices in Schleppe et al. 2019).

Data collected in the FIM and analyzed using the FHSI are used to identify and define values that may be present or important to shoreline function, fish and wildlife species or species at risk. This will aid land use planning decisions by identifying areas where potential risks associated with different land uses or activities may occur. The FHSI is intended to be used as a tool by a variety of different user groups, including local, provincial and federal agencies in planning or approval processes. The FHSI is not a statistical model to be used to understand specific fisheries or wildlife processes or provide estimates of productivity. Also, this index does not provide a detailed habitat assessment of any given space or property and should not be interpreted as such. Detailed habitat assessments may be required by government agencies as part of a development application process to better determine the particular habitat values present along any specific shoreline area.

The FHSI utilizes many different criteria collected during the FIM that summarize general shoreline condition and level of urbanization, as well as additional habitat inventories or field assessments. The index uses a “points”-based mathematical scale to assign the relative habitat value or sensitivity to each different criterion in the index. Natural or important habitat features are assigned positive values whereas features that have impaired the habitat value (e.g., groynes) are assigned negative scores to reflect the current condition of the shoreline. It is assumed that urbanization tends to reduce habitat sensitivity to change (see Section

3.2.2), whereby further changes in highly urbanized areas pose relatively lower risk to shoreline disruption when compared to changes in more natural areas or areas with high habitat values such as shore-spawning areas for fish.

The criteria the FHSI considers can be broken down into key categories, where some originate from the FIM inventory (FIM FHSI criteria) and others originate from other datasets (non-FIM FHSI criteria). A working example for the criteria can be found in 0. The FIM and non-FIM FHSI criteria can be grouped into the following broad categories:

1. *FIM*
    i. Shore type (see Section 2.4.2.3)
    ii. Substrates (see Section 2.4.2.5)
    iii. Percentage Natural (see Section 2.4.2.1)
    iv. Aquatic Vegetation (see Section 2.4.2.7)
    v. Overhanging Vegetation (see Section 2.4.2.7)
    vi. Large Woody Debris (see Section 2.4.2.7)
    vii. Riparian Vegetation Band 1 and Band 2 (see Section 2.4.2.6)
    viii. Shoreline Modification (see Section 2.4.2.8)

non-FIM:

2. *Fisheries* – Fisheries criteria generally include all habitats that are important to finfish or shellfish.
3. *Wildlife* – Wildlife criteria include all shoreline habitats that are important for either large or small wildlife. Examples may include ungulate winter range or bat roosting locations.
4. *Herptile* – Herptile criteria are shoreline areas that provide habitat for snakes, lizards or amphibians and often include breeding or overwintering areas.
5. *Waterfowl* – Waterfowl criteria are shoreline areas that provide habitat for ducks, geese and other waterfowl. These areas often include nesting, rearing or migratory areas for a variety of different species.
6. *Ecosystem* – Ecosystem criteria are shoreline areas with known large-scale ecosystem values. Examples include specific areas that are known to be important habitat such as low or mid floodplain benches (MacKenzie and Moran 2004) or areas identified in processes such as Sensitive Ecosystem Inventory or Terrestrial Ecosystem Mapping. For provincially ranked or listed ecosystems, the Rare or Endangered Species or Ecosystem category below should be used.
7. *Rare or Endangered Species or Ecosystem* – Rare or endangered species or ecosystems are shoreline areas that are known to have Species at Risk, Critical Habitat areas identified as part of the federal *Species at Risk Act* (SARA) process or contain provincial areas that are mapped for particular species or habitat and are identified by the Conservation Data Centre (CDC). These categories are focused on BC-specific classifications but can be easily adapted to any provincial mapping process as required. *Note that these criteria could be fish, wildlife, ecosystems or otherwise. These criteria must be identified by some known provincial or federal process. A parameter should only be considered in the Rare or Endangered Species or Ecosystem category if it meets these conditions and it should not be considered in both categories in the FHSI.*

First Nations' TEK data can be included in any of the above categories as required. To avoid potential for duplication of data in the FHSI, TEK data should not be treated as an independent category.

The FHSI designates the lake shoreline into segments, representing important values and habitats. This shoreline segment scale is similar to how a river is broken into reaches. However, there are often site-specific habitats or unique shoreline areas that occur within or adjacent to shoreline segments. These unique sites (e.g., dense natural riparian area in urban context, urban stream confluences etc.) are often included in the FHSI but can also be mapped independently as a Zone of Sensitivity (ZOS). Section 3.5 provides a summary of how to include and develop ZOS within the FHSI Ecological Rank procedure.

3.1 FHSI Process Overview

The following summarizes the FHSI steps in sequential order, noting that these steps may be repeated as required.

1. Determine relevant FIM-related FHSI criteria that should be included in the index (see Section 3.2.1).
2. Determine if other FHSI categories are relevant and if sufficient data exists to incorporate them (see Section 3.2.3 to 3.2.9).
3. Using best available science and inventory information, assign starting ranks to all criteria in all FIM and non-FIM FHSI categories (see Section 3.3).
4. Calculate the first FHSI index iteration (see Section 3.4.1).
5. Calibrate the FHSI Ecological Ranks, as required (see Section 3.4).
6. Evaluate if any Zones of Sensitivity are needed or warranted (see Section 3.5).

Finalize the FHSI Ecological Ranks and complete reporting and analysis (see Section **3.4**–3.6). Recommendations for Conservation Zones should also be prepared (see Section 3.6.2), if relevant.

3.2 FHSI Criteria

There are several different FIM and non-FIM criteria that can be considered and incorporated into the FHSI categories. The index relies upon the biophysical data collected during the FIM field inventory (FIM FHSI criteria) and other datasets that may be available (non-FIM FHSI criteria). The intent of the FHSI is to develop a rank for each segment that was delineated during FIM. The rank represents the sensitivity of the shoreline to changes from land use or proposed shoreline activities. The index is calibrated by professionals, agencies, First Nations and other knowledgeable individuals such as local naturalists with extensive experience on the lake (see Section 3.4) involved in the project.

The following provides a summary of the different categories (FIM and non-FIM) and their respective specific criterion that may be considered for the FHSI. The total habitat value for each shoreline segment includes the sum of all positive and all negative index parameters. During development of the index, assessors must, at a minimum, consider the FIM criteria (see working example in 0). Any additional criteria may be included if data are available. Any non-FIM criteria should only be added to the FHSI if sufficient data exists to support their addition and they do not increase the complexity of the index unnecessarily (see Section 3.4). The process outlined below can be adapted on a case-by-case basis for any given lake to address lake size, lake management (i.e., large drawdowns from operational

management), flood risks, species values or any other relevant factors. The objective is to consider key areas, species and habitats along a shoreline at a lake-wide scale that may be susceptible to development impacts.

First Nations TEK data, if shared, can be incorporated into any of the FHSI criteria categories (Appendix A). To be included, the data must be translated into a meaningful spatial parameter. These data would typically be considered in a similar fashion as observed features such as fisheries spawning records. As with any parameter, it is important not to duplicate criteria as this would result in over valuing information (see Section 3.3). For instance, if TEK identified important shore-spawning areas for kokanee and recent shore-spawning surveys completed using GIS mapping techniques were used, an overlap in datasets would occur. This can be addressed through creation of one kokanee shore-spawning criterion that considered both TEK and more recent data. In this way, TEK data can be included directly in the FHSI process. However, for inclusion in the FHSI, TEK data must be accurately identified for the entire lake so that that data is used and interpreted within the quantitative FHSI index.

3.2.1 Foreshore Inventory and Mapping Category – Criteria

The biophysical criteria to be considered in the FHSI index and an overview of how the values may be weighted are summarized below.

1. *Shore type* – A shore type is related to many aspects of fish or wildlife productivity. Previous habitat indices (e.g., Schleppe and Arsenault 2006) have used a fish life stage habitat specificity table to determine the value of a shoreline. This similar approach was used for Windermere Lake (McPherson and Hlushak 2008). A matrix approach is generally recommended to rank shore types. It may be important to add criteria other than just fisheries to the matrix if ecologically warranted.
2. *Substrate* – Substrates relate directly to productivity because they provide key foraging areas, shoreline spawning and other key functions needed in aquatic environments. There are generally two types of productive substrates: those used for spawning and those that produce biomass. The substrate values used in many of the assessments are similar to those originally used on Okanagan Lake (e.g., Schleppe and Arsenault 2006). Thus, lakes such as Mabel (Schleppe 2010) and Windermere Lake (McPherson and Hlushak 2008) ranked spawning substrates highest, followed by foraging substrates. These examples should generally be referenced when determining values for similar fish assemblages. If lakes have an entirely different fish assemblage, a matrix approach similar to Shore Type can be used to rank substrates in the FIM dataset. It may be important to consider different bands of substrates as well but this would involve more detailed data collection. Substrates need to be ranked from highest to lowest value for spawning and biomass to address lake-specific habitats or species, provided they can be ecologically supported.
3. *Percent Natural* – This parameter is similar to that used in nearly all the previous FHSI (see summary in Schleppe et al. 2019). This factor relates to the risks of change from a natural state, where the closer to a natural state, the higher the risks of change to ecosystem function are likely to be.

4. *Aquatic Vegetation* – Native aquatic vegetation is included in the index because it provides important habitat function for both fish and wildlife. The benefits of aquatic vegetation are many and include forage, biomass production, cover etc.
5. *Overhanging Vegetation* – Overhanging vegetation is important because it provides valuable habitat function, such as nutrient additions and forage opportunities. The weight assigned to this criterion in the FHSI may vary depending upon the lake or importance of the vegetation to habitat. For instance, in lakes that are bordered by grasslands, overhanging vegetation may be extremely important. In lakes where rearing habitat is limited, this feature may provide important cover for juvenile fish.
6. *Large Woody Debris* – Large woody debris provides important cover for fish and has been related to increases in fish productivity; it also provides a variety of wildlife functions (e.g., turtle basking areas). Add this criterion to the FHSI if ecologically warranted, with the weighting applied accordingly. For instance, in small lakes LWD may provide important functions that require more weighting when compared to larger lakes.
7. *Vegetation Band 1 and 2* – Riparian criteria are added to the index because of the many functions they provide. Riparian habitat is the focus of many best management practices and regulatory policies. Consider lakeside vegetation (Band 1/Riparian) and upland areas (Band 2/Upland). The index can factor in vegetation quality (i.e., tall shrub thickets or wetland areas have a higher quality than landscaped yards) and overall width of the bands. As with the other indices, vegetation bandwidths can be categorized based upon the measured bandwidth in the FIM database. Vegetation bandwidth categories typically include 0 to 5 m, 5 to 10 m, 10 to 15 m, 15 to 20 m and greater than 20 m. Vegetation Band 1 directly adjacent to the lake is usually assigned more value than Vegetation Band 2, since it is in closer proximity and typically has a greater overall contribution to fish and wildlife habitat along the shoreline. In cases where there is only one band, the B1 is valued accordingly and the second band should not affect the index. There may be other ways to consider riparian vegetation depending upon the specific lake. The specific weightings may need to be altered when considering the full suite of influences riparian vegetation may have.

3.2.2 Shoreline Modification Criteria

Habitat shoreline modification criteria are described by Schleppe and Arsenault (2006) and have been referenced in nearly all previous FHSI projects (see review by Schleppe et al. 2019).

In a review of lakes that previously underwent the FIMP process (Schleppe et al. 2019), shoreline modifications generally accounted for less than 5% of the weight within the FHSI. For this reason, utilization of 5% negative influence or weight in the index is recommended as a starting point for all shoreline modification criteria combined. There has been a general reduction in the weight assigned to shoreline modification criteria over time, possibly because the presence of urban features may not have reduced habitat values to the extent previously thought (see summary in Schleppe et al. 2019). There are examples of fish, wildlife and even rare and endangered species in urban and rural areas. For this reason, care should be taken when assigning the overall influence of shoreline modifications in the FHSI. Finally, the Percent Natural field is also analogous to impact from shoreline

modifications, supporting the concept of not over weighting the shoreline modifications criteria.

A brief summary of shoreline modifications typically considered in an FHSI is listed below. Other shoreline modification criteria, such as percent substrate modification or percent roadway, are not typically included in the analysis because they may compound urbanization effects within the index (i.e., including too many measures of the same urban impact may exert a stronger influence than intended within the index; see Section 3.4 for calibration considerations).

3.2.2.1 Retaining Walls

Retaining walls impact habitat in a variety of ways. These structures are generally constructed to armour or protect shorelines from erosion. Kahler et al. (2000) summarized the effects of piers, docks and bulkheads (retaining walls) and suggested that these structures may reduce the diversity and abundance of nearshore fish assemblages because they eliminate complex habitat features that function as critical prey refuge areas. However, Kahler et al. (2000) also found evidence of some positive effects for armouring structures along a shoreline such as increased cover and complexity, and the positive influences are more apparent in cases where the shorelines were previously impacted and riprap increased structural complexities (Quigley and Harper 2004). Carrasquero (2001) indicated in his review of overwater structures that retaining walls might also reduce the diversity of benthic macroinvertebrate communities more than other structures such as riprap shoreline armouring because they reduce habitat complexity.

Natural erosion along a shoreline can be the result of removal of riparian or lakeside vegetation. In other cases, retaining walls have been constructed to hold up soil material, possibly reclaiming land, so that lawns can be planted or for other landscaping purposes. During floods, riparian vegetation is important to reduce shoreline erosion. For example, along Okanagan Lake during recent flooding events, it was observed that erosion was greater on sites with less riparian vegetation and retaining walls were a key mechanism that significantly reduced or removed this vegetation at the HWM (Schleppe, J. personal observation).

Previous FIM projects on large lakes have documented the impacts of retaining walls on shoreline ecosystems. Often, retaining walls were used to construct or create level building areas for turf and landscaping. This construction resulted in impacts to riparian vegetation and foreshore substrates, thereby negatively affecting fish and/or wildlife habitats.

3.2.2.2 Docks

Docks alter fish habitat in many ways. Docks are often associated with other anthropogenic disturbances such as shoreline substrate modification, landscaping and retaining walls (Kahler et al. 2000; Carrasquero 2001). Riparian disturbance and increased recreational usage are other associated impacts that can have greater effect than the dock itself.

Docks have been identified to have varied impacts on fish. For example, docks may provide refuge areas for fish from ambush predators as well as shaded/cover areas; pilings can also provide structure for periphyton growth (Carrasquero 2001). Increased fish density has also been observed around dock structures (Lange 1999). However, increased fish density was based on the general congregation of fish around these structures, which actually decreased

fish diversity (Lange 1999). Overall, fish diversity and density were negatively correlated with increased density and diversity of shoreline development (Lange 1999) and docks are often one of the more common forms of shoreline development observed. In addition, Chinook salmon have been documented to avoid areas with increased densities of overwater structures (e.g., docks) and riprap shorelines. Construction of these structures may also affect migrating juvenile salmonids (Piaskowski and Tabor 2001). Numerous factors, such as the scale of study and the cumulative effects of these structures, are important and should be considered when understanding the impacts of overwater structures (Carrasquero 2001).

The influence of docks may vary depending upon the lake system and site. Lakes with a high drawdown may use different dock construction (e.g., mostly floating docks) than lakes with lesser drawdown (i.e., pile-supported). The influence of the dock may also vary depending upon the location. For instance, floating docks that cover substrates in spawning areas may deter fish from using the space (J. Schleppe and K. Hawes, personal observation during shore-spawning surveys on Okanagan Lake). Poorly constructed, shallow docks may lead to ongoing maintenance dredging. Moorage in shallow water may also disrupt littoral sediments as a result of repeated boat propeller scour. These impacts pose unique challenges.

Regardless of the controversy, it is apparent that docks do affect fish communities and the magnitude of the effects are most likely related to the intensity of the development, the scale of the assessment and fish assemblage life history requirements. Different fish assemblages may respond differently to increased development intensity and fish assemblages containing salmonids may be more sensitive than southern or eastern fish assemblages (e.g., bass, perch and sunfish etc.). It is for these reasons that dock density is usually included as a negative factor in the FHSI index, with increasing dock density considered to be more influential than lower dock densities.

3.2.2.3 Groynes

Groynes are structures that are constructed to reduce or confine sediment drift along a shoreline. Groynes are often used to retain sand for beaches. This typically involves piling up larger substrates to provide beaches with greater predominance of gravels and sands. These structures are typically constructed using large boulders, concrete or some other hard, long-lasting material. Reducing sediment transport along the shoreline can have a variety of effects on fish habitat, including increasing the embeddedness of gravels which can reduce spawning habitat quality or removing emergent aquatic vegetation that acts as an important area of forage and cover for juvenile fish. Published literature regarding the specific effects of groynes on fish habitat is scant, but these structures are believed to be negative because they affect the habitat available for fish (e.g., Murphy 2001) and they often involve extensive shoreline disruption through substrate piling and redistributing the larger lakebed substrates. During this substrate disruption, shore-spawning areas can be lost, extensive emergent aquatic vegetation (e.g., willows, sedges, grasses, etc.) can be removed and use of heavy equipment during construction is often necessary, which can damage shoreline areas. For instance, in the Shuswap watershed, groynes were considered to be a habitat modification of concern, since they altered extensive shoreline areas, impacted large areas of juvenile rearing habitat, exposed shorelines to greater erosion (i.e., loss of natural armour due to removal of larger lakebed substrate and vegetation) and caused a variety of other shoreline process alterations (Schleppe 2009b). For these reasons, groyne density is often included in the FHSI and considered a negative influence.

3.2.2.4 Boat Launches

Boat launches permanently alter shoreline substrates either through compaction of lakebed substrates or hard armouring from concrete that extends below the HWM. The imperviousness of this material results in a permanent loss of habitat, which ultimately reduces habitat quality and quantity for fish. Concrete does not allow growth of aquatic macrophytes and reduces foraging and/or refuge areas for small fish and macroinvertebrates. The extent of the potential effects of boat launches relates to their size. Thus, multiple-lane boat launches tend to have a large effect on fish habitat compared to smaller launches with fewer lanes because there is more surface area affected. Other impacts from boat launches include boat propeller scour of substrates at shallow water launches and vehicle impacts (e.g., tire skid and trampling disturbances). For these reasons, boat launches are considered a negative influence and are included in the FHSI.

3.2.2.5 Marinas

Marinas are a concentration of boat slips, offering a place of safety to vessels. In general, when marinas are constructed in the littoral zone, there tends to be a large increase in shading, which reduces the potential for aquatic macrophyte growth and therefore reduces the productivity of a particular shoreline area. At the same time, it has been observed that marinas tend to have more invasive aquatic plants such as milfoil due to the transfer of plants via boats from infected areas. Marinas tend to have other activities associated with them that can also impact shoreline habitats. For example, engine noise and boat propeller wash can scare sensitive fish species like rainbow trout (*Onchorhynchus mykiss*). Large marinas tend to have breakwaters, which can further affect wave action, sediment scour and deposition, and circulation. Other activities in marinas include fuelling stations, boat cleaning, bilge water and sanitary waste disposal stations, which can negatively affect the surrounding water quality. Each of these activities has the potential to alter benthic communities, possibility altering the fish assemblage (i.e., congregations of more tolerant species and displacement of less tolerant species) and potentially resulting in a loss in biodiversity. This can ultimately affect fish and/or fish habitat (Kahler et al. 2000). Marinas also tend to be associated with other high-intensity land developments, which may have a variety of effects on habitat (e.g., loss of riparian vegetation) and water quality (e.g., inputs of chemicals, increases in turbidity and reduction in oxygen concentration). For these reasons, marinas are considered a negative influence and are included in the FHSI.

3.2.3 Non-FIM Category – Fisheries Criteria

Fisheries criteria often include important habitats for different species or life stages. Spawning, rearing, cover or other habitat attributes all may be considered. Data can be incorporated into the FHSI in many ways and weights can be assigned to apply more importance to habitat attributes that may be limiting factors. For instance, known shore-spawning, rearing or staging areas may be very important and deserve a high weighting in the FHSI. Shared First Nations TEK data can be included as required, provided that the information can be transcribed in a spatial and quantitative fashion. Important fisheries-related criteria can be considered for site-specific ZOS as discussed in Section 3.5.

3.2.4 Non-FIM Category – Wildlife Criteria

Wildlife criteria are important habitats for different species or life stages. These may include: thermal refuges, wintering ranges, mineral licks, migration corridors or any other important habitat attribute. Data can be incorporated into the FHSI in many ways and weights can be assigned to apply more importance to habitat attributes that may be limiting factors. For instance, known bat roosting areas may be very important and thus given a high weighting in the FHSI. Only the most important wildlife-related criteria should be considered for site-specific ZOS discussed in Section 3.5. Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.2.5 Non-FIM Category – Herptile Criteria

Reptile and amphibian criteria are important habitats for different species or life stages. Breeding areas, hibernacula, migration corridors or any important habitat attributes may be considered. Data can be incorporated into the FHSI in many ways and weights can be assigned to apply more importance to habitat attributes that may be limiting factors. For instance, known hibernacula may be very important and thus given a high weighting in the FHSI. Only the most important herptile-related criteria should be considered for site-specific ZOS discussed in Section 3.5. Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.2.6 Non-FIM Category – Waterfowl Criteria

Waterfowl criteria are important habitats for different species or life stages. Breeding or nesting areas, key migration corridors or any important habitat attributes may be considered. Data can be incorporated into the FHSI in many ways and weights can be assigned to apply more importance to habitat attributes that may be limiting factors. For instance, known nesting for species like grebes may be very important and thus given a high weighting in the FHSI. Only the most important waterfowl-related criteria should be considered for site-specific ZOS discussed in Section 3.5. Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.2.7 Non-FIM Category – Ecosystem/Habitat Feature Criteria

Ecosystem criteria often include important habitats for different species or life stages. Breeding or nesting areas, key migration corridors or any important habitat attributes may be considered. Data can be incorporated into the FHSI in many ways and weights can be assigned to apply more importance to habitat attributes that may be limiting factors. For instance, known floodplains may be very important and thus given a high weighting in the FHSI. Only the most important ecosystem-related criteria should be considered for site-specific ZOS discussed in Section 3.5. Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.2.8 Non-FIM Category – Rare or Endangered Species or Ecosystem Criteria

Rare or Endangered Species or Ecosystem criteria are specific criteria that have been identified in either a provincial or federal framework (e.g., *Species at Risk Act* Management Plan etc.). Critical habitat as defined by SARA must be identified. Data can be incorporated

into the FHSI in many ways. It is recommended that a site-specific ZOS be developed for all Rare Occurrences. Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.2.9 Non-FIM Category – Other Criteria

Other criteria that may influence habitat value that cannot be easily placed into one of the categories above can be included here. Often, these may be used to describe important habitats that are present in highly urbanized areas. Use of this group should be made with caution, as it is often employed as an "Index Correction" for areas in the FHSI that do not adequately reflect the habitat value present (e.g., a significant juvenile salmon migration corridor that contains many marinas and other shoreline modifications that cannot be accounted for appropriately within the above groupings[2]). Similar to Fisheries criteria, First Nations TEK data can be included provided it can be adapted in spatial and quantitative fashion.

3.3 FHSI Consideration for Assigning Starting Weights to Categories

Assigning a starting weight to each category and respective criteria is the first step in determining the FHSI Ecological Rank. Schleppe et al. (2019) summarized the variability in standardized assigned values from FHSI analyses that were conducted during previous FIMP lake processes. The starting weights or values of all the FIM and non-FIM categories should initially be equal (see working example in 0); these values can be adjusted during FHSI calibration (see Section 3.4). Adjustments to the weightings must be defended with scientific knowledge and rationales (e.g., gravel beaches are important kokanee spawning habitats in the lake being surveyed). One exception is for the Shoreline Modification criteria as this is to be assigned a weight of 5% in the index as a starting point (Section 3.2.2).

In summary, the following occurs:

1. The FIM and non-FIM FHSI categories are all assigned an equal weight i.e., 5 categories – 20 points each for a total of 100 points.
2. Within each non-FIM FHSI category, weights can be assigned to individual criteria —i.e., fisheries category total value 100 based on 5 criteria valued at 20 points each—based upon the expected influence of the criterion.
3. During calibration, the weight assigned to the FIM or non-FIM categories can be amended with supporting rationales. Use best available scientific knowledge and inventory information to confirm values.
4. During calibration, the weight or influence assigned to any criteria can be amended with supporting rationales. Use best available scientific knowledge and inventory information to confirm values.

Section 3.3.1 below provides guidance on assigning an equal starting weight for the FIM and non-FIM categories.

[2] For example, in this case, a fisheries Migration Corridor may be used in the FHSI but unless it is given substantial and unrealistic weighting, the critical migration corridor is overlooked. To address this, an "Other" parameter is used to reflect the extreme values that are assumed to be undervalued in the index.

3.3.1 FHSI Criteria Starting Weights for FIM and Non-FIM Categories

When considering the criteria in the FHSI index there are the FIM and non-FIM FHSI categories to consider, which are initially assigned equal weights. The following is a stepwise procedure to develop the starting point for the FHSI index:

1. Start with a review of the FHSI working example provided in 0.
2. Determine the number of non-FIM categories that will be added to the FIM variables (i.e., fisheries, wildlife, SAR etc.).
3. To determine the weight for each of the FIM and non-FIM FHSI categories, complete the following steps:
   i. Count the total number of FIM and non-FIM categories used in the FHSI, excluding shoreline modifications.
   ii. The starting value is determined by the following formula:

$$Starting\ FIM\ /\ Non-FIM\ FHSI\ Category\ Percentage = 95\%\ /\ (\#\ of\ FIM\ and\ non-FIM\ FHSI\ Categories\ excluding\ shoreline\ modifications)$$

   iii. This calculation provides the starting point or percentage for each different FIM and non-FIM category, weighing all non-FIM groups equally. Ninety-five percent is used because 5% is assigned to Shoreline Modifications.

3.3.2 FHSI Considerations for Assigning Weights to Criteria

When assigning weights to criteria, the total number of different criteria must be carefully considered. There is a relationship between the number of criteria used in the index and the associated weighting of each of these criteria if they are all equal. In general, as the number of FIM and non-FIM categories and criteria within the categories increases, there is a general reduction in influence of each parameter in the index and the complexity of the index increases. It is for this reason that the first index iteration should be completed assuming that all FIM and non-FIM criteria are equal (see Section 3.3.1). During calibration, care should be taken to not over or underestimate the influence of any FHSI category, unless specific rationale can be provided (see Section 3.4). The following are important considerations to help assign weights to either the FIM or non-FIM FHSI categories and/or criteria within those categories:

1. The influence or weight assigned to any given parameter and the potential for collinearity or “duplication” in the index.
2. The total number of criteria and whether they are all necessary or whether they can be condensed into a smaller, more meaningful summary of the data.
3. The level of accuracy of the data being relied upon to generate the FHSI criteria.
4. The rationale for the criteria and the weight assigned to each. Weighting should consider data available, accuracy and other factors deemed relevant.

Each FIM criterion and non-FIM category and criterion must be scrutinized and the rationale for inclusion and its assigned weight should be documented. The following is a stepwise procedure for assigning weights to criteria.

1. Assign a value for each criterion within the FIM category. The summary by Schleppe et al. (2019) provides useful information on FIM criteria and weightings applied historically. A starting point can also be found in 0.

2. Assign a value for each criterion in the non-FIM category. The summary by Schleppe et al. (2019) contains useful information to help assign a starting point.
3. Assign a starting value for each different shoreline modification.
4. To determine the total influence of each criterion, the percentage assigned to the category is multiplied by the percentage assigned to the criteria. For instance, if the Fisheries Category is assigned 10% of the total FHSI index and shore-spawning is assigned 50% of the value of all Fisheries Criteria, shore-spawning would have a total weight of 5% of the FHSI index (10% x 50% = 5%).

This process of assigning ranks repeats during the calibration process outlined in Section 3.4.

3.4 FHSI Calibration and Determining the FHSI Ecological Rank

The output of the FHSI is a five-class ranking system[3], ranging from very low to very high, referred to as the FHSI Ecological Rank. To determine the FHSI Ecological Rank the following are the general steps and procedures.

1. Using the initial starting points, calculate the FHSI score (see Section 3.4.1) and determine the FHSI Ecological Rank (refer to Step 2 in Section 3.4.3).
2. Review the FHSI Ecological Ranks. If concerns exist about whether the value accurately represents the habitat value or feature, amend the weights using logical deductions and supporting information based upon the categories or criteria in question.
3. Calculate the FHSI score (see Section 3.4.1) and determine the FHSI Ecological Rank (refer to Step 2 in Section 3.4.3).
4. Repeat this process until FHSI Ecological Ranks accurately represent the values based upon the opinions of the QEP and the FIMP working group.

The full process for calibration and determination of the FHSI Ecological Rank is discussed below.

3.4.1 Calculating the FHSI Score

The FHSI consists of a variety of categories and criteria, with each category/criterion having a range of potential influences on the overall habitat value or FHSI score of each shore segment. To determine the FHSI score, calculate the sum of all the index criteria for each segment. The total habitat value for each shoreline segment includes the sum of all positive and all negative index criteria.

3.4.2 Calibration Overview

The index is calibrated by reviewing relevant scientific knowledge and inventory information as well as accessing the collective biological expertise of a group of working professionals, agencies, First Nations, and other knowledgeable individuals such as local volunteer naturalists who are familiar with the lake and have specific experience documenting habitat or species through inventories. Calibration of the index is a process of reviewing the

[3] The FHSI could also produce a three- or four-class system if desired.

influences of each of the different FIM and non-FIM FHSI categories and criteria and associated weightings to ensure that the index values are appropriately scored.

The FHSI Ecological Rank reflects the relative value of a shoreline segment and the risks associated with riparian or foreshore activities when compared to other shoreline segments within the lake being assessed. This ranking reflects the relative value of a shoreline segment and the risks associated with riparian or foreshore activities when compared to other shoreline segments within the lake being assessed. The FHSI is a tool that considers risks to the many different habitat values along shorelines. The intent of the index is to allow working professionals, agencies, landowners, non-profit organizations and any other party to collectively view key habitats along shoreline areas in a broad sense. The FIMP companion process (Foreshore Development Guidelines – FDG) of identifying Conservation Zones and developing management guidelines allows government agencies and communities to protect and manage the lake shorelines by lake segment or by Conservation Zone and facilitates development approval processes. The index is intended to act as a tool to identify areas where risks are likely greater to species or habitats (at risk or otherwise) from proposed land-altering activities. The FHSI along with specific ZOS support the FDG guidelines. This process is considered accurate enough to identify areas of higher shoreline value for the purpose of determining subsequent risks from shoreline activities within each of the different FHSI Ecological Ranks (e.g., Very High, High, Medium, Low etc.).

3.4.3 FHSI Iteration Process

To calibrate the index, numerous iterations are recommended to determine if the FHSI Ecological Ranks reflect observed values along a shoreline. There is no set number of iterations that must occur but this process is generally repeated until the index represents the best relative values for the index ranks. Since numerous different professional opinions are incorporated, the resultant outputs are a reasonable approximation of shoreline values present and are representative of different overall risks associated with proposed shoreline activities.

The QEP leading the assessment of the index should develop several different scenarios for review. Each of these scenarios is then provided for review, where the reviewers consider the weightings of the different criteria in the FHSI and the weightings of the different FHSI categories. The working group for the FHSI assigned to a lake should work through this process until consensus is reached. During this process, it will also be important to consider what habitat attributes may be needed in the designation of Zones of Sensitivity (ZOS) (see Section 3.5) or Conservation Zones (see Section 3.5); the designation of Conservation Zones is further explained in Section 3.6.2.

For each iteration, the following steps are recommended:

1. Review the minimum, maximum, median and distribution of FHSI scores for the lake.
2. Create appropriate boundaries for each FHSI Ecological Rank considering the distribution of scores. This is accomplished by plotting the FHSI score data after reviewing the distribution of the data from the iterations.
3. FHSI score data for each segment can be plotted as the FHSI score for each different segment plotted against itself to compare scores for all segments. This initial step provides an indication of any logical score breaks that may be apparent. This can also be accomplished using a simple histogram of scores. While reviewing the distribution of the FHSI Ecological Ranks (i.e., the tally of shoreline segments

assigned to each different ecological rank [Very Low, Low, Medium, High, Very High]), decide if the numbers used to define the range of each ecological criterion or category should be adjusted to improve the distribution of data.

4. View the FHSI Ecological Ranks visually in GIS to determine if each of the segments matches the professional opinion of the author. Ultimately, the value of habitat is a continuum and there is room for some interpretation of this information when considering the most appropriate spot to create a boundary between different FHSI Ecological Ranks (e.g., it is possible to have a High or Moderate value area that is on the cusp of a boundary or break).

The calibration process can identify concerns with the FHSI Ecological Ranks. Index calibration results need to consider new or different segment breaks because key habitat values are not accounted for at the scale of field mapping[4]. During calibration, it may be necessary to consider removing or including additional criteria. The final output of the index should generally represent a consensus of the professional, agency representatives and other practitioners involved in the FIMP working group or project team.

Index calibration should also consider the total lengths of shoreline within each different segment FHSI Ecological Rank (i.e., Very High, High, Moderate, Low etc.). Generally, each lake will have areas of lower and higher overall value. The final determination of the FHSI Ecological Rank may not represent equal lengths of shoreline between all FHSI rank categories and this may vary depending upon the lake. Thus, it is important that assessors consider the length of shoreline during calibration. The final determination should rest with the site-specific FHSI outputs around a lake, ensuring that appropriate segment breaks are made. It is possible for the distances of shorelines in each of the FHSI Ecological Rankings to be skewed.

In particular, a skew in shoreline lengths in each FHSI Ecological Rank may occur when large stretches of lakeshore have Crown land or are undisturbed. In general, this skew is often at the sacrifice of the Low and Very Low ranks. However, this may be expected given that the purpose of the calibration is to assess shoreline values as they relate to different proposed shoreline-altering activities. Since some lakes only have a few isolated areas of high impact, it is plausible that the FHSI does not have long lengths of shore with either a Low or Very Low FHSI ranking. In these cases, during index calibration, the shore segments, ZOS and the FHSI categories and criteria should be reviewed to ensure that the shorelines are accurately represented and a skewed distribution of shoreline lengths is warranted. Finally, the scale of mapping may also be important to consider. For instance, very large lakes with extensive natural Crown lands may have longer segments. In this example, the FHSI may not capture important habitats at a fine scale. In this example, assessors may wish to reduce the value they place on the FHSI outputs in these areas or increase the scale of the mapping by breaking out segments further.

Throughout this process, it may be necessary to simplify the FHSI index within a larger category such as Fisheries or Wildlife Criteria. For instance, it may be that spawning areas for several different fish species are present and rather than considering each of them uniquely, they could be combined into one summary of shore-spawning sites. There are numerous different ways to develop key criteria in the larger FHSI categories such as fisheries and wildlife and assessors are ultimately responsible for developing a key list of

[4] This highlights the importance of determining the key field data that need to be collected during the FIM inventory. Survey efforts should focus on factors that will be considered as criteria in the FHSI or as a ZOS.

criteria for inclusion based upon the data available, the total number of criteria, the quantity and quality of data available and a variety of other factors. Each criterion considered should represent the entire lake and be collected in a quantitative or spatial sense (i.e., directly observed shore-spawning surveys or digitization of historic DFO or TEK knowledge).

3.5 Determining Zones of Sensitivity (ZOS)

ZOS are specific areas that are identified as important habitats for either species or general ecosystem function. Zones of Sensitivity are spatially independent of the FHSI Ecological Rank but may be included in the rank calculation as non-FIM categories. Each ZOS can be created as a point, line or polygon with an appropriate buffer around the ZOS. Examples of ZOS are habitats that are extremely important to a species-specific life stage (e.g., nesting, spawning, etc.), a habitat type that is limited in a particular lake (e.g., wetland), a unique or rare habitat (e.g., mussel beds) or a specific habitat feature such as an eagle nest. Rationale should be developed for each identified ZOS and presented in the FDG process (see Section 6.0). All associated ZOS should be identified on the FDG maps in the specific colour scheme presented in Appendix D.

Mapping is used to identify where important ZOS occur along a shoreline. Display each ZOS as either a polygon, line or point. As part of the identification of ZOS, appropriate buffer areas are also recommended. The ZOS buffers should be dependent upon the scale of the data collected. The full extent of ZOS may not be known so the buffer should account for this and protect the core ZOS from potential impacts from adjacent activities. A generous width is thus suggested with the provision that it may be fine-tuned if a detailed assessment of a development proposal is completed. The detailed assessment will likely consider topographic boundary, feature characteristics, ecological value etc. Both the ZOS and buffer should be transparent enough to allow orthophoto details to be evident on maps. Present details on each ZOS, including how each was defined and how the buffers were determined, in the FDG.

As outlined in the FDG, ZOS are intended to highlight important or valuable habitats in a way that is independent from the FHSI Ecological Rank. All ZOS should be scrutinized carefully to determine if they warrant inclusion in the FDG as an independent habitat unit for consideration. If certain features identified are deemed important and warrant being a ZOS, habitat maps must be of sufficient detail to aid in data interpretation. A more comprehensive FHSI map set to support the FDG maps provides a useful spatial summary of all key habitat criteria and may be needed for lakes with more complicated or sensitive habitats if there are multiple ZOS present (see Section 4.0). The framework of these methods allows inclusion of as many ZOS as required to manage key shoreline areas. As the habitat complexities of a shoreline increase there is likely an increase in the risks from development activities and consequently the need for more careful consideration of potential impacts to these habitat areas in the FDG.

3.6 FHSI Data Analysis

3.6.1 FHSI Analysis

There are numerous different ways to analyze the data and present the results. The results of the FHSI, however, are best viewed in a mapping framework such as the generated PDF map set for the FDG or on an online viewing platform.

The following is a list of standard analyses that are normally completed:

1. Total shoreline length and/or percentage of shoreline for each different FHSI Ecological Rank. These can also include the total length of natural and disturbed shoreline.
2. Total shoreline length for each shore type for each FHSI Ecological Rank. These can also include incorporating the total length of natural and disturbed shoreline.
3. Total shoreline length for each land use type for each FHSI Ecological Rank. These can also include incorporating the total length of natural and disturbed shoreline.

3.6.2 Recommending Conservation Zones

Conservation Zones can be identified utilizing the FHSI Ecological Ranks and/or the identified ZOS, where applicable. Conservation areas tend to have an FHSI Ecological Rank of Very High or High, likely contain one or more ZOS and may contain SAR Critical Habitat or other identified rare species or habitats. The intent of identifying Conservation Zones is to provide a framework for consideration of habitat areas around lakes that can be protected using different mechanisms, such as those available under the federal *Fisheries Act* or local land use plans. Conservation Zone recommendations are provided in the FDG.

The recommendation may be presented as a percentage or length of the lake shoreline and/or as specific areas that may be suitable for protection (e.g., red zone or ZOS areas). For each Conservation Zone identified, a rationale for the recommendation should be provided. For instance, if the Conservation Zone is to ensure connectivity with other already protected shoreline areas it should be clear as to why it is being recommended for conservation status.

3.7 FHSI Reporting

Reporting the FHSI data involves both written and graphical or GIS mapping display of the FHSI Ecological Ranks. Reporting should focus on supporting the data used to develop the criteria in the FHSI through careful development of a rationale. Reports should summarize the rationale for inclusion and weighting of all criteria used in the FHSI. It is assumed that numerous different data sources may be used in the development of an FHSI and it is important to document how these data were used and incorporated into the FHSI, referencing the original data source. Presenting data in tables with a short rationale is useful.

Reporting of the final FHSI output (e.g., the FHSI Ecological Ranks and ZOS) is best accomplished by displaying them graphically on maps and using GIS mapping tools.

4.0 FIMP MAPPING

The FIM, FHSI and FDG are best viewed using maps. There are several ways maps can be prepared depending upon the level of data available for any given lake. The following is a general summary of the three mapping products that could be produced. Since data is collected in GIS, any or all of these mapping products are possible to present, depending upon layers turned on or off in the GIS map.

1. *FIM Maps* – FIM maps are produced to document the summary of the FIM dataset. If GPS points for shoreline modifications are known, these could also be shown. The FIM data summarizes the biophysical data present.
2. *FHSI Maps* – FHSI maps provide a summary of the FHSI results and possibly the non-FIM categories such as fisheries information. Depending upon the amount of

data available, several map sets may be required, such as one for each of fisheries, wildlife, ZOS and other FHSI data.

3. *FDG Maps* – The FDG maps are created using a reduced FHSI and FIM dataset that is simple and easy to interpret and intended to provide a summary of FIMP. These maps are usually used by the public and agencies to streamline the planning and permitting processes. Typically, only the FHSI Ecological Rank and ZOS are displayed, while other data is left out or contained in either the FHSI or FIM maps.

A working colour palette is provided in Appendix D. This appendix contains colours to be used for all of the above maps and is a guide to help standardize colour palettes between different lakes for consistent representation of data across BC. Alteration to map colours may be made as necessary but is not recommended.

5.0 QA/QC, GIS AND DATABASE MANAGEMENT IN FIMP

5.1 FIM Data Processing, Management and Quality Control/Assurance

The data processing and quality assurance portions of these projects are extremely important. It is recommended that assessors carry out these steps because they have first-hand knowledge of the shoreline and its condition. Although data entry into the GPS unit results in minimal errors (i.e., forgotten fields etc.), sometimes small items are missed or accidentally overlooked. It is during the data processing stages that data gets reviewed and finalized.

5.1.1 FIM Data Processing and Trimble GPS Processing and Clean-up

Data processing for FIM projects is slightly different than SHIM (Mason and Knight 2001). Module 5 of the SHIM manual provides very detailed information regarding accuracy requirements for stream mapping. This manual should be reviewed as it contains useful information regarding standard GPS receivers, data logging and other requirements that field assessors need to know and be able to do. The methodology below is intended to provide assessors with a summary of the post-processing steps that occur as part of a FIM project and does not contain a summary of methods for use of the GPS or GIS software.

Data management is extremely important. One of the typical GPS settings used is a copy feature that allows assessors to quickly begin a segment. However, use of this feature can result in data field carry-over (i.e., substrate data from Segment 25 is carried over to Segment 26). For example, the assessor may forget to zero a substrate percentage and the number carries over, so that the substrates total now exceeds 100%. Therefore, once data has been collected, it must be proofed. This process involves review of photos, data fields, handwritten notes etc. The following are specific items that should be reviewed:

1. *Lake Reference* – Errors in data collection are not common in this section. Clean-up of spelling and comments is most common.
2. *Segment Class* – In this section, the shore type and shore modifier fields are most important and percentages in other sections should be consulted to confirm. Review percentages and ensure that photo numbers are correct. Video time can be entered if available.

3. *Shore Type* – Field pictures and air photos should be reviewed in conjunction with field data entered. Typically, only minor adjustments are required to ensure data adds to 100%.
4. *Land Use* – Land Use is often more difficult to determine in rural areas. Oftentimes, digital data is lacking and land use is assessed by field interpretation. Review of local government zoning is helpful as it provides a basis for interpretation. Assessors should do their best to document land uses as observed and adjustments should be made as necessary.
5. *Substrates* – Field photos can be reviewed to assist in final determination of substrates. Generally, these fields just need to be reviewed to determine that they add to 100%.
6. *Vegetation Bands* – Review of field photos is necessary to verify these fields. Having a large number of photos can help assessors to ensure these sections are accurate. Adjustments should be made as necessary.
7. *Littoral Zone* – A review of air photos to look at the littoral zone widths will help improve accuracy.
8. *Shoreline modifications* – In these fields, the docks per kilometre and groynes per kilometre need to be calculated. These fields are calculated as follows:

   Dock (or groynes) per Kilometre = # of Docks/Shore Segment Length

   All modifiers should be reviewed. Air photos and photos should be carefully reviewed to confirm these fields.
9. *Flora and Fauna* – These fields usually require a brief review with edits as necessary.

5.1.1.1 FIM Accuracy and Determining Shoreline High Water Mark

Typically, accuracy targets for stream mapping using SHIM are ± 5 m (Mason and Knight 2001). These targets are realistic for stream mapping but are not possible while carrying out surveys of a shoreline from a boat. When using a Trimble GPS or equivalent data collector, the GPS line from the boat surveys is 20 to 30 m from the actual shoreline being measured. Thus, there is an immediate accuracy issue as the line feature being collected with the GPS unit is already inaccurate because it is 20 to 30 m from the shoreline. Thus, precision mapping with the GPS is not required for FIM projects (i.e., Position Dilution of Precision (PDOP) values are meaningless as outlined in Mason and Knight 2001) because of the inherent data inaccuracies. For this reason, other technologies such as a laptop or tablet device rather than a Trimble unit may be used to log data.

The spatial accuracy of the shore segment information ultimately relates to the accuracy of the shoreline HWM being used. Mapped shorelines and the spatial data associated with them should be spatially located at the approximate HWM. The shoreline HWM accuracy with these surveys is typically obtained through air photo interpretation, detailed topographic modelling, LiDAR or by using existing lake shoreline information. Each of the above provides a different level of accuracy and typically a combination approach is preferred. Accuracy of the shoreline segment features can affect the following:

1. The length of the shoreline segment;
2. The location of segment breaks; and
3. Calculations in the database such as docks per kilometre.

The first step in post-processing is to accurately identify the location of the approximate HWM of the lake being assessed. This can be accomplished, as mentioned above, by using one or a combination of the following:

1. Delineation of the HWM shoreline by air photo interpretation using changes in vegetation, retaining walls and other visible features;
2. Use of a topographical model and spatial analyst software to calculate an elevation, which can be used for a shoreline (e.g., 343 m asl is often used for Okanagan Lake); and/or
3. Using the existing TRIM (BC only) or other provincial/federal shoreline mapping standard.

There are distinct advantages and disadvantages to each of the above. The advantage of air photo interpretation is that it tends to be quite accurate with high-resolution aerial imagery. However, it also tends to be quite time-consuming to complete. Use of spatial analyst software to develop set contours for a lake is possible but often the data available to create the model is not very accurate and the software used to develop the line can be costly. Use of the TRIM shorelines is very cost-efficient but this line work can often be quite inaccurate (i.e., up to 20 linear metres in some instances). Given the above, assessors must consider the accuracy requirements of their assessments to ensure that the desired accuracy is achieved. Assessors should attempt to achieve the 5 m accuracy recommendations of SHIM for the HWM and utilize whatever means necessary within allowable budgets to achieve these results. GIS software allows data to be updated as increased accuracy becomes possible.

Once the shoreline HWM has been mapped and segment breaks have been determined, the database should be “transferred spatially” or the data copied to the shoreline. This process involves moving the spatial line features to the shoreline with the appropriate breaks. Some databases include the transferred GPS settings (e.g., PDOP data). This data can be retained but is unnecessary because it is associated with line features collected during the boat survey and not associated with the manually determined shoreline features discussed above.

5.1.1.2 FIM Spatially Locating Segment Breaks

Segment breaks are often determined in field assessments by marking field aerial imagery that was produced for the survey because it is more efficient than manually marking the point using the GPS. These visual markers allow segment breaks to be easily added to the shoreline once it has been determined (above) and allows field crews to be very specific about where the break is being made from the boat. If field maps cannot be generated, assessors are strongly encouraged to manually mark the segment break using a point feature on the GPS unit. Using offset features, it is possible to mark this from the vessel. This is recommended because it is the most accurate way to ensure the segment break occurs where desired on lakes without high-resolution aerial imagery.

5.2 GIS Data Processing, Management and Quality Control/Assurance

GIS Data management includes development and maintenance of the GIS dataset. The information below summarizes the different datasets used in the FIMP process, including the FIM, FHSI and FDG.

1) *FIMP GIS dataset* – This GIS dataset includes all components of the FIMP process including:
    i. FIM – Standard set of biophysical data.
    ii. Extra FIM data – Any additional FIM data collected, such as additional littoral zone bands, aquatic vegetation polygons, total marina cover, or other useful data can be collected. These data include all of the point data for stream confluences, boat launches, groynes collected. These datasets can be numerous and the extent of GIS mapping undertaken should be reviewed in the pre-field assessment (See Section 2.2).
    iii. Biophysical polygon data including any identified ZOS or vegetation polygons.
    iv. FHSI – the outputs of the FHSI ranking process.
    v. Foreshore Development Guide data – any information necessary for the FDG.
2) *FIM Dataset* – Includes the data from FIM only (refer to table with FIM definitions):
    i. For some lakes, there may be a need to add data unique to the lake, for instance in a lake with a large drawdown there may be three foreshore substrate bands or additional littoral zone bands. Any extra useful FIM data that assessors opt to collect (e.g., additional substrate bands) should be kept separate in GIS. The data can be linked as long as the same segment number structure is used.
    ii. Biophysical polygon data such as:
        a. Aquatic Vegetation.
        b. Floodplain Mapping.
        c. Spawning Data (this would be any products developed versus raw data from the original source).
3) *FHSI Database* (FDG)
    i. FIM.
    ii. Extra FIM data.
    iii. Biophysical Polygon Data.
    iv. FHSI Ranks.
    v. FHSI Restoration Analysis Ranks.

These data may be kept in separate databases or as one larger geodatabase. The FIM datasets should be consistent with the methods presented herein. As long as data are consistent, reproducible, contain appropriate metadata and references to reporting, any additional data collected can be added to the dataset as required.

6.0 FORESHORE DEVELOPMENT GUIDE

This Foreshore Development Guide (FDG)[5] provides development planning guidelines, aimed at protecting sensitive fish and wildlife species and their habitats identified through the previous FIM and FHSI analyses. The FDG is an initial tool used when planning for, prescribing or reviewing riparian and shoreline alterations. Based on the environmental (species and habitat) values, the FDG identifies the levels of risk associated with shoreline alteration from various types of development activities. Based on those risks, the anticipated regulatory steps required to proceed with the project are to be identified. The guidelines

[5] Foreshore Development Guide was previously known as Shoreline Development Guidelines.

provide important information to support both the landowner in preparing foreshore work applications and the government agencies during their review of the applications.

The FDG methods were first developed for Windermere Lake by the East Kootenay Integrated Lake Management Partnership (EKILMP et al. 2009). The original methods used the BC Ministry of Environment (BC MoE) document: High Value Habitat Maps and Associated Protocol for Works along the Foreshore of Large Lakes within the Okanagan (BC MoE 2008) and input from the various EKILMP members including: DFO, BC MoE, Regional District of East Kootenay (RDEK) and Wildsight. Additional lake projects followed and expanded on the initial EKILMP FDG. Notable lake projects included: Moyie Lake (Schleppe 2009a), Tie Lake (McPherson et al. 2012) and Kootenay Lake (Kootenay Lake Partnership 2019). With each iteration of these documents, the general process for developing an FDG were refined.

The FDG is intended to be consistent from project to project. This is because it provides standard information that remains unchanged regardless of the lake. Consequently, a large portion of the FDG methods explanation is provided in the form of a template report (Appendix E). The FDG template and associated forms are available in Word and Excel versions (https://livinglakescanada.ca/). The template may be used in full and modified where needed. The template provides notes to the author to help guide its preparation. Some of these notes have also been provided here to support the explanation of the methods used to prepare an FDG.

6.1 Lake-Specific Contact Information

When preparing the FDG, list and provide contact information for organizations that the proponent may need to contact when planning their proposed activities. This list will likely include the provincial regulatory agency that coordinates referrals (e.g., FrontCounter BC), the regional district, local municipality, First Nations and relevant lake partnership group(s).

6.2 Process Overview

The FDG is intended to help direct applicants through planning for their proposed development, project or activity and identify sensitive habitats (ZOS) and areas recommended for conservation. Prepare the FDG according to the following stepwise process:

Step 1: Prepare the FDG map using the FHSI outputs to depict: a) the FHSI Ecological Ranking for each segment (ranging from very high to very low) as colour zones; and b) the ZOS. This is the pertinent fish and wildlife information needed to guide development planning.

Step 2: Summarize and provide general recommendations for each colour zone and ZOS. Include information on habitat sensitivity, anthropogenic disturbance risks and acceptable activities. Also provide conservation recommendations for the lake.

Step 3: Review and update (as necessary) the Activity Risk Matrix (ARM) and associated recommendations. The ARM identifies the level of risk of typical activities for each colour zone and for the ZOS. The risk is indicative of the acceptability of a project to regulators.

Step 4: Provide an overview to guide the applicant in identifying the necessary regulatory approvals/permits/authorizations (collectively "approvals") to be obtained.

6.3 Step 1 – Prepare the FDG Map

The FDG map synthesizes pertinent ecological information and is a primary reference tool when planning foreshore developments. Prepare the FDG map using the FHSI tabular and mapping outputs. Depict the following two items on the maps (using the colour scheme provided in Appendix D):

1. *The FHSI Ecological Rankings for each segment* – The rankings are shown as one of five colour zones, ranging from very high to very low value.
2. *The ZOS* – Every ZOS is presented as either a polygon, line or point, and should have an outer buffer. This buffer accounts for unknowns of the ZOS's full extent and protects the core ZOS from potential impacts from adjacent activities (see working example in 0). Details on each ZOS, including how each was defined and how the buffers were determined, are presented in Section 6.4).

The proponent (or the developer, their contractor or the regulatory reviewer) can use the FDG map to identify the values present along or within their proposed development area. Together, the FHSI Ecological Rank and the ZOS mapped features provide a science-based tool to guide development planning.

6.3.1 First Nations Traditional Ecological Knowledge (TEK)

If TEK has not already been included in the FHSI and/or if the FDG is a stand-alone report, then identify if efforts to obtain TEK were made and how they have informed the FDG (Appendix A). In general, if TEK was provided, identify:

1. The quantity and quality of the information.
2. How TEK was incorporated (Pathway 1 or 2; Appendix A) and the implications of that pathway.
    - Pathway 1 is where quantitative TEK was provided and was incorporated into the FHSI calculations under the corresponding category (e.g., fish, wildlife, herptile, waterfowl etc.). The information may have also been mapped as a ZOS. This information would be presented on the FDG map with the activity risk determined using the standard FDG steps presented here (e.g., the recommendations and existing ARM would apply).
    - Pathway 2 is where qualitative biological TEK was provided. Although this information would likely not be included in the FHSI, it may be identified and mapped if the FIMP working group deems the information important and relevant and is included in the Terms of Reference for the FIMP. The First Nation consultation process should be outlined. Pathway 2 TEK may also be identified in the FDG report. This may involve development of a unique ARM that applies only to TEK ZOS.

6.4 Step 2 – Provide Colour Zone (Ecological Rank), ZOS and Conservation Recommendations

Provide recommendations for each colour zone and ZOS by using the FHSI results to complete the summary tables in the template FDG document. Present the recommendations to guide development proposals to reduce the impacts on sensitive fish and wildlife values. The fish and wildlife value/risk and subsequent regulatory review process are highest in red zones and areas with ZOS. Identify that areas with the highest natural value will require the highest level of ongoing protection. Further, identify that the values/risk in the grey zones are lowest and that since there is already likely significant impact from development in these areas, future development therein would generally cause less impact provided current mitigation guidelines are followed.

Project proponents should review and consider the FDG recommendations for the colour zone and ZOS where their project is situated. This information will provide an understanding of the values and risks present and guide their planning decision moving forward.

6.4.1 Shoreline Colour Zone (Ecological Rank) Recommendations

Prepare a summary table for each shoreline colour zone (Ecological Rank), which includes the following information that would be relevant to the lake segments represented by the colour zone:

- The percent of the lake shoreline represented by the colour zone.
- The main values that were present in or define the colour zone.
- If the study is an updated FIM, identify the rate of change seen in the lake for the colour zone and provide a statement on the relevance of the change.
- Recommendations to potentially minimize impacts on the colour zone (including acceptable and unacceptable activities).
- Opportunities for restoration.

An example of a summary table for a shoreline colour zone (Ecological Rank) is provided below. Note that in the FDG template and the example below, the [blue font text in square brackets identifies information that the FDG author is to insert], while the black font is considered standard information that remains consistent amongst lake reports.

Red Shoreline	
Defined by:	Very High FHSI Ecological Rank.
FHSI summary:	Red zones account for X% of the total shoreline length of Y Lake.
Sensitivity summary:	Red shoreline areas have been identified as essential for the long-term maintenance of fish and/or wildlife values through the FHSI analysis. These areas are essential for fish and/or wildlife populations. [Use the FHSI results to summarize the main values that define these areas. If this is an updated FIM, identify the rate of change seen in the lake and make a statement on the relevance of this change.]
Recommendations:	Due to their high value (sensitive communities present), to promote conservation use limited development is recommended for Red shoreline areas. Low-impact water-access recreation and traditional First Nation uses are examples of acceptable activities in these areas, while permanent structures or alteration of habitats are not. Habitat restoration may be appropriate in these areas, where applicable. Invasive aquatic plant removal is often acceptable, provided there is an approved aquatic plant removal program, including trained personnel and appropriate permitting in place. [If possible, expand on the recommendations – e.g., by identifying opportunities for restoration.]

6.4.2 ZOS Recommendations

To prepare the ZOS recommendations, use the FHSI results to identify all the ZOS that are present along the lake shoreline. Create summaries similar to the one below for each unique ZOS. The FDG template report provides empty ZOS template tables for each ZOS category. Delete the tables that are not relevant to the lake of interest. Include the following information for each ZOS:

- The specific species or habitat value represented by the ZOS.
- The information used to map the main body (line, point or polygon) of the ZOS.
- The methods/assumptions used to establish the buffer.
- What makes this an important value.
- Provide recommendations on how to protect this ZOS from development impacts.

The proponent should refer to the FDG map and identify if the proposed development aligns with the outer edge of a mapped ZOS buffer. Then the proponent should refer to the corresponding ZOS summary table for general information on the values present and recommendations to reduce impacts.

Fisheries - Kokanee Spawning Area (example)	
Lake summary:	[Input lake and ZOS-specific text here on: a) what the ZOS is, b) the information used to map the main body (line, point or polygon) of the ZOS and c) the methods/assumptions used to establish the buffer. For example: Kokanee spawning areas were mapped as polygons along the shoreline using the provincial fisheries database accounts (iMap). The polygon boundaries were confirmed during the FIM survey, by ensuring suitable gravel was present in the mapped locations. Kokanee spawning polygons were mapped in segments 1, 7 and 15. These were respectively located at the inlet of the lake, at the mouth of the main tributary flowing into the lake and at the lake outlet. A 30 m buffer was applied to the ZOS, around its full perimeter. This buffer was recommended to protect the spawning area from neighbouring development risks and to capture peripheral spawning areas that may have been missed in the assessments.]
Sensitivity summary:	[Input details on why this was selected as a ZOS. Example: Kokanee spawning habitat is important to the long-term viability of this species. It is limited to only select locations along the shoreline where suitable conditions are present. These conditions include a combination of appropriate gravel beds and the presence of upwelling or springs to keep the gravels clean and allow the eggs to be oxygenated.]
Recommendations:	[Input recommendations on how to protect this ZOS from development impacts. For example: These sensitive habitats are to be protected, with no permanent developments recommended both within and adjacent to the mapped polygon areas.]

6.4.3 Shoreline Conservation Recommendations

Summarize the shoreline conservation recommendations for your lake of study. Use the FHSI, TEK, local land use plans, community consultations, updated FIM rate of change data and other available sources of information to identify conservation areas that should be considered for long-term protection. Conservation Zones by their nature will exclude most activities. Management options for conservation areas should be established. A limited number of activities such as low-impact nature trails could be considered but should be consistent with management objectives. Identify potential options to protect each Conservation Zone. This may include: a) establishment of protected areas (potentially through any level of government); b) Section 16 *Land Act* Reserves; c) regional or municipal official community plans (OCPs), which designate these areas as development permit areas

of limited development potential (e.g., not within an urban growth boundary as an example); or, d) through private land conservation agreements, such as tenure covenants or direct land sales to land conservancy organizations such as the Land Conservancy of Canada. Landowners may want to sell, place a covenant on or swap land in exchange for regulatory approval of their project. If a recommended Conservation Zone has no official protective status and a development proposal is proposed then it is strongly recommended that a QEP be retained by the proponent to provide advice on potential impacts and approval requirements.

6.5 Step 3 – Review and Update the Activity Risk Matrix (ARM), Which Determines Project Risk

An ARM is supplied in the FDG template (see example below in Table 1). The ARM was created based on the concept that the potential for negative potential environmental impacts is deemed greatest in areas where values and risk are highest. In the ARM, each colour zone and activity combination has been rated as having a risk of either: Very High (VH), High (H), Moderate (M) or Low (L). These risk ratings reflect the potential impacts on fish and wildlife, with a Very High risk posing the greatest potential concern and the Low Risk a lower level of concern. The ARM also identifies that if a ZOS is present the risk also increases. The developer should refer to the ARM to determine what the predicted level of risk is for their specific proposed activity, given the shoreline colour zone and ZOS present.

Table 1. Activity Risk Matrix (ARM) example section – Risk ratings: NA = Not Allowed, VH = Very High, H = High, M = Moderate, and L = Low (Refer to Excel spreadsheet for the full working draft).

Activity	Risk rating based on Ecological Ranking				Risk rating if Zone of Sensitivity Present
	Very High	High	Moderate	Low/ Very low	
Aquatic Vegetation Removal					
Removing native aquatic vegetation – by hand, or mechanical cutting for swimming areas and private beach access	VH	VH	VH	VH	NA
Removing non-native/invasive aquatic vegetation – by hand or mechanical cutting for swimming areas and private beach access	VH	VH	H	M	NA

This step in the methods involves simply reviewing the ARM provided in the template and updating it, if appropriate. Note the risk rating for the various ecological colour zones was developed and revised by EKILMP, through subsequent studies (Kootenay Lake) and during this Living Lakes methods process. Any changes to existing risk should be done with careful consideration. An Excel version of the ARM is available: see Appendix B or Windermere Lake FIMP Report (Schleppe and McPherson 2021).

One example of a change to the ARM is to add a new activity that is not already listed and to determine the risk for each colour zone appropriately. Another potential update may be to incorporate the Not Allowed risk (NA). Currently, NA is only present for ZOS, given their

unique high values. It is recognized that NA is not legally binding, since a DFO authorization could be sought to alter fish habitat in a designated NA zone. However, if there was consensus among the lake partnership or management group, the FDG could incorporate a policy of NA for other high-value colour zones (conservation candidates) and/or for select activities. This was done at Kootenay Lake, whereby new groynes and residential boathouses were determined to be Not Allowed in any colour zone (Kootenay Lake Partnership 2019). Overall, the NA risk should be included in the ARM if significant and negative impacts will occur. The FDG would thus provide a science-based recommendation based on the risk but the legal decision would lie with the agencies.

Additionally, the template report provides a general mitigation hierarchy and overarching recommendations for combined Very High and High-risk activities as well as for combined Moderate and Low-risk activities. The author of the FDG report may wish to further expand or clarify on these recommendations.

6.6 Step 4 – Provide a Regulatory Process Guide

As a final step, review and update the information presented in the FDG template, which outlines applicable regulatory requirements necessary for projects to proceed. This includes:

a. The list of federal, provincial and local environmental legislation that may be applicable.
b. The table outlining the typical regulatory requirements for each activity listed in the ARM (example section provided below in Table 2).
c. The list of provincial best management practices (BMP) available.

Table 2. Example section of typical legal environmental requirements for select development activities. Refer to Excel spreadsheet for the full working draft.

Activity	Crown Land Tenure	BC Water Sustainability Act	Canada Fisheries Act Review
Aquatic Vegetation Removal			
Removing native aquatic vegetation – by hand, or mechanical cutting for swimming areas and private beach access	N	Y	Refer to DFO website
Removing non-native/invasive aquatic vegetation – by hand or mechanical cutting for swimming areas and private beach access	N	Y	Refer to DFO website

In addition, review and update the final FDG template section accordingly, which outlines other considerations to facilitate project review. This section identifies circumstances where the installation of past structures may result in concerns that impact the regulatory review of new works and provides approaches to facilitate the review of new proposed works.

Given the information presented in the template, there will likely be limited writing to complete this final step of preparing the FDG. Some additional resources to aid with this task of reviewing the supplied information and making updates are:

- A list of current provincial BMPs is available at: https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices
- DFO's Projects Near Water website: https://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html
- Contact FrontCounter BC or the relevant provincial agency that coordinates environmental applications.

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Appendix A. Incorporating First Nations Traditional Ecological Knowledge

Introduction

The FIMP framework is designed to incorporate First Nations Traditional Ecological Knowledge (TEK) when it is available. While including TEK into FIMP is not generally a legal requirement given the nature of these types of projects, it's strongly encouraged because TEK can contribute to a broader understanding of existing ecological values. The objectives of this appendix are to:

- Introduce the regulatory background;
- Define TEK as it pertains to the FIMP framework;
- Discuss the two pathways for including TEK in projects; and
- Provide guidance for engaging First Nations on FIMP.

Regulatory Background

Section 35 of the *Constitution Act* (1982) provides recognition and protection of existing Aboriginal and treaty rights. It also stipulates that the Crown has a duty to consult First Nations when it acts in a manner that may adversely affect those Aboriginal and treaty rights (MVEIRB 2005; Sterling and Landmann undated). While FIMP projects do not generally interact with Aboriginal and treaty rights, there is still ample room to engage, build meaningful relationships and develop strategic land planning tools that consider First Nations TEK.

In 2007, the United Nation (UN) General Assembly adopted the *Declaration on the Rights of Indigenous Peoples* (UNDRIP). It's made up of 46 articles that outline Indigenous peoples' rights to identity, culture, language, community, education, and health, among others (BC Gov 2020a). For example, Article 31 of UNDRIP states (UNDRIP 2020):

> *Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions*.

While the UN Declaration is not legally binding according to international law, it was passed into BC legislation in 2019 (BC Gov 2020b). By passing UNDRIP into legislation, BC has made an important step towards reconciliation. The BC *UNDRIP Act* (2019) reaffirms UN UNDRIP Article 31, and states the following:

> *For the purposes of implementing this Act, the government must consider the diversity of the Indigenous peoples in British Columbia, particularly the distinct languages, cultures, customs, practices, rights, legal traditions, institutions, governance structures, relationships to territories and knowledge systems of the Indigenous peoples in British Columbia.*

Defining TEK

Traditional Ecological Knowledge (TEK) is difficult to define because it's not static. It's wisdom that accumulates and evolves over time (MVEIRB 2005). Nonetheless, TEK generally consists of (MVEIRB 2005):

1) **Knowledge about the environment** (e.g., specific observations about biophysical phenomena, associations or patterns);

2) **Knowledge about the use and management of the environment** (e.g., common practices that exist currently or that occurred in the past); and

3) **Environmental values** (which are strongly influenced by culture and spirituality as well as morals and ethics).

The Forest Stewardship Council of Canada (FSC), in its *Free, Prior and Informed Consent Guidance* (2019), defines Traditional Knowledge as:

> *Information, know-how, skills and practices that are developed, sustained and passed on from generation to generation within a community, often forming part of its cultural or spiritual identity.*

Because the breadth of information that can constitute TEK is so large, it's useful to keep the objectives and scope of the FIMP framework in mind when engaging with First Nations. Since the focus of FIMP is on fish and wildlife values, the most relevant (and applicable) TEK will also be information related to fish and wildlife values such as known spawning areas, key migration corridors or other types of biological information. In contrast, TEK related to other topics (e.g., archaeology, spirituality, social and ceremonial practices) are more difficult to include in the FIMP framework and are generally not included in the Foreshore Habitat Sensitivity Index. These data can still be considered in the Foreshore Development Guide but expanding upon or including the datasets supporting these other values is not normally part of the FIM dataset or analyzed in the FHSI process.

Benefits of Including TEK

1. It can add unique information or fill knowledge gaps in western science.
2. It can provide a historical perspective since it often consists of large, long-term sets of observations about the abiotic and biotic environment.
3. It can identify unique associations or linkages between seemingly unrelated components or events.
4. It can provide local First Nations communities the opportunity to support Foreshore Integrated Management Plans for lakes in their territories.

Methods

Overview

There are two pathways that First Nations TEK can be incorporated into FIMP. Quantitative fish and wildlife data can be incorporated via Pathway 1—the FSHI Analysis (Section 3.2), while qualitative or sensitive data can be included via Pathway 2—designated interest areas (similar to Zones of Sensitivity in Section 3.5). The pathway used to include TEK will determine how the information is treated in the FDG. That is, TEK included via Pathway 1—

the FHSI analysis, will influence the FHSI Ecological Rankings and be subject to the same recommendations made in the Activity Risk Matrix. In contrast, TEK included in FIMP via Pathway 2—mapped polygons, will be identified for further considerations in the FDG. Data included this way will not influence the FHSI analysis and no additional risk assessment will be completed by the FIMP Project Team (i.e., the Activity Risk Matrix will not be applied to mapped TEK polygons). However, there may be opportunities to develop unique recommendations for TEK polygons, depending on the circumstance at hand.

Foreshore Habitat Sensitivity Index

Pathway 1—FSHI Analysis

As mentioned, quantitative TEK data can be included in the FHSI analysis. In this way, the data would influence the FHSI Ecological Rankings and be subject to the same recommendations outlined in the FDG report.

To include First Nations TEK in the FHSI, the data must be unmasked (i.e., all facets of the data must be made transparent to the Project Team) so that all the same QA/QC procedures can be applied. One of the most important being that the TEK must be compared against all existing information to avoid double counting and biasing the results (in favour of whatever data are double counted). It is not recommended to include TEK data in the FHSI analysis if it is masked. Instead, consider including these data via Pathway 2 as mapped polygons.

Pathway 2—Mapped Polygons

If the TEK data are qualitative (or must remain masked due to their sensitive nature), they cannot be used in the FHSI analysis. However, they can be geospatially mapped and used to identify areas that warrant further consideration. In this case, the TEK data will not influence the FHSI results but rather will appear in the final FDG maps as important indicators of First Nations fish and wildlife values.

Foreshore Development Guide

The pathway used to include TEK in the FIMP framework will dictate how the information is treated in the FDG. That is, TEK included via Pathway 1—FHSI analysis will influence the habitat segment rankings (Section 3.5) and be subject to the same recommendations made in the Activity Risk Matrix (Section 6.0). In contrast, TEK included in FIMP projects via Pathway 2—mapped polygons, will be identified for further consideration in the FDG report. No additional risk assessment will be completed by the FIMP Project Team. That said, there may be opportunities to develop unique recommendations for mapped TEK polygons, depending on the circumstance at hand.

TEK Acquisition Procedures

Principles

1. Traditional knowledge is the intellectual property of the First Nations. Determine how prior informed consent will be obtained from participating traditional knowledge holders.
2. Be clear about what TEK may be most useful to the project.
3. Understand and follow the established traditional knowledge policies from local or regional First Nations organizations.

4. Consider any budgetary measures that may be necessary to allow First Nations to provide TEK.
5. Provide reasonable time for First Nations to provide TEK.
6. Determine if available TEK can be used as provided or requires further research. Consider project timelines and budgets when determining if additional TEK studies are possible.
7. Make efforts to keep TEK in context (since disaggregating information can lead to loss of connections or misinterpretation).
8. Determine accuracy of shared TEK information (and potentially adjust weightings or inclusion/exclusion of the data accordingly).
9. Ensure the TEK is credible (e.g., collected following community protocols and peer-reviewed by the First Nations community).
10. If First Nations do not want to share TEK, the Project Team cannot impose the request on them. In this case, the Project Team should report on the reasons why TEK was not provided.
11. Report back to First Nations on how the TEK was included in the project.

Data Acquisition

The following steps are recommended for requesting First Nations TEK:

1. Determine the geographic area of interest and identify overlap with First Nations territories.
2. Identify the appropriate communities, First Nation organizational structures and contact persons and explain the FIMP details and data-sharing request (via email, phone and/or in-person).
3. Propose a meeting to introduce the project, the FIMP framework and role of TEK in FIMP. Address any comments or concerns expressed by First Nations.
4. Discuss and agree, if possible, on a process for data, budgets (as necessary and appropriate), formats and timelines for TEK data acquisition.
5. Review, understand, and follow all TEK policies and terms of use (e.g., prior informed consent, sensitivity of the information and/or confidentiality agreements, data storage and access restrictions).

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Appendix B. Foreshore Inventory and Mapping Database Definitions Table

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
Lake Reference	LAKE_NAME	Lake Name			Alphanumeric	The official name of the lake (Gazetted) being surveyed from provincially sourced website.
	LAKE_REF	Lake Reference			Alphanumeric	Local (Alias) regional name for a lake. Examples include "Arms" like Seymour, North, or West Arm.
	LAKE_LEVEL	Lake Level		Meter	Numeric	This field is for the current level or elevation of gauges lakes on the date of the assessment. This field should be left blank if the lake level is unknown or if the lake is not gauged.
	HWM	High Water Mark		Meter	Numeric	The mean maximum over a 2- to 5-year period, using staff gauge measurements. If not available, examine shoreline for evidence of water level heights. Examples include marks on rock faces, trees, lichen, wave action debris lines, ice damage, pollen lines etc.
	SECHI_DEPT	Secchi Depth		Meter	Numeric	Secchi depth is measured by deploying a Secchi disc from the shaded side of a vessel until it is no longer visible and then measuring the point where it reappears upon raising it. The depth of this point is recorded from the water surface to the disk.
	ORGANIZATI	Organization			Alphanumeric	Organization is the government, non-profit organization, or companies who are responsible for collection of the field data.
	DATE	Date		DD-MMM	Alphanumeric	Date field data was collected.
	YEAR	Year		YYYY	Alphanumeric	Year field data was collected
	TIME	Time		HH:MM	Time	Time field data was collected using 24-hour clock.
	CREW	Crew			Alphanumeric	Include the initials of all field crew, including boat operators.
	WEATHER	Weather	Light Rain, Heavy Rain, Snow/Sleet, Over Cast, Clear, Partly Cloudy, Other		Categorical	Categorical options include Light Rain, Heavy Rain, Snow/Sleet, Over Cast, Clear, Partly Cloudy, and Other. If the Other category is selected, describe weather observations in the comments field.
	AIR_TEMP	Air temperature		Celsius	Numeric	Air temperature observed during the start of the assessment.
	WATER_TEMP	Water Temperature		Celsius	Numeric	Water temperature recorded during the start of the assessment.
	JURISDICTI	Jurisdiction			Alphanumeric	Jurisdiction is the governmental entity (e.g., Crown land, local government, regional district, native band) that has predominant governance over the shoreline being assessed. If possible, field assessors should break segments at all major changes in jurisdiction to allow for better management of shore line segments. If a segment break is not included at a change in jurisdiction, the jurisdiction with the predominant length of shoreline should be listed here and the secondary jurisdiction should be noted in the comments field.
	RD_ELECT	Regional District Electoral Area			Alphanumeric	Indicate the Regional District Electoral Area with the predominant length of shoreline and the secondary Regional District can be noted in the comments field, if necessary. This field is optional and only needs to be added if required.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	COMMENTS	Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
	SEGMNT_NUM	Shoreline Segment Number		#	Numeric	Shoreline segment number is the unique numerical identifier given to each segment. Typically, shore segments begin at "1" and continue until the entire shoreline has been mapped.
	SHORE_TYPE	Shore Type	Cliff/Bluff, Rocky Shore, Gravel, Sand, Stream Mouth, Wetland, Other		Categorical	Select the predominant shore type that occurs along the length of the shore segment (i.e., the highest percentage of the lineal shoreline length). Shore types include Cliff/Bluff, Rocky Shore, Gravel, Sand, Stream Mouth, Wetland, and Other. If other is selected, describe the shore type observed in the comments.
	SHORE_MODI	Shore Type Modifier	Log Yard, Small Marina (6 - 20 slips), Large Marina (> 20 slips), Railway, Roadway, None, Other		Categorical	Describe significant shoreline modifications that influence the shoreline. Choices include Log Yard, Small Marina (6-20 slips), Large Marina (greater than 20 slips), Railway, Roadway, Utility Corridor (hydro, gas, fiberoptic), None, and Other. If other is selected, the comments field should be used to identify the modifier.
Segment Class	SLOPE	Slope	Low (< 5%), Medium (5 - 20%), Steep (20 - 60%), Very Steep (> 60%), Bench		Categorical	Categories include Low (less than 5%), Medium (5-20%), Steep (20-60%), Very Steep (>60%), and Bench. A bench is a shoreline that rises steeply, has a flat area typically greater than 15 horizontal meters, and then rises steeply again. On bluff shore types are typically steep or very steep (i.e., do not use bench).
	LAND_USE	Land Use	Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single Family, Rural, Transportation, Urban Park		Categorical	Land use is a categorical field that is used to describe the predominant land use observed along the segment within an area of up to 50 m within the vegetation band zones. Categories include Agriculture, Commercial, Conservation, Forestry, Industrial, Institution, Multi-Family, Natural Area, Park, Recreation, Single Family, Rural, Transportation, and Urban Park.
	LEV_OF_IMP	Level of Impact	None, Low (< 10%), Medium (10 - 50%), High (> 50%)		Categorical	Disturbance categories include High (>50%), Medium (10-50%), Low (<10%), or None. Disturbances are considered any anthropogenic influence that has altered shoreline including foreshore substrates, vegetation, or the shoreline (e.g., retaining walls). Level of impact is considered both looking at the length of the shore line (i.e., along the segment) and the depth of the shore zone area between 15 to 50 m back. Assessors should consistently use the same criteria to determine the level of impact.
	LIVEST_ACC	Livestock Access	Yes, No, or Unknown		Categorical	Livestock access is a categorical field that is used to determine whether livestock, such as cattle, have access to the foreshore. This can be completed in the field and re-evaluated during the office analysis. Choices include Yes or No or Unknown.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	DISTURBED	Percentage of the Shoreline that is Disturbed		%	Numeric	Assessors should use a combination of field observations and air photo interpretation to determine the percentage disturbed using 5% increments. Generally, the percentage disturbed should correspond to the level of impact (i.e., a high percentage of disturbance should translate into a High level of impact). The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.
	NATURAL	Percentage of the Shoreline that is Natural		%	Numeric	Assessors should use a combination of field observations and air photo interpretation to determine the percentage in natural condition using 5% increments. Generally, the percentage natural should correspond to the level of impact. The summation of the Percentage Disturbed and the Percentage Natural should equal 100%.
	PHOTONUM	Photo Number			Alphanumeric	The number / name of the photo that is most representative of the segment indicated in SEGMNT_NUM
	PHOTO_STRT	Number of photo at segment start			Alphanumeric	The number / name of the photo taken at the beginning of the segment indicated in SEGMNT_NUM
	PHOTO_END	Number of photo at segment end			Alphanumeric	The number / name of the photo taken at the end of the segment indicated in SEGMNT_NUM
	TAPE_NUMB	Tape Number			Alphanumeric	Original Video tape number
	VIDEO_TIME	Video Time			Alphanumeric	Start and stop time of the video segments. Assessors may also just enter in the start time of the segment, as it is generally inferred that the start time of one segment corresponds with the stop time of a previous segment.
	CMMNT_CLAS	Class Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Shore Type	CLIFF_BLUF	Cliff and/or Bluff Shore Type		%	Numeric	The Cliff / Bluff field contains the percentage of the segment, based upon the shore segment length, that is a cliff or bluff shore type. A cliff shore type is typically very steep with substantial vertical elements. A bluff shore type is typically steep or very steep, and then flat for a substantial distance.
	ROCKY	Rocky Shore Type		%	Numeric	The Rocky Shore field contains the percentage of the segment, based upon the shore segment length, that is rocky. Rocky shores consist mostly of boulders and bedrock, with components of cobble and some gravels. These shores tend to occur on steeper shorelines. Previous versions of the data dictionary called these shorelines low rocky shorelines or possible (but less so) vegetated shorelines.
	GRAV_STYPE	Gravel Shore Type		%	Numeric	The Gravel shore type field contains the percentage of the segment, based upon the shore segment length, that is predominantly gravel. Gravel shores tend to occur on Low or Medium slopes, and substrates are predominantly gravels and cobbles. These shore types may also contain small percentages of gravels and or bedrock.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	SAND_STYPE	Sand Shore Type		%	Numeric	The Sand shore type field contains the percentage of the shoreline, based upon the shore segment length, that is a sand beach. Sand shore types tend to occur on Low slope shorelines and are predominated by sands and small gravels. These shore types may also contain some gravel shoreline areas in places that are more exposed to wind and wave action (e.g., points).
	STREAM_MOU	Stream Mouth Shore Type		%	Numeric	The Stream Mouth shore type field contains the percentage of the shoreline, based upon the shore segment length, that is a stream mouth. A stream mouth is defined as the confluence between a lake and a stream or a river where the stream has a direct influence on sediment movements and deposition or is part of the active floodplain. Typically, the stream mouth segment is larger for rivers and smaller for creeks. A separate segment should be created for stream mouths where the length along the shoreline is greater than 50 m. A point location (nested feature) is added for stream mouths where the length along the shoreline is less than 50 m.
	WETLAND	Wetland Shore Type		%	Numeric	The Wetland shore type field contains the percentage of the shoreline, based upon the shore segment length, that is a shore marsh wetland. A wetland segment typically occurs on Low slope sites where the littoral zones is wide and shallow, substrates are predominantly silts, organics, or clays, and there is emergent vegetation present. Wetlands that span greater than 50 m along the segment should be designated as their own segment. A point location is added for wetlands that span less than 50 m. For segments with large shore wetlands or emergent vegetation, Littoral Bands can be used to provide a more accurate description of the area.
	STYP_OTHER	Other Shore Type		%	Numeric	The Other shore type field allows assessors to enter in shore types that do not fit into one of the general categories above. If the other shore type field is used, assessors should add comments to describe the shore type and provide justification for use of this field.
	STYPE_COMM	Shore Type Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Land Use	AGRICULTUR	Agriculture Land Use		%	Numeric	The Agriculture land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for crop-based agriculture or as active livestock range lands (i.e., extensive holding areas, large numbers of cattle). Livestock pastures that are not active rangelands (i.e., a few cows or horses) are not considered an agriculture land use (see rural).
	COMMERCIAL	Commercial Land Use		%	Numeric	The Commercial land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for commercial purposes. Commercial purposes include anything that is operated as a business such as retail, hotels, food establishments, marinas with fuel, stores and can also include campsites used for recreation and RV pads etc. Commercial areas tend to occur along highly impacted shorelines. Where feasible, significant commercial areas should be part of one segment because the land use on these shore types has a different assortment of potential impacts. Commercially zoned, but yet to be constructed areas, may also warrant their own segment.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	CONSERVATN	Conservation Land Use		%	Numeric	The Conservation land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for conservation of critical or important habitats. Conservation shorelines include lands held by conservation groups (e.g., Nature Conservancy of Canada, Land Conservancy, etc.), biological reserves or other conservation properties. Conservation lands cannot occur on privately held shorelines, unless conservation covenants or other agreements are in place to protect areas in perpetuity.
	FORESTRY	Forestry Land Use		%	Numeric	The Forestry land use field is the percentage of the shoreline, based upon the shore segment length, where there is visible evidence of impacts of past or present forestry operations. These areas are typically Crown Lands that are part of active cut blocks. Log Yards are not considered a Forestry land use as they are Industrial.
	INDUSTRIAL	Industrial Land Use		%	Numeric	The Industrial land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for industrial purposes. Examples of industrial purposes include log yards, processing facilities, lumber mills, etc. These shorelines are typically heavily impacted.
	INSTITUTIO	Institutional Land Use		%	Numeric	The Institutional land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for institutional purposes. Examples of institutional land uses include schools, public libraries, universities, colleges, etc.
	MULTI_FAMI	Multi-Family Land Use		%	Numeric	The Multi-Family land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for multi-family residences. Multi-family developments are typically condominiums or town homes.
	NATURAL_AR	Natural Areas		%	Numeric	The Natural Areas land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly natural crown lands. These areas do not occur in provincial parklands and cannot be privately held.
	PARK	LU_PARK or Park		%	Numeric	The Park land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly natural areas parklands. Park areas can be provincial, federal, or municipal parks. These parks tend to be predominantly natural and are different from urban parks, which are used intensively for recreational purposes (e.g., public beaches).
	RURAL	Rural Land Use		%	Numeric	The Rural land use field is the percentage of the shoreline, based upon the shore segment length, that is predominantly used for rural purposes. Rural shorelines are typically large lots, private estates, or hobby farms. Differentiation between rural and single-family land use can be difficult when lots are narrow but deep (i.e., appear dense on the shoreline but extend quite far back). When doubt exists between a rural designation and a single-family land use, assessors should be consistent in their judgements.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	SINGLE_FAM	Single Family Residential		%	Numeric	The Single-Family Residential land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used for single family residential purposes. Typically, single family residential occurs in more densely developed areas. However, seasonal use cottages or cabins can often be considered single family residential areas if the dwellings have associated outbuildings, docks, and other features consistent with more densely developed areas.
	TRANSPORTN	LU_TRANS		%	Numeric	Transportation land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used as a transportation corridor. Transportation land use includes public roads or railways directly adjacent to the shoreline, sometimes with fill into the lake. Shorelines dominated by this land use tend to have limited riparian vegetation in locations of fill, but can maintain larger buffers if initial road or rail construction was setback from the water course. This land use type may not extend the full extent of the land use assessment zone (i.e., 50 m back from the foreshore) but should be counted as the predominant land use for that area.
	URBAN_PARK	LU_PARK or Park		%	Numeric	The Urban Park land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used as an urban park. Examples of Urban Park include public beaches, picnic areas, etc.
	UTIL_CORR	Utility Corridor		%	Numeric	Utility Corridor land use is the percentage of the shoreline, based upon the shore segments length, that is predominantly used as a transmission corridor including gas, hydro and fiberoptic transmission lines. This land use type may not extend the full extent of the land use assessment zone (i.e., 50 m back from the foreshore) but should be counted as the predominant land use for that area.
	LANDU_COMM	Land Use Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Foreshore Substrates	FOR_MARL	Marl Substrate		%	Numeric	The Marl substrate field allows assessors to enter the relative percentage of marl occurring along the foreshore. Marl is a substrate that is typically white in colour associated with clear lakes and consists of a loose clay, precipitated calcium carbonate, mollusk/invertebrate shells, and other impurities.
	FOR_MUD	Mud Substrates		%	Numeric	The Mud substrate field allows assessors to enter the relative percentage of mud occurring along the foreshore. Mud is a substrate that is typically dark in colour and consists of a mixture of silts, clays, and finely decayed organic material that is not typically discernible.
	FOR_ORGAN	Organic Substrates		%	Numeric	The Organic substrate field allows assessors to enter the relative percentage of organic materials that occur along the foreshore. Organic substrates are typically associated with wetland sites and consist of detritus material that is identifiable to some extent (e.g., sticks, leaves, etc.).
	FOR_FINES	Fine Substrates		%	Numeric	The Fines substrate field allows assessors to enter the relative percentage of fines that occur along the foreshore. Fines consist of silts and clays and these substrates are typically less than 1 mm in size. Fines are differentiated from mud because there is little to no organic content.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	FOR_SAND	Sand Substrates		%	Numeric	The Sand substrates field allows assessors to enter the relative percentage of sands that occur along the foreshore. Sands are any particle that contains granular particles visible to the naked eye. These particles are typically .06 to 2 mm in size.
	FOR_GRAVEL	Gravel Substrates		%	Numeric	The Grave substrates field allows assessors to enter the relative percentage of gravels that occur along the foreshore. Gravels are particles that range from 2 mm to approximately 64 mm. Thus, they are the size of a lady bug to the size of a tennis ball or grapefruit. This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine and coarse gravels.
	FOR_GR_FIN	Fine Gravel Substrates		%	Numeric	The Fine Gravel substrates field allows assessors to enter the relative percentage of fine gravels that occur along the foreshore. Fine gravels are particles that are 2 mm to approximately 16 mm or the size of a ladybug to the size of a grape. This field should only be used when assessors have good visibility and can confidently identify fine gravels. If this field is used, the generally gravel category should not be used.
	FOR_GR_COA	Coarse Gravel Substrates		%	Numeric	The Coarse Gravel substrates field allows assessors to enter the relative percentage of coarse gravels that occur along the foreshore. Coarse gravels are particles that are 16 mm to approximately 64 mm or the size of a grape to the size of a tennis ball or grapefruit. This field should only be used when assessors have good visibility and can confidently identify coarse gravels. If this field is used, the generally gravel category should not be used.
	FOR_COBBLE	Cobble Substrates		%	Numeric	The Cobble substrates field allows assessors to enter the relative percentage of cobbles that occur along the foreshore. Cobbles are particles that are 64 to 256 mm in size (Tennis ball to basketball).
	FOR_CO_FIN	Fine Cobble Substrates		%	Numeric	The Fine Cobble substrates field allows assessors to enter the relative percentage of fine cobbles that occur along the foreshore. Fine cobbles are particles that are 64 to 128 mm in size (tennis ball to coconut). This field should only be used when assessors have good visibility and can confidently identify fine cobbles. If this field is used, the general cobble category should not be used.
	FOR_CO_COA	Coarse Cobble Substrates		%	Numeric	The Coarse Cobble substrates field allows assessors to enter the relative percentage of coarse cobbles that occur along the foreshore. Coarse cobbles are particles that are 128 to 256 mm in size (coconut to basketball). This field should only be used when assessors have good visibility and can confidently identify coarse cobbles. If this field is used, the general cobble category should not be used.
	FOR_BOULD	Boulder Substrates		%	Numeric	The Boulder substrates field allows assessors to enter the relative percentage of boulders that occur along the foreshore. Boulders are particles that are greater than 256 mm in size (bigger than a basketball). These substrates can not typically be lifted by one person as they are too heavy.
	FOR_BEDRCK	Bedrock Substrates		%	Numeric	The Bedrock substrates field allows assessors to enter the relative percentage of bedrock that occurs along the foreshore. Bedrock is considered any rock where blocks are larger than 4 m or is solid, unweathered underlying rock.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	FOR_EMBEDD	Embeddedness	None (0%), Low (0 - 25%), Medium (25 - 75%), High (> 75%), Unknown		Categorical	Embeddedness is a categorical field that allows assessors to enter the approximate embeddedness of substrates. Embeddedness is a measure of the degree to which boulders, cobbles and other large materials are covered by fine sediments. Categories include None (0%), Low (0 to 25%), Medium (25-75%), High (>75%), or Unknown. When assessors are unclear of the embeddedness they should either complete measurements of foreshore substrates or leave the field as unknown. This field is not mandatory.
	FOR_SUB_SH	Shape of Substrates	Angular, Blast rock, Smooth		Categorical	Shape is a categorical field that allows assessors to identify the shape of larger particles such as cobble or boulders. Angular shapes refer to naturally occurring angular rock material that has not been substantially weathered. Blast rock refers to angular blast rock materials, such as rip rap. Smooth materials are rocks that are generally rounded. This field should be used to describe the predominant substrates that occur along the shoreline (e.g., if 85 % of the substrates are round and smooth, and 10% are blast rock, the field should be used to describe the 85%). This field is not mandatory.
	FOR_SUB_CM	Substrate Comments			Alphanumeric	The foreshore substrate comments field allows assessors to enter applicable information that is not included in the data fields above.
Littoral Substrates	LIT_MARL	Marl Substrate		%	Numeric	The Marl substrate field allows assessors to enter the relative percentage of marl occurring along the littoral zone. Marl is a substrate that is typically white in colour associated with clear lakes and consists of a loose clay, precipitated calcium carbonate, mollusk/invertebrate shells, and other impurities.
	LIT_MUD	Mud Substrates		%	Numeric	The Mud substrate field allows assessors to enter the relative percentage of mud occurring along the littoral zone. Mud is a substrate that is typically dark in colour and consists of a mixture of silts, clays, and finely decayed organic material that is not typically discernible.
	LIT_ORGAN	Organic Substrates		%	Numeric	The Organic substrate field allows assessors to enter the relative percentage of organic materials that occur along the littoral zone. Organic substrates are typically associated with wetland sites and consist of detritus material that is identifiable to some extent (e.g., sticks, leaves, etc.).
	LIT_FINES	Fine Substrates		%	Numeric	The Fines substrate field allows assessors to enter the relative percentage of fines that occur along the littoral zone. Fines consist of silts and clays and these substrates are typically less than 1 mm in size. Fines are differentiated from mud because there is little to no organic content.
	LIT_SAND	Sand Substrates		%	Numeric	The Sand substrates field allows assessors to enter the relative percentage of sands that occur along the littoral zone. Sands are any particle that contains granular particles visible to the naked eye. These particles are typically .06 to 2 mm in size.
	LIT_GRAVEL	Gravel Substrates		%	Numeric	The Gravel substrates field allows assessors to enter the relative percentage of gravels that occur along the littoral zone. Gravels are particles that range from 2 mm to approximately 64 mm. Thus, they are the size of a lady bug to the size of a tennis ball or grapefruit. This field should only be used when substrates are difficult to identify and assessors cannot determine whether fine and course gravels.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	LIT_GR_FIN	Fine Gravel Substrates		%	Numeric	The Fine Gravel substrates field allows assessors to enter the relative percentage of fine gravels that occur along the littoral zone. Fine gravels are particles that are 2 mm to approximately 16 mm or the size of a ladybug to the size of a grape. This field should only be used when assessors have good visibility and can confidently identify fine gravels. If this field is used, the generally gravel category should not be used.
	LIT_GR_COA	Coarse Gravel Substrates		%	Numeric	The Coarse Gravel substrates field allows assessors to enter the relative percentage of coarse gravels that occur along the littoral zone. Coarse gravels are particles that are 16 mm to approximately 64 mm or the size of a grape to the size of a tennis ball or grapefruit. This field should only be used when assessors have good visibility and can confidently identify coarse gravels. If this field is used, the generally gravel category should not be used.
	LIT_COBBLE	Cobble Substrates		%	Numeric	The Cobble substrates field allows assessors to enter the relative percentage of cobbles that occur along the littoral zone. Cobbles are particles that are 64 to 256 mm in size (Tennis ball to basketball).
	LIT_CO_FIN	Fine Cobble Substrates		%	Numeric	The Fine Cobble substrates field allows assessors to enter the relative percentage of fine cobbles that occur along the littoral zone. Fine cobbles are particles that are 64 to 128 mm in size (tennis ball to coconut). This field should only be used when assessors have good visibility and can confidently identify fine cobbles. If this field is used, the general cobble category should not be used.
	LIT_CO_COA	Coarse Cobble Substrates		%	Numeric	The Coarse Cobble substrates field allows assessors to enter the relative percentage of coarse cobbles that occur along the littoral zone. Coarse cobbles are particles that are 128 to 256 mm in size (coconut to basketball). This field should only be used when assessors have good visibility and can confidently identify coarse cobbles. If this field is used, the general cobble category should not be used.
	LIT_BOULD	Boulder Substrates		%	Numeric	The Boulder substrates field allows assessors to enter the relative percentage of boulders that occur along the littoral zone. Boulders are particles that are greater than 256 mm in size (bigger than a basketball). These substrates can not typically be lifted by one person as they are too heavy.
	LIT_BEDRCK	Bedrock Substrates		%	Numeric	The Bedrock substrates field allows assessors to enter the relative percentage of bedrock that occurs along the littoral zone. Bedrock is considered any rock where blocks are larger than 4 m or is solid, unweathered underlying rock.
	LIT_EMBEDD	Embeddedness	None (0%), Low (0 - 25%), Medium (25 - 75%), High (> 75%), or Unknown		Categorical	Embeddedness is a categorical field that allows assessors to enter the approximate embeddedness of substrates. Embeddedness is a measure of the degree to which boulders, cobbles and other large materials are covered by fine sediments. Categories include None (0%), Low (0 to 25%), Medium (25-75%), High (>75%), or Unknown. When assessors are unclear of the embeddedness they should either complete measurements of foreshore substrates or leave the field as unknown. This field is not mandatory.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	LIT_SUB_SH	Shape of Substrates	Angular, Blast rock, Smooth		Categorical	Shape is a categorical field that allows assessors to identify the shape of larger particles such as cobble or boulders. Angular shapes refer to naturally occurring angular rock material that has not been substantially weathered. Blast rock refers to angular blast rock materials, such as rip rap. Smooth materials are rocks that are generally rounded. This field should be used to describe the predominant substrates that occur along the shoreline (e.g., if 85 % of the substrates are round and smooth, and 10% are blast rock, the field should be used to describe the 85%).
	LIT_SUB_CM	Substrate Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Vegetation Band 1	B1_CLASS	Vegetation Band 1 Land Cover Class	Coniferous Forest, Broadleaf Forest, Mixed Forest, Shrubs, Herbs/Grasses, Exposed Soil, Landscape/Lawn, Natural Wetland, Disturbed Wetland, Row Crops, Unvegetated		Categorical	The Vegetation Band 1 Land Cover Class is a description of the predominant vegetation class present. Class categories include Coniferous Forest, Broadleaf Forest, Mixed Forest, Shrubs, Herbs/Grasses, Exposed Soil, Landscape/Lawn, Natural Wetland, Disturbed Wetland, Row Crops or Unvegetated Sites. See FIM methodology document for detailed description of each class.
	B1_STAGE	Vegetation Band 1 Stage	Sparse, Grass/Herb, Low Shrubs (< 2m), Tall Shrubs (2m - 10m), Pole/Sapling, Young Forest, Mature Forest, Old Forest		Categorical	The Vegetation Band 1 Stage is a description of the structural stage of the dominant vegetation. Stage categories include Sparse, Grass/Herb, Low Shrubs, Tall Shrubs, Pole/Sapling, Young Forest, Mature Forest, and Old Forest. See FIM methodology document for detailed description of each class.
	B1SHRUB_CO	Vegetation Band 1 Shrub Coverage	None, Sparse (< 10%), Moderate (10% - 50%), Abundant (> 50%)		Categorical	The Shrub Coverage categorically describes shrub coverage within the foreshore zone. Categories include Sparse (less than 10% shrub coverage), Moderate (between 10 to 50% coverage) and Abundant (greater than 50% shrub coverage).
	B1TREE_COV	Vegetation Band 1 Tree Coverage	None, Sparse (< 10%), Moderate (10% - 50%), Abundant (> 50%)		Categorical	The Tree Coverage categorically describes tree coverage within the foreshore zone. Categories include Sparse (less than 10% Tree coverage), Moderate (between 10 to 50% coverage) and Abundant (greater than 50% coverage).
	B1_DISTRIB	Vegetation Band 1 Distribution	Continuous, Patchy		Categorical	The Distribution field is used to describe whether the vegetation band described is Continuous or Patchy along the segment. An example of a patchy distribution is a shore segment where most areas are extensively landscape, with the exception of a few shore lots which remain relatively natural.
	B1_BANDWID	Vegetation Band 1 Bandwidth		Meter	Numeric	The Vegetation Band 1 Bandwidth field is used to provide an estimate of the approximate width of the band being described. In cases where bandwidth varies along the segment, a representative length should be used.
	B1_COMMNT	Vegetation Band 1 Comments			Alphanumeric	The Band 1 comments field allows assessors to enter applicable information that is not included in the data fields above.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
Vegetation Band 2	B2_CLASS	Vegetation Band 2 Class	Coniferous Forest, Broadleaf Forest, Mixed Forest, Shrubs, Herbs/Grasses, Exposed Soil, Landscape/Lawn, Natural Wetland, Disturbed Wetland, Row Crops, Unvegetated		Categorical	See Vegetation Band 1 Class for a description.
	B2_STAGE	Vegetation Band 2 Stage	Sparse, Grass/Herb, Low Shrubs (< 2m), Tall Shrubs (2m - 10m), Pole/Sapling, Young Forest, Mature Forest, Old Forest		Categorical	See Vegetation Band 1 Stage for a description.
	B2SHRUB_CO	Vegetation Band 2 Shrub Cover	None, Sparse (< 10%), Moderate (10% - 50%), Abundant (> 50%)		Categorical	See Vegetation Band 1 Shrub Cover for a description.
	B2TREE_COV	Vegetation Band 2 Tree Cover	None, Sparse (< 10%), Moderate (10% - 50%), Abundant (> 50%)		Categorical	See Vegetation Band 1 Tree Cover for a description.
	B2_DISTRIB	Vegetation Band 2 Distribution	Continuous, Patchy		Categorical	See Vegetation Band 1 Distribution for a description.
	B2_BANDWID	Vegetation Band 2 Width		Meter	Numeric	See Vegetation Band 2 Width for a description.
	B2_COMMNT	Vegetation Band 2 Comments			Alphanumeric	The band 2 comments field allows assessors to enter applicable information that is not included in the data fields above.
Littoral Zone	LITT_Z_N	Littoral Zone Number		#	Numeric	The Littoral Zone Band number field allows assessors to identify and add in bands as required.
	LITTORAL_Z	Littoral Zone Width Categories	Narrow (< 10m), Medium (10 - 50m), Wide (> 50m)		Categorical	The Littoral Zone Width field provides a general classification of the littoral zone. Categories include Narrow (less than 10 m wide), Medium (10 to 50 m), and Wide (greater than 50 m).
	LITT_WIDTH	Littoral Width		Meter	Numeric	The Littoral Width field allows assessors to enter the average width of the littoral zone in the segment. This field can be determined using air photo interpretation or field measurements. In cases where littoral zone width varies along the segment, a representative length should be used. Typically recorded to nearest 5 m.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	DRWDWN_GRD	Drawdown Zone Slope	Low (< 5%), Medium (5 - 20%), Steep (20 - 60%), Very Steep (> 60%), Bench		Categorical	Drawdown Zone Slope Gradient is a categorical determination of the predominant type of shoreline. Categories include Low (less than 5%), Medium (5-20%), Steep (20-60%), Very Steep (>60%), and Bench. A bench is a shoreline that rises, typically steep or very steep, has a flat area typically greater than 15 horizontal meters, and then becomes steep or very steep again.
	LIT_LWD_CA	Littoral Large Woody Debris Category	None, Low (< 5 pieces), Moderate (5 - 25 pieces), Abundant (> 25 pieces)		Categorical	This field is used to describe the quantity of LWD observed in the littoral zone. This is a separate count form the foreshore LWD_FOR_CA (below).
	DRWDWN_CMT	Drawdown Zone Comments			Alphanumeric	The drawdown comments field allows assessors to enter applicable information that is not included in the data field above.
	COMMNT_LIT	Littoral Zone Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Aquatic Vegetation	OVERHANG_V	Overhanging Vegetation		%	Numeric	The Overhanging Vegetation field is used to describe the percentage of the shore segment length that contains significant overhanging vegetation. Overhanging vegetation should be considered as if the lake was at full pool or the mean annual high water level.
	AQUATIC_VE	Aquatic Vegetation		%	Numeric	The Aquatic Vegetation field is used to describe the percentage of the shoreline that contains either emergent, submergent, and/or floating aquatic vegetation.
	SUBMERGE_V	Submergent Vegetation Quantity		%	Numeric	The Submergent Vegetation field is used to describe the percentage of the shoreline segment that contains submergent vegetation. Submergent vegetation includes species such as milfoil, Potamogeton spp., etc.
	SUB_VE_PRS	Submergent Vegetation Presence	Yes, No		Categorical	The Submergent Vegetation Presence field is used to indicate whether submergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.
	EMERGENT_V	Emergent Vegetation Quantity		%	Numeric	The Emergent Vegetation field is used to describe the percentage of the shoreline segment that contains emergent vegetation. Emergent vegetation includes species such as cattails, bulrushes, varies sedges, etc.
	EMR_VE_PRS	Emergent Vegetation Presence	Yes, No		Categorical	The Emergent Vegetation Presence field is used to indicate whether emergent vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.
	FLOATING_V	Floating Vegetation Quantity		%	Numeric	The Floating Vegetation field is used to describe the percentage of the shoreline segment that contains floating vegetation. Floating vegetation includes species such as pond lilies, etc.
	FLT_VE_PRS	Floating Vegetation Presence	Yes, No		Categorical	The Floating Vegetation Presence field is used to indicate whether floating vegetation is present along the segment. In cases where assessors cannot determine the percentage of the segment but are aware it is present, this field should be used.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	AVEG_CMT	Aquatic Vegetation Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Large Woody Debris	LWD_FOR_CA	Large Woody Debris Presence	None, Low (< 5 pieces), Moderate (5 - 25 pieces), Abundant (> 25 pieces)		Categorical	The Large Woody Debris quantity field allows assessors to indicate whether LWD is present along the segment. Categories include None, Less than 5 Pieces, 6 to 25 Pieces, and Greater than 25 Pieces.
	LWD_NUMBER	Large Woody Debris Count		#	Numeric	The Large Woody debris count field allows assessors to enter the total number of large woody debris pieces counted along the shore segment. Only significant pieces of large woody debris, that are contributing to fish habitat, should be counted.
	LWD_CLUST	Large Woody Debris Clusters		#	Numeric	The LWD cluster field allows assessors to inventory any notable clusters of wood are present along the shoreline segment. Clusters can be added as locational data or a total count can be made along each shoreline segment. The number of pieces of LWD that make it a cluster is up to the assessor at this time.
	LWD_CMT	Large Woody Debris Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Modifications	RETAIN_WAL	Retaining Wall Count		#	Numeric	The Retaining Wall Count field is the total number of retaining walls occurring along the segment. Retaining walls should only be counted if they are within 5 m of the high water level (i.e., HWM). Retaining walls must have a vertical element that is greater than 30 cm and must be retaining earth to some degree. On steep sloping sites, more than one retaining wall may be present (i.e., the property is tiered). In these cases, each retaining wall is counted.
	PERRETAIN	Percent Retaining Wall		%	Numeric	The Percent Retaining Wall field indicates that approximate percentage of the shore segment length where retaining walls occur.
	DOCKS	Docks Count		#	Numeric	The Docks Count field is the total number of pile-supported or floating docks that occur along the segment that are attached to the shoreline. A dock has less than 6 boat slips. Each structure that touches the shoreline counts as a dock. Properties may have more than one dock present and each different structure is considered a separate dock. Removable docks (if identifiable) can be inventoried separately using the Other category if required as these have different impact implications.
	DOCKS_KM	Docks Per Kilometer		#	Numeric	The Docks per Kilometer field is determined during post processing in the office. This field is calculated by dividing the total number of docks observed by the total length of the shore segment.
	DOCK_GROYN	Dock / Groyne Count		#	Numeric	The Dock-Groyne Count field is the total number of observed docks that also had groynes underneath them. These include large rock crib docks, or piles of large boulder/rubble underneath a dock structure. This feature is counted separate or independent from the total number of docks, meaning there can be either a dock, a groyne, or a "dock-groyne".

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	SWIM_FLOAT	Swim Float Count		#	Numeric	The Swim Float Count field is the total number of swim floats observed. Swim floats are floating structures, not for mooring boats, that are often anchored adjacent to swimming areas. They vary in size and each separate structure is counted. Point location of each swim float should be added and comments can be used to describe more elaborate structures.
	FL_BOAT_HS	Floating or Lake Access Boat House Count		#	Numeric	The Floating or Lake Access Boat House Count field is used to count boat houses that occur along the segment. Boat Houses are structures that are specifically designed to house boats or watercraft with four walls and floating or lake access boat houses can either be located on land with direct floating boat access or as structures over the water.
	LD_BOAT_HS	Boat House on Land above High Water Level Count		#	Numeric	The Land Boat House Count field is used to count boat houses that occur along the segment above the high water mark. Boat Houses are structures that are specifically designed to house boats or watercraft with four walls and land boat houses usually contain a concrete boat ramp or marine rail for access.
	BOAT_CVR	Boat Covers		#	Numeric	Boat Cover Count field is used to count all structures that cover boats along the shoreline that are not a boat house.
	GROYNES	Groyne Count		#	Numeric	The Groyne Count field is used to count any structure that are perpendicular to the shoreline that are impacting regular sediment drift along the shoreline. Groynes can be constructed out of concrete, rock, piles, wood, or other materials. Rock lines that are too small to significantly impact sediment movement should not be counted as a groyne.
	GROYNES_KM	Groynes per Kilometer		#	Numeric	The Groynes per Kilometer field is determined during post-processing of data in the office. This field is calculated by dividing the total number of groynes observed by the total length of the shore segment.
	BOAT_L_CON	Concrete Boat Launch Count		#	Numeric	The Boat Launch count field is the total number of formal boat launches that were observed along the shoreline. Only permanent (i.e., formal) boat launches are counted (e.g., made of concrete). Do not count non-formal launches such as a gravel launch that is used once or twice per year. Gravel launches that are well used would be included herein. Point location of each needs to be added descriptions can be included in the comments.
	BOAT_L_GRA	Gravel Boat Launch Count		#	Numeric	The Gravel Boat Launch count field is the total number of informal gravel boat launches that were observed along the shoreline. These are less formal launches such as a gravel launch that is used once or twice per year. Gravel launches that are well used should not be included. Point location of each needs to be added descriptions can be included in the comments.
	PERRAIL_MO	Percent Rail Modifier		%	Numeric	The Percent Rail Modifier field is used to describe the percentage of the linear shore segment length that contains railways in close proximity to the shoreline. They should only be counted if they are within 5 m of the HWM.
	PERROAD_MO	Percent Road Modifier		%	Numeric	The Percent Road Modifier field is used to describe the percentage of the linear shore segment length that contains a roadway in close proximity to the shoreline. They should only be counted if they are within 5 m of the HWM.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	MARIN_RAIL	Marine Rail Count		#	Numeric	The Marine Rail Count field is the total number of marine rails that occur along a shore segment. Marine Rails are a track system that is used to remove boats from a lake during the winter months. They should only be counted if they are within 5 m of the HWM.
	MARINAS	Marina Count		#	Numeric	The Marinas field is the total number of large and small marinas along a shore segment. A marina is considered to be any pile supported or floating structure that has slips for 6 or more boats. A small marina is considered to be any pile supported or floating structure that has between 6 and 20 slips whereas a large marina has greater than 20 slips. A dock has less than 6 slips. Point location of each marina needs to be added and comments can be used to describe (i.e., size and if associated with boat basin).
	FENCES	Fence Count		#	Numeric	The Fences field is the total number of fences that occur along a shore segment. They should only be counted if they are within 15 m of the HWM. If a property has a fence on both sides of its property line, then this is counted as two fences.
	STAIRS	Stairs Count		#	Numeric	The Stairs field is the total number of stairs that occur along a shore segment. They should only be counted if they are within 15 m of the HWM.
	MOOR_BUOYS	Mooring Buoys Count		#	Numeric	The Mooring Buoys field is the total number of mooring buoys that occur along a shore segment. Point location of each needs to be added.
	BT_RCK_LFT	Boat Rack/Lift Count		#	Numeric	The Boat Rack/Lift field is the total number of boat racks and lifts that occur along a shore segment. Point location of each needs to be added and comments can be used to describe (i.e.., covered/uncovered).
	BOAT_BASIN	Boat Basins		#	Numeric	The Boat Basin field is the total number of areas within the Littoral Zone (LZ) that have been modified to create a boat basin. A boat basin is an area that has been modified with large boulders, wood, concrete etc. to build a protective bay area for boats. Point location of each needs to be added and comments can be used to describe. A marina could also be located within the boat basin. Marinas within a boat basin should also be inventoried as per the Marina field separately (see above).
	BUILD_SHED	Buildings/Sheds		#	Numeric	The Buildings/Sheds field is the total number of small buildings and/or shed-like structures that are within 15 m of the HWM or be within the B1 Vegetation Band (riparian zone).
	PUMPHOUSE	Pumphouse		#	Numeric	The Pumphouse field is the total number of structures that have pipes and/or other features to pump/extract water. These can be within 15 m of the HWM or be within the B1 Vegetation Band (riparian zone). Point location of each needs to be added and comments can be used to describe. Use the Buildings/Sheds field count if unknown.
	GEO_GRD	Geothermal Grid		#	Numeric	The Geothermal Grid field is the total number of pipes observed in the water. It is difficult to know whether a pipe is a geothermal grid but it can be inventoried under this category.
	MODI_OTHER	Modi other comments			Alphanumeric	The modifications other field is to be used for any other modification that does not fall under one of these categories. Point location needs to be added and comments used to describe further.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	POND_POOL	Ponds/Pools		#	Numeric	The Ponds/Pools field is the total number of anthropogenic ponds and/or pools that occur along a shore segment. These are in the Littoral Zone (LZ) and could potentially be within 5 m of the HWM.
	PILINGS	Pilings		#	Numeric	The Pilings field is the total number of pilings that occur within the Littoral Zone (LZ) along a shore segment. Pilings are usually wood poles that are driven into littoral substrates that likely have most of their length underwater depending on water levels.
	PILE_STRCT	Pile Supported Structures		#	Numeric	The Pile Supported Structures field is the total number of structures that are supported by piles that are not identified in another category.
	TRAM	Tram		#	Numeric	The Tram Count field is the total number of electronic trams that occur along a shoreline segment. A tram is similar to an elevator but moves up and down the slope rather than vertically.
	SUB_MODIFI	Substrate Modification Presence	Yes, No		Categorical	The Substrate Modification Presence field is used to document whether substrate modification is occurring along the shore segment. Substrate modification includes any type of importation of sands, significant movement of natural substrates (e.g., to construct groynes), or earthworks.
	PERSUB_MOD	Percent Substrate Modification		%	Numeric	The Percent Substrate Modification field is the estimated percentage of the shore segment where substrate modification has occurred.
	P_ERO_PROT	Percent Erosion Protection		%	Numeric	The Percent Erosion Protection field is the estimated percentage of the shore segment where erosion protection modifications have occurred. Examples of erosion protection include retaining walls, groynes and other similar structures that hold back sediment/soils to prevent erosion due to wave and/or wind action.
	COMMNT_MOD	Modifications Comments			Alphanumeric	The comments field allows assessors to enter applicable information that is not included in the data fields above.
Flora and Fauna	VETERANS	Veteran Trees	None, Low (< 5 Trees), Moderate (5 - 25 Trees), Abundant (> 25 Trees)		Categorical	The Veteran Tree field is a categorical field to describe the number of veteran trees that occur along the shore segment. Veteran trees are defined as a tree that is significantly older than the dominant forest cover and provides increased structural diversity. Categories include None, Less than 5 Trees, 5 to 25 Trees, and Greater than 25 trees.
	SNAGS	Snags	None, Low (< 5 Snags), Moderate (5 - 25 Snags), Abundant (> 25 Snags)		Categorical	The Snags field is a categorical field to describe the number of dead standing trees (i.e., snags) that occur along the shore segment. Categories include None, Less than 5 Trees, 5 to 25 Trees, and Greater than 25 trees.
	BEAVER_LDG	Beaver Lodges		#	Numeric	The Beaver Lodges field is the number of beaver lodges observed along the shore segment. Point location of each needs to be added.
	WILD_DEN	Wildlife Dens		#	Numeric	The Wildlife Dens field is the total number observed along the shore segment.
	WILD_TRAIL	Wildlife Trails		#	Numeric	The Wildlife Trails field is the total number of runs and trails observed along the shore segment.
	MIN_LICK	Mineral Lick		#	Numeric	The Mineral Lick field is the total number of mineral licks observed along the shore segment.

FIM Section	Database Field	Full Database Field Name	Categories (Case Specific)	Units of Measurement	Type	Definition
	SHELLFISH	Shellfish		#	Numeric	The Shellfish field can be used to inventory the total number of areas where shellfish such as mussels/mussel beds have been observed. A polygon or point location can also be added.
	STICK_NSTS	Stick Nests		#	Numeric	The Stick Nests field is the total number of nests observed along a segment. Use the comments field to describe species, where warranted.
	FLOFAU_OTH	Other		#	Numeric	The Other field is the total number of any other flora/fauna features observed along the shore segment that is user defined. Use the Other comments field to describe further.
	CMMNT_OTH	Other Comments			Alphanumeric	The other comments field allows users to enter in comments related to any other observations they have defined within a shore segment.
	CMMNT_FLRA	Flora Comments			Alphanumeric	The flora comments field allows users to enter in comments regarding flora observed within the shore segment.
	CMMNT_FAUN	Fauna Comments			Alphanumeric	The fauna comments field allows users to enter in comments regarding fauna observed within the shore segment.

Appendix C. Working Example and Maps

The following are some working examples for use:

Foreshore Habitat Sensitivity Index FIM and Non-FIM Criteria and Categories

Table 3: An example of the categories, criteria and logic that were used for the Windermere Lake FHSI.

Category	Criteria	Percent Within Group	Logic	Uses Weighted FIM Data	Value Categories
FIM	Shore Type	41.3%	% of Segment * Percentage of FHSI	Yes	Stream Mouth = Wetland (1) > Gravel Beach = Rocky Shore Beach (0.5), > Other (0.3)
	Foreshore Substrate	12.7%	% Substrate * Percentage of FHSI	Yes	Cobble = Gravel (1) > Boulder = Organic = Mud = Marl = Fin > Sands (0.3) >
	Littoral Substrate	15.9%	% Substrate * Percentage of FHSI	Yes	Cobble = Gravel (1) > Boulder = Organic = Mud = Marl = Fin > Sands (0.3) >
	Percentage Natural	7.9%	% Natural * Percentage of the FHSI	No	N/A
	Aquatic Vegetation	7.9%	% Submergent * (0.5 * Percentage of the FHSI) + % Emergent * (0.5 * Percentage of FHSI)	No	N/A
	Overhanging Vegetation	1.6%	% Overhanging Vegetation * Percentage of the FHSI	No	N/A
	Large Woody Debris	1.6%	# of Large Woody Debris/km * Relative Value * Percentage of the FHSI	No	15 LWD (1) > 10 to 15 LWD (0.8) > 5 - 10 LWD (0.6) >
	Vegetation Band 1	7.9%	Vegetation Bandwidth Category * Vegetation Quality * Percentage of the FHSI	Yes	Vegetation Bandwidth Category 20 m (1) 15 m (0.6) > 5 to 10 m (0.4) > 0 to 5 m
	Vegetation Band 2	3.2%	Vegetation Bandwidth Category * Vegetation Quality * Percentage of the FHSI	Yes	Vegetation Quality Category Natural Wetla Broadleaf = Shrubs (1) > Coniferous Forest = Mixed Fores Unvegetated (0.6) > Lawn = Landscaped = Row Crops (0.
Fish	High Value Kokanee Area	45.5%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Mussel Presence	27.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Burbot Spawning or Rearing	27.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
Wildlife	Den / Burrow / Wildlife Tree Observation	33.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Avian Bank Nesting Locations	66.7%	Confirmed Bank Swallow (1), General Bank Nesting (0.5), Absent (0)	No	Present (1), Absent (0)
Waterfowl	Aquatic Vegetation Nesting	57.1%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Migration Corridor	42.9%	Present (1), Absent (0)	No	Present (1), Absent (0.5)
Ecosystem	Grassland Ecosystem	33.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Connectivity Corridors	33.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
	Wetlands	33.3%	Present (1), Absent (0)	No	Present (1), Absent (0)
Rare Occurrences	Red or Blue Listed Community	100.0%	Present (1), Absent (0)	No	Present (8), Absent (0)
Modifications	Retaining Wall	14.3%	% Retaining Wall * (Percentage of the FHSI)	No	N/A
	Docks	7.1%	High = Percentage of the FHSI, Moderate (0.75 * Percentage of the FHSI), Low (0.5 * Percentage of the FHSI)	No	A histogram of Dock Density per km using segment data density as High, Moderate, and Lo
	Groynes	7.1%	High = Percentage of the FHSI, Moderate (0.75 * Percentage of the FHSI), Low (0.5 * Percentage of the FHSI)	No	A histogram of Groyne Density per km using segment dat density as High, Moderate, and Lo
	Boat Launch	28.6%	High = Percentage of the FHSI, Moderate (0.75 * Percentage of the FHSI), Low (0.5 * Percentage of the FHSI)	No	A histogram of Boat Launch Density per km using lake se categorize density as High, Moderate, a
	Marina	28.6%	High = Percentage of the FHSI, Moderate (0.75 * Percentage of the FHSI), Low (0.5 * Percentage of the FHSI)	No	A histogram of marina total from segment data was used High, Moderate, and Low.
	Substrate	14.3%	% Substrate Disturbance * % FHSI	No	N/A

Foreshore Habitat Sensitivity Index Non-FIM Criteria and Categories

Category	Criteria	ZOS	Rationale
FIM	Shore Type	No	Shore type describes the shoreline morphology and is related to many aspects of fish or w type values were determined using the initial habitat index that considered fish life (Schleppe and Arsenault 2006), and subsequent studies completed in the East Ko Windermere Lake (McPherson and Hlushak 2008). These values further considered the m on all lakes, where the general ranges in former habitat rankings were summarized for a completed (Schleppe et al. 2019). Finally, shore type was considered based upon the s around Windermere Lake. Stream mouth habitat was highly valued because it was lim and provides important spawning, staging and forage habitat for native fish (e.g., burbot cutthroat trout, and kokanee). Wetlands were also valued high for their fish rearing and rocky shorelines supported emergent bulrush communities and were often proximal t substrates. Cliff/bluffs were associated with high value emergent vegetation, as well a habitat. Sand beach habitat was of the lowest value to fish and wildlife and was typic intensive recreation.
	Foreshore Substrate	No	Substrates relate directly to aquatic life productivity. Lakebed substrate provides key gro and supports benthic invertebrate communities, fish foraging areas, shoreline spawni functions. Littoral substrates also support wildlife and avian fauna by providing a grow submergent and floating aquatic vegetation. Substrates were evaluated considering watershed studies (e.g., see summary Schleppe et al. 2019), and subsequent studies in t The Windermere Lake studies were an important consideration (McPherson and H substrates were assessed in two bands, foreshore and littoral (Schleppe et al. 2020). were ranked slightly higher than foreshore substrates in the FHSI because they provide
	Littoral Substrate	No	aquatic life, meaning they were more significant to lake-wide productivity for all spec (gravel and cobble) were valued highest, followed by foraging substrates (finer subst substrates were generally limiting, but supported important habitats including kokanee and invertebrate production. Boulder, organic, mud, marl and fines all supported aquatic provided important forage and cover areas for fish, avian fauna and wildlife. On Winde not commonly observed, and provided less overall value than other lakes where it may be or deep refuge habitat. Sand had a lower biodiversity potential and was mostly associ recreation areas and were ranked lowest (with there being the potential for imported m
	Percentage Natural	No	The length of shoreline in a natural condition was determined for an approximate depth was used to determine the % natural for the segment. As the percentage of lake-wide na the inherent value of any remaining natural areas will increase. The % natural criteria ha over time in FHSI because even disturbed habitat has value depending upon the leve (Schleppe et al. 2019). It is noted that this criterion considers all categories of FIM dat overlap with other FIM criteria.
	Aquatic Vegetation	No	Native aquatic vegetation provides important habitats for fish and wildlife, including production and cover. The % aquatic vegetation for each segment was determined usi aquatic vegetation types (submerged, floating and/or emergent). Overall, this criterion w in the FHSI because of overlap with other criteria such as wetland shore types. This crit used in the original Windermere FIM (McPherson and Hlushak 2008), but was used in East Kootenay Region.
	Overhanging Vegetation	No	Overhanging vegetation provides important habitat function, such as cover, nutrie opportunities. The weight assigned to this criterion in the FHSI was similar to past stu Region. This criterion was not included in the original Windermere Lake study.
	Large Woody Debris	No	Large woody debris (LWD) provides important cover for fish and also provides a variety low weight assigned to this criterion reflects the small ecological contribution and pres lake. Large woody debris was not included in the past study at Windermere Lake, or in o
	Vegetation Band 1	No	Riparian vegetation provides important ecological values for both aquatic and terrest include food, cover, nesting areas, erosion protection etc. The original Windermere st Vegetation Band 1 width. This study considered both vegetation bandwidth and an esti values for the riparian Bands 1 and 2 that were included in the FIM dataset. Band 1 was t zone along the shore, while band 2 occurred immediately upslope of it. The two band maximum 50 m width along the segment. Vegetation Band 1 was assigned a higher wei 2 because it contributed to shoreline fish and wildlife habitat to a greater extent.
	Vegetation Band 2	No	
Fish	High Value Kokanee Area	Yes	The Province has identified kokanee spawning habitat as high conservation value areas i Kootenay Lake Forest District (Neufeld pers. comm. 2021, Chirico 2005). The most recent upstream and downstream of the Athalmer Bridge were 2,500 in 2009 and 2,000 in 2 2021). Numbers have decreased with time in this area, with 15,000 spawners reported i at the lake outlet 50 m upstream and 200 m downstream of the Athalmer Bridge (Oliver reported 1,500 kokanee spawners in the lower 500 m of Windermere Creek and 50 fish i Creek. Kokanee may also utilize other shoreline areas for spawning. During the original W example, 30 spawning kokanee were evident 200 m upstream of the lake outlet al (McPherson and Hlushak 2008). The lake outlet was also formally classified as an impo (referenced as Salmon beds Archaeological Site EdQa 121), given its use as a campsite an First Nations for over the last 1,000 years (Royal BC Museum 1999).
	Mussel Presence	Yes	Native mussels are considered a fish under the federal *Fisheries Act*, they hold First Nat value, and many populations are declining. Declines are largely the result of habitat l mussel species have a complex life cycle involving a fish host, free living form, and the r mussel. Previous sampling on Windermere Lake has found *Anodonta califor* (California/Winged Floater) mussels to be present (Moore and Machial 2007, McPherso Anodonta species are evidenced by their singular “finger-like” papillae. Mussel presenc noted in only a few sites (segments 11 and 16), and these sites were masked as Biologic included in the FDG. This FIMP identified that mussels were present to a much greate Marked points were compiled into polygons where mussel presence was expected. because mussel densities were not mapped.

Category	Criteria	ZOS	Rationale
Wildlife	Burbot Spawning or Rearing	Yes	Burbot are considered a species of regional concern in the Columbia River system due t numbers (McPhail 2007). A conservation strategy for the upper Columbia River burb Columbia Lake) is anticipated to be developed, once the outcomes of the Upper Conservation Strategy are realized (East Kootenay Burbot Scientific Working Group [EKB rivers, burbot generally spawn in shallow depths (0 to 10 m) over a variety of substrates fr gravel and cobble (McPhail and Paragamian 2000). At Windermere Lake, burbot his hundreds in weed beds at the Windermere and Goldie creek mouths and other areas of t (Westslope 2001). At Windermere Lake and other lakes in the East Kootenay, peak spaw of February (Arndt 2001, EKBSWG 2019). Studies in Columbia and Windermere lake fo strongly associated with interstitial spaces in the substrate. Shoreline with gravel and c preferred habitat for age 0 burbot, while older juveniles were associated with larger boulders (Taylor 2001 and 2002). Where aquatic vegetation was utilized, extensively bushy pondweed (*Najas flexis*) was preferred (Taylor 2001). The western shoreline of W found to provide juvenile burbot habitat (mean density was 4.5 age 0 burbot/100 m, and Taylor 2002). For this reason, the outlets of Windermere Creek and Goldie Creek, and sh habitat and low %fines (<10%) were mapped and reported as being high value in the o and were included in this dataset. In addition, areas with proximal deep-water hab substrates to the western shore were considered possibly important to burbot and were
	Den / Burrow / Wildlife Tree Observation	No	Observations of wildlife trees, dens, or possible burrows were included in the FHSI. Wh dens, or burrows were identified or verified, these observations are considered relevant wide wildlife productivity. The American badger is a sensitive species, known to inhabit th and may have prepared some of the dens identified. The American badger is classified (Schedule 1 SARA 2018) and provincially (Province of BC 2021b). Windermere Lake lies in habitat, which extends throughout the Rocky Mountain Trench from the US border n Spillimacheen (Province of BC 2021b). Some relevant habitat details are as follows Protection [BC WLAP] 2002): "*Females raise their young in dens from late winter through evidenced by a large mound of soil at the entrance, with droppings and shed hair. From la badgers begin to disperse in search of suitable home ranges of their own, which may tak their birth area and involve crossing rivers, highways and farmland. This is the perio badgers. In BC, their main prey is Columbia ground squirrels, but they are opportunistic small animals (rodents and reptiles).*"
	Avian Bank Nesting Locations	Yes	The bank swallow (*Riparia riparia*) is a Threatened species under the SARA that has docur the shoreline of Windermere Lake (Darvill 2021). Bank swallows generally arrive at their b America during early spring and depart late summer to mid fall. Bank swallows have high successful the previous year (BC CDC 2021, Darvill pers. comm.). At Windermere Lake, ne sand/gravel banks, near the top of the bank, along the edge of the water. Due to thei swallow nesting locations were masked. Known bank swallow nests were valued highe nesting locations, which either had past nesting evidence or potential for nests for bank s If a project is planned in an area marked as having avian bank nesting, the QEP is to ref confirm if bank swallow nesting habitat is present, as this is where the masked data reside
Waterfowl	Aquatic Vegetation Nesting	Yes	Surveys in the Columbia Wetlands have documented Lake Windermere as important bir to the rest of the Columbia Wetlands ecosystem (Darvill 2019). Darvill (2019) summarize Windermere to birds, as follows: "Bird data retrieved from an online database indicates t been detected at Lake Windermere, with 17 of these species considered to be at-risk." lies within the Columbia Wetlands Wildlife Management Area (the WMA). As outline (2021c), "The WMA was established for the conservation and management of fish landscape connectivity so that the Columbia River Wetlands continues to function ecosystem. Several species of birds that make floating nests were observed, including sev grebe (*Aechmophorus occidentalis*) listed as Special Concern by COSEWIC). Large wind a generated from boats can cause nests to become submerged. For this reason, areas identified using the floating and emergent data sets, looking for areas with large covera of the lake, where nesting and foraging opportunities were most probable. All these area large expanses of floating and emergent vegetation data collected in this study to important to waterfowl that nest using floating platforms. These data can be spatially nesting survey data becomes available, and these areas are only considered possible nesting may vary from data presented.
	Migration Corridor	Yes	As outlined by the Province of BC (2021) "*The WMA is an important component of the P migration route stretching from nesting areas on the Arctic Ocean to wintering grounds in is adjacent to the Columbia River, extending 180 km from Canal Flats to the head of th Donald.*" Darvill (2019) further described that "*The south end of the lake has consistently of staging waterfowl during migration and had the highest single day bird counts coordinated bird count (i.e., Columbia Wetlands Waterbird Survey). When compared acr the Columbia Wetlands, the south end of Windermere Lake appears to contain the mo within the continuous wetlands ecosystem for at-risk grebe species, as well as for o American coot. Creek mouths at Windermere Lake are also important habitat for birds shorebirds.*" The south end of the lake and the Windermere Creek mouth (due to it be were digitized to inform areas most likely important to migrating waterfowl. These data as more specific waterfowl staging density data becomes available. These areas are locations based upon data available using air photo interpretation and associated aquatic in this study.

Category	Criteria	ZOS	Rationale
Ecosystem	Grassland Ecosystem	Yes	The following summarizes some of the unique and sensitive values of grassland Conservation Council of BC [GCCBC] 2018): *"Grasslands cover less than one percent of t largely due to loss or fragmentation of habitat. Where they remain, grasslands are freq causes including: invasive species, ranching/hay fields, industrial development gr encroachment, and fire suppression. Many animals use grasslands for at least parts of th BC's species at risk are found in the grasslands. In the Kootenay Region, grasslands pr habitat, and in many areas provide critical ungulate winter range. Much of the gra Mountain Trench is on private land and is considered to be a rare or at-risk ecosyste* sensitive species that are associated with grasslands along the shoreline of Windermere badger (see Wildlife dens/burrows/trees above) and Lewis's woodpecker. Lewis's Threatened federally (SARA Schedule 1, 2012), and Special Concern provincially (bl documented utilizing grassland habitat south of Goldie Creek (Province of BC 2021b). were mapped using the RDEK Official Community Plan areas, BC Provincial Grassland Resource Inventory data. A composite layer was created using all data layers.
	Wildlife Connectivity Corridors	Yes	Connectivity to habitat is important for wildlife immigration and emigration. Connectivit requirements to facilitate this process varies by species. As outlined in the original FIMP 2008): "*Foreshore areas are highly productive and diverse, providing important foragi wildlife. They also provide a critical link between aquatic and terrestrial ecosystems. Ma unrestricted access to upslope habitats is thus important*." In accordance with the origina this ZOS includes connectivity corridors for wildlife in general, riparian habitat of cr movement and important high-value ungulate winter range (RDEK 2019 and McPherso badger linkage is provided by the BC Hydro right-of-way, Copper Point Golf Course and The ungulate winter range of note is located along the southwest-facing slopes and inclu areas. These original FIMP and OCP should be referenced for further specifics by area. were mapped using the RDEK Official Community Plan areas. Additional areas included t painted turtle in Dorothy Lake in Kinsmen Park. The Painted Turtle - Intermountain - Roc listed as a species of Special Concern both federally (SARA Schedule 1, 2007), and provinci of BC 2021b).
	Wetlands	Yes	Emergent shore wetlands were present in many areas of Windermere Lake. These a emergent bulrush areas to very complex habitats with submergent, floating and emerge end of the lake identified in the WMA. There were also several backwater wetlands iden fill that were likely historically connected to the lake. Wetlands provide valuable fish example, sampling during the original FIMP found mountain whitefish fry in the vege Segment 25 (Cemetery/Hidden Bay shoreline area), and juveniles and subadults in the v of the lake (McPherson and Hlushak 2008). Wetland areas were identified as all areas th emergent or floating vegetation, and those that were in backwater wetlands.
Rare Occurrences	Red or Blue Listed Community	No	Red listed refers to any species or ecosystem that is at risk of being lost (extirpated, en Blue listed refers to any species or ecosystem that is of special concern. The following F were considered: Alkali Saltgrass - Foxtail Barley (B), Lewis's Woodpecker (B), Painted Turt Mountain Population (B), Stiff-leaved Pondweed (B). American Badger (R) was also ident in the numerical weighting because its habitat areas covered the entire lake shoreline. obtained from the BC Datawarehouse. Sensitive species present and rankings are updat During a proposed review, the qualified environmental professional (QEP) will need to loo for further details using the BC Species and Ecosystems Explorer (Province of BC 202 change with time as more information becomes available. We noted that some spe sensitive in the original FIMP were no longer listed (i.e., scarlet globe mallow and Hooke of BC 2021b).
Modifications	Retaining Wall	No	Retaining walls influence fish in a variety of ways and are indicative of further shoreline u for rationale).
	Docks	No	Dock influence fish in a variety of ways and are indicative of further shoreline urban rationale).
	Groynes	No	Groynes influence fish in a variety of ways and are indicative of further shoreline urba rationale).
	Boat Launch	No	Boat launches influence fish in a variety of ways and are indicative of further shoreline u for rationale).
	Marina	No	Marinas influence fish in a variety of ways and are indicative of further shoreline urba rationale).
	Substrate	No	Substrate modification or foreshore or littoral lakebed substrates can impact fisheries a numerous ways. Highly urbanized shoreline areas typical experience the most substrat often dislodge emergent or riparian vegetation. This was also included to reflect the o ballast along the western shoreline.

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Appendix D. Working Colour Palette for Reports and Maps

Primary Rankings	Secondary Criteria	RGB Colour Distribution		
Risk based on FHSI Ranking		R	G	B
Very High		255	0	0
High		255	192	0
Moderate		255	255	0
Low and Very Low		191	191	191
Risk based on Zone of Sensitivity				
Fisheries		47	117	181
		0	169	230
		0	197	255
		155	223	255
		192	232	255
Wildlife		115	76	0
		146	97	0
		137	112	68
		172	142	88
		206	181	150
Herptile		205	102	102
		218	139	139
		255	179	179
		237	197	197
		255	230	230
Waterfowl		62	193	149
		102	205	171
		139	218	192
		177	231	213
		216	243	233
Ecosystem		112	168	0
		138	204	0
		153	230	0
		187	255	51
		230	255	179
Rare Species*		112	68	137
		170	102	105
		202	122	245
		194	158	215
		232	190	255
Vegetation		128	128	0
		179	179	0
		215	215	0

Appendix E. Foreshore Development Guide - Template Report

Foreshore Development Guide

Template (with methods)

Suggested Citation

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    - Habitat
    - Lands
- Okanagan Nation Alliance
- Ktunaxa Nation Council
- Regional District of East Kootenay
- Regional District of Central Kootenay
- Wood Environment & Infrastructure
- Foreshore Inventory and Mapping Technical Committee

Note to author – Using this Template to Prepare a Foreshore Development Guide

The Foreshore Development Guide (FDG) is intended to be consistent from project to project. This is because the FDG provides standard information that remains unchanged regardless of the lake, including: steps to follow to identify values, associated risks for given values, and typical planning and regulatory approaches. Consequently, a large portion of the FDG methods explanation is provided in the form of this report template. The FDG template and associated forms are available in Word and Excel versions at the Living Lakes Canada website (https://livinglakescanada.ca/). The template may be used in full, and modified where needed. Notes specifically for the author preparing the FDG are provided in square parentheses using blue font. [It is within the square brackets that project-specific information should be provided by the author.]

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Appendices

1. Introduction

In recent years, environmental impacts to lake shorelines (e.g., degraded habitat, recreational use conflicts, and deteriorating water quality) have prompted government agencies to initiate projects focused on increasing our understanding of lake shorelines to support evidence-based lake management strategies. For example, [Include partnership details here, including importance of this planning tool to the partnership]. The guidelines presented in this document are founded on the concept that sustainable management is the shared responsibility of all stakeholders, including proponents, professionals and all levels of government.

This Foreshore Development Guide (FDG) provides development planning guidelines aimed at protecting sensitive fish and wildlife species and their habitats that were identified through the previous Foreshore Inventory and Mapping (FIM) and Foreshore Habitat Sensitivity Index (FHSI) analyses. The FDG is an initial tool used when planning for, prescribing, or reviewing riparian and shoreline alterations. Based on the environmental (species and habitat) values, the FDG identifies the levels of risk associated with shoreline alteration from various types of development activities. The risks identify the anticipated regulatory steps required to proceed with the project. The guidelines provide important information to support both the landowner in preparing foreshore work applications, and the government agencies during their review of the applications.

The FDG recommends areas to be conserved, where development may present very high or significant risk to high-value species and their habitats that require shoreline areas to carry out their life cycle. These sensitive habitats may be protected by various means, including local government inclusion in local planning processes such as Official Community Plans (OCP) and bylaws. Additionally, the FDG describes how restoration opportunities should be sought to improve previously disturbed habitat, and to potentially aid in obtaining regulatory support for new restoration projects.

The FDG methods were first developed for Windermere Lake by the East Kootenay Integrated Lake Management Partnership (EKILMP et al. 2009). These original methods used the BC Ministry of Environment (BC MoE) document: High Value Habitat Maps and Associated Protocol for Works along the Foreshore of Large Lakes within the Okanagan (BC MoE 2008), and input from the various EKILMP members including: Fisheries and Oceans Canada (DFO), BC MoE, Regional District of East Kootenay (RDEK) and Wildsight. Additional lake projects followed and expanded on the initial EKILMP FDG. Notable lake projects included: Moyie Lake (Schleppe 2009), Tie Lake (McPherson et al. 2012) and Kootenay Lake (Kootenay Lake Partnership 2019). With each iteration of these documents, the general process for developing an FDG were refined.

2. Important Contact Information

Proponents may use the contact information provided below when planning their proposed activities. Even with the use of this document, it is recommended that anyone who is planning work on Crown land (such as the shoreline) first contact FrontCounter BC or retain the services of a Qualified Environmental Professional (QEP) who will contact FrontCounter BC on their behalf. Depending on the situation, FrontCounter BC will provide guidance on whether the proposed works are allowed under the respective legislation. Similarly, works on private lands must also consider local government's requirements (e.g., permitting or notifications).

FrontCounter BC – FrontCounter BC should be contacted for any works planned on Crown land, including work along the lake shoreline.
Phone: 1-877-855-3222
Email: FrontCounterBC@gov.bc.ca

Regional District – [Enter specific regional district] should be contacted for any works planned on private land within the region's jurisdiction.
Phone: [enter #]
Email: [enter email]

Local Municipality – [Enter specific municipality] should be contacted for any works planned on private land within the city's jurisdiction.
Phone: [enter #]
Email: [enter email]

First Nations – [Enter specific Nation] should be contacted for any works that require First Nation engagement.
Phone: [enter #]
Email: [enter email]

Lake Partnership Group – The [enter group name and role]
Phone: [enter #]
Email: [enter email]

2.1. First Nations Traditional Ecological Knowledge (TEK)

[If TEK has not already been included in the FHSI, and/or if the FDG is a stand-alone report, then say whether efforts to obtain TEK were made and how they have informed the FDG. In general, if TEK was provided, identify:

1. The quantity and quality of the information.
2. How TEK was incorporated (Pathway 1 or 2); see Appendix A of the Foreshore Integrated Management Plan Methods (Schleppe et al. 2021) and the implications of that pathway.
    - Pathway 1 is where quantitative TEK was provided, and was incorporated into the FHSI calculations, under the corresponding category (e.g., fish, wildlife, herptile, waterfowl etc.). This information would be presented on the FDG map with the activity risk determined using the standard FDG steps presented here (e.g., the recommendations and existing Activity Risk Matrix [ARM] would apply).
    - Pathway 2 is where qualitative biological TEK was provided. Although this information would likely not be included in the FHSI, it may be identified and mapped if the FIMP working group deems the information important and relevant and is included in the Terms of Reference for the FIMP. The First Nation consultation process should be outlined. Pathway 2 TEK may also be identified in the FDG report. This may involve development of a unique ARM that applies only to TEK Zones of Sensitivity (ZOS).]

3. FDG Process Overview

The FDG provides a step-wise process to help direct applicants through the initial planning stages for their proposed shoreline development, project or activity (**Figure 4**).

Step 1: Identify the fish and wildlife habitat values where the project is situated using the FDG map. The FDG map was prepared using the FHSI outputs, and depicts: a) values by segment, with different colours representing high to low values; and b) where Zones of Sensitivity (ZOS) may be present. Zones of Sensitivity are areas with exceptionally high value, which should if at all possible be conserved according to local, provincial or federal plans or through private land agreements.

Step 2: Review the general recommendations for the applicable colour zone and ZOS to understand associated habitat sensitivity of the area, and the risks that anthropogenic disturbances pose.

Step 3: Use the Activity Risk Matrix (ARM) to identify the level of risk of the proposed project on the habitat. The risk is indicative of the acceptability of a project to regulators.

For areas of greater risk, a very high level of detail is needed in order to submit an application that can be considered for regulatory review. In these cases, it should not be expected that because information is submitted that approvals are forthcoming.

Step 4: Determine the necessary regulatory approvals/permits/authorizations (collectively "approvals") that must be obtained. This final step is project-dependent, depends on many factors and is subject to change based on government policy. Hence, only an overview is provided here, along with logistical considerations.

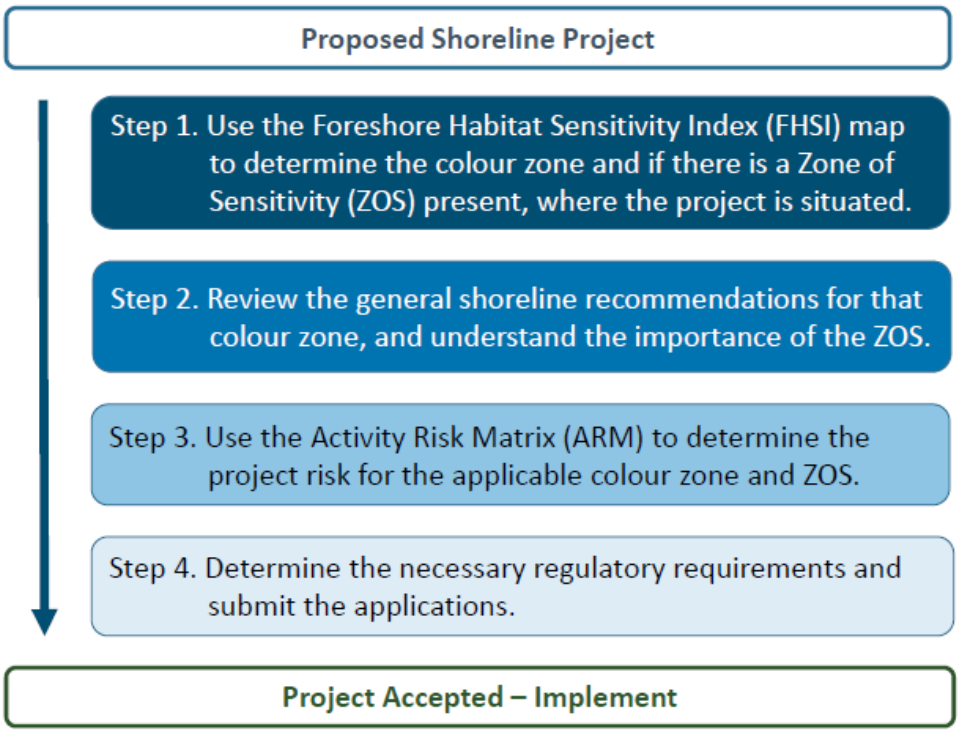


Figure 4. Four steps when planning to develop or modify foreshore habitat.

3.1. Interpret the FDG Map

The key results of the FIM and FHSI are presented in tables and maps [include cross reference to FIMP report section(s), or to the report if this FDG is a stand-alone document]. When planning foreshore development, the FDG map is the primary reference tool because it synthesizes the pertinent fish and wildlife information into an easy-to-understand map (Appendix A of the template). In the FDG map, the FHSI ecological rankings for each segment are depicted as one of five colour zones, ranging from very high to very low value (Table 3).

Table 3. FHSI ecological rank and ZOS colour scheme applied to the FDG map.

Value type	Rank/Sensitivity	Map Colour
Ecological Rank	Very High	Red
	High	Orange
	Moderate	Yellow
	Low & Very Low	Grey
Zones of Sensitivity	Fisheries	Blue
	Wildlife	Brown
	Herptiles	Mauve
	Waterfowl	Teal
	Ecosystem/Habitat Feature	Green
	Rare occurrences	Purple
	Vegetation	Olive

The FDG map also depicts each ZOS in a specific colour scheme. Each ZOS is presented as either a polygon, line, or point, and should include an outer buffer. This buffer accounts for unknowns of the ZOS's full extent, and protects the core ZOS from potential impacts from adjacent activities (**Figure 5**). Details on each ZOS, including how each was defined and how the buffers were determined, are presented in Section 5.2.

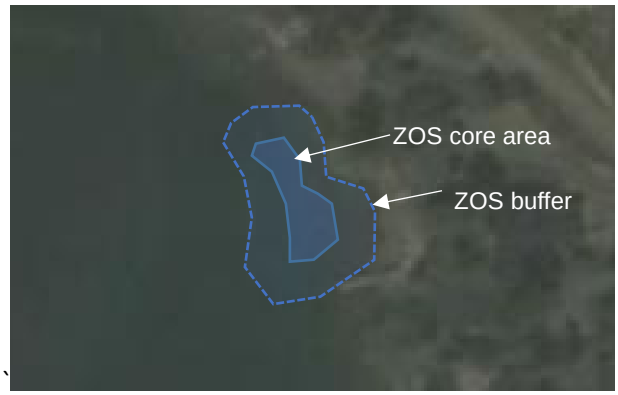


Figure 5. Zone of Sensitivity with an appropriate buffer.

4. Step 1 – Locate Project Relative to Shoreline Colour Zones and Zones of Sensitivity

Use the FDG map to identify the values present along or within their proposed development area. Together, the FHSI colour zone and the ZOS mapped features provide a science-based tool to guide development planning. The fish and wildlife value/risk and subsequent regulatory review process are highest in red zones and areas with ZOS. Since these areas have the highest natural value and are at greatest risk to shoreline alteration, they require the highest level of ongoing protection. The values/risk in the grey zones are lowest. Since there is already likely significant impact from development in grey zones, future development is less likely to cause negative impacts. The specific recommendations for each colour zone and ZOS are provided in the next section.

5. Step 2 – Review Colour Zone, ZOS and Conservation Recommendations

For this step, review the recommendations for the respective colour zone and ZOS that aligns with the proposed development. The summary tables below provide detail on the values present, and identify how to potentially minimize impacts. Also, refer to the conservation recommendations to see how your project may align with an area that has been identified as a candidate for protection. Proposed development should adhere to these recommendations to reduce impacts on sensitive fish and wildlife values. Opportunities for restoration or redevelopment should be explored in any zone where work is proposed.

5.1. Shoreline Colour Zone Recommendations

Red Shoreline	
Defined by:	Very High FHSI Ecological Rank.
FHSI summary:	Red zones account for X% of the total shoreline length of Y Lake.
Sensitivity summary:	Red shoreline areas have been identified as essential for the long-term maintenance of fish and/or wildlife values through the FHSI analysis. These areas are essential for fish and/or wildlife populations. [Use the FHSI results to summarize the main values that define these areas. If this is an updated FIM, identify the rate of change seen in the lake, and provide a statement on the relevance of this change.]
Recommen-dations:	Due to their high value (sensitive communities present), to promote conservation use Red shoreline areas should have limited development (Section 5.3). Low-impact water-access recreation and traditional First Nation uses are examples of acceptable activities in these areas, while permanent structures or alteration of habitats are not. Invasive aquatic plant removal is often acceptable, provided there is an approved aquatic plant removal program, including trained personnel, and appropriate permitting in place. Habitat restoration may be appropriate in these areas, where applicable. [If possible, expand on the recommendations – e.g., by identifying opportunities for restoration.]

Orange Shoreline	
Defined by:	High FHSI Ecological Rank.
FHSI summary:	Orange zones account for X% of the total shoreline length of Y Lake. [Use the FHSI results to summarize the main values that define these areas. If this is a re-FIM, identify the rate of change seen in the lake, and make a statement on the relevance of this change.]
Sensitivity summary:	Orange shoreline segments have been identified as high-value habitat areas for fish and/or wildlife. These areas are comprised of relatively natural undisturbed habitats [elaborate for lake of interest]. These areas are sensitive to development, continue to provide important habitat functions, but may be at risk from adjacent development pressures.

Orange Shoreline	
Recommen-dations:	Proponents should consider moving high-risk activities to other areas if possible, or pursuing activities that have lower associated risks. The lake environment can benefit from having orange shoreline areas set aside to contribute to the overall lake conservation area. The conservation options identified in Section 5.3 would likely apply through most of the orange areas, to the benefit of the lake. Restoration opportunities potentially exist in these areas. [If possible, expand on the recommendations – e.g., by identifying opportunities for restoration.]

Yellow Shoreline	
Defined by:	Medium FHSI Ecological Rank.
Lake summary:	Yellow zones account for X% of the total shoreline length of Y Lake. [Use the FHSI results to summarize the main values that define these areas. If this is a re-FIM, identify the rate of change seen in the lake, and make a statement on the relevance of this change.]
Sensitivity summary:	These areas have experienced a moderate amount of development disturbance and pressures. Although these areas have been impacted to some degree, they still are largely intact and habitat values remain important.
Recommen-dations:	Development along Yellow shoreline areas would likely result in less of an impact than along Red or Orange areas. However, activities should incorporate protection of habitat features that remain, be well above the high-water mark, and/or be situated outside of the riparian area. Restoration may be an option in some areas that have experienced past developments. Development may proceed for low-risk activities provided a Best Management Practice (BMP) or Regional Operating Statement (ROS) is available and followed (Appendix B of the template). High-risk activities without a BMP or ROS will require an environmental assessment from a QEP. [If possible, expand on the recommendations – e.g., by identifying opportunities for restoration.]

Grey Shoreline	
Defined by:	Low and Very Low FHSI Ecological Rank.
Lake summary:	Grey zones account for X% of the total shoreline length of Y Lake. [Use the FHSI results to summarize the main values that define these areas. If this is a re-FIM, identify the rate of change seen in the lake, and make a statement on the relevance of this change.]
Sensitivity summary:	Grey shorelines have a lower ecological ranking. However, they still may contain valuable habitats requiring some protection, such as aquatic or riparian vegetation. Their importance as corridors to neighbouring high-value areas should also be considered during development.
Recommen-dations:	Human development has been concentrated in these areas and has resulted in disturbances to the natural fish and wildlife habitat. Important habitats do exist in degraded and developed areas, and at least minimal standards are required to protect fish and wildlife habitat in grey zones. In keeping with the objective of concentrating development in areas that are already disturbed or of low value, new developments may be considered in these areas. Redevelopment will also be considered. Proposals should incorporate fish and wildlife habitat restoration or improvement features, where feasible and practicable. For example, a retaining wall redevelopment may be moved back from the HWM and/or incorporate revegetation or other fish and wildlife features in the design. Obtain advice from a QEP for habitat restoration techniques. [If possible, expand on the recommendations – e.g., by identifying opportunities for restoration.]

5.2. Zones of Sensitivity Recommendations

A total of X types of ZOS were identified through the FHSI analysis. The ZOS with their corresponding buffers are identified on the FDG map. For this step, use the map and identify if the proposed development aligns with any of the mapped ZOS (use outer edge of buffer). Then refer to the corresponding ZOS summary table(s) below for general information on the values present and recommendations to reduce impacts.

[Create summaries similar to the example below for each unique ZOS identified through the FHSI for the lake of study. Blank template tables are provided for each ZOS category. Delete tables not relevant to the lake of interest.]

Fisheries - Kokanee Spawning Area (example)	
Lake summary:	[Input lake and ZOS-specific text here on: a) what the ZOS is, b) the information used to map the main body (line, point or polygon) of the ZOS and c) the methods/assumptions used to establish the buffer. For example: Kokanee spawning areas were mapped as polygons along the shoreline using the provincial fisheries database accounts (iMap). The polygon boundaries were confirmed during the FIM survey, by ensuring suitable gravel was present in the mapped locations. Kokanee spawning polygons were mapped in segments 1, 7 and 15. These were respectively located at the inlet of the lake, at the mouth of the main tributary flowing into the lake and at the lake outlet. A 30 m buffer was applied to the ZOS, around its full perimeter. This buffer was recommended to protect the spawning area from neighbouring development risks and to capture peripheral spawning areas that may have been missed in the assessments.]
Sensitivity summary:	[Input details on why this was selected as a ZOS. Example: Kokanee spawning habitat is important to the long-term viability of this species. It is limited to only select locations along the shoreline where suitable conditions are present. These conditions include a combination of appropriate gravel beds and the presence of upwelling or springs to keep the gravels clean and allow the eggs to be oxygenated.]
Recommendations:	[Input recommendations on how to protect this ZOS from development impacts. For example: These sensitive habitats are to be protected, with no permanent developments recommended both within and adjacent to the mapped polygon areas.]

Wildlife – enter specific ZOS	
Lake summary:	[See fisheries example and notes]
Sensitivity summary:	

Wildlife – enter specific ZOS	
Recommen-dations:	

Herptile – enter specific ZOS	
Lake Summary:	[See fisheries example and notes]
Sensitivity summary:	
Recommen-dations:	

Waterfowl – enter specific ZOS	
Lake Summary:	[See fisheries example and notes]
Sensitivity summary:	
Recommen-dations:	

Ecosystem/Habitat Feature – enter specific ZOS	
Lake Summary:	[See fisheries example and notes]
Sensitivity summary:	
Recommen-dations:	

Rare or Endangered Species or Ecosystem – enter specific ZOS	
Lake summary:	[See fisheries example and notes]
Sensitivity summary:	
Recommen-dations:	

Vegetation – enter specific ZOS	
Lake summary:	[See fisheries example and notes]
Sensitivity summary:	
Recommen-dations:	

5.3. Shoreline Conservation Recommendations

[Summarize the shoreline conservation recommendations for your lake of study. Use the FHSI, TEK, local land use plans, community consultations, updated FIM rate of change data and other available sources of information to identify conservation areas that should be considered for long-term protection. Conservation Zones by their nature will exclude most activities. Management options for conservation areas should be established. A limited number of activities such as low-impact nature trails could be considered but should be consistent with management objectives. Identify potential options to protect each Conservation Zone. This may include: a) establishment of protected areas (potentially through any level of government); b) Section 16 *Land Act* Reserves; c) regional or municipal Official Community Plans (OCPs), which designate these areas as development permit areas of limited development potential (e.g., not within an Urban growth boundary, as an example); or, d) through private land conservation agreements, such as tenure covenants or direct land sales to land conservancy organizations such as the Land Conservancy of Canada. Landowners may want to sell, place a covenant on or swap land in exchange for regulatory approval of their project.]

6. Step 3 – Refer to the Activity Risk Matrix (ARM) to Determine Project Risk

This step involves using the ARM to determine what the predicted level of risk is for your specific proposed activity, given the shoreline colour zone and ZOS present. It is a well-understood concept that the potential for negative environmental impacts is deemed greatest in areas where values and risk are highest (**Figure 6**; DFO 2006). In the ARM, each colour

zone and activity combination has been rated as having a risk of either: Very High (VH), High (H), Moderate (M), or Low (L) (Appendix B of the template). These risk ratings reflect the potential impacts on fish and wildlife, with a Very High risk posing the greatest potential concern, and the Low Risk a lower level of concern. The ARM also identifies that if a ZOS is present, the risk also increases.

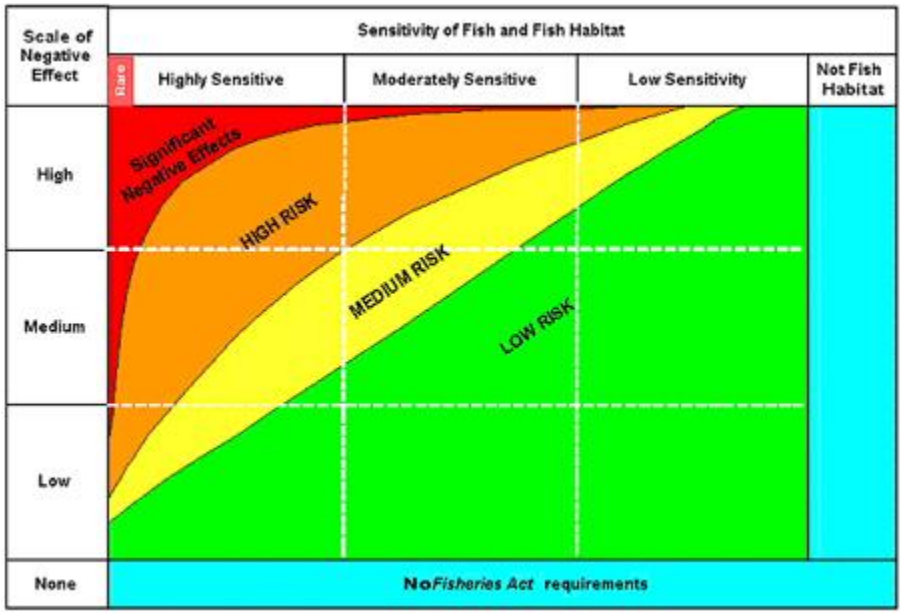


Figure 6. How the potential for negative effects relates to sensitivity and risk (DFO 2006).

6.1. Using the ARM

Clarifications for using the ARM are listed below:

1. If your activity is not listed, assume High Risk and contact FrontCounter BC for advice.
2. Where several activities with differing risk rating are proposed for a single project, the cumulative risk may increase. Consequently, it is recommended that the advice of a QEP be sought to determine if the higher of the two risk ratings effectively captures the cumulative risk, or if the highest risk rating should be used [i.e., Very High]).
3. The ARM distinguishes between several activities above and below the present natural boundary (NB). The NB is the legal term BC Crown Land Branch uses to define the Crown land property boundary along the shoreline. High Water Mark (HWM) is a similar standard term used by DFO when considering impacts to fish values. The NB and HWM are often located in the same location, but this can vary. Only a registered BC Legal Land Surveyor may determine the NB.
4. In some instances, the project may not seem to have a high degree of risk. However, the ARM also accounts for other accompanying impacts likely to occur once the modification is in place. For instance, once a dock is in place, other likely associated impacts are: prop wash, maintenance, and boat traffic.

[The author may review the ARM and update it if appropriate. Note, the risk rating for the various ecological colour zones was developed and revised by EKILMP, through subsequent studies (Kootenay Lake), and during this Living Lakes methods process. Any changes to existing risk should be done with careful consideration. An Excel version of the ARM has been made available to support updates.

One example of a change to the ARM is to add a new activity that is not already listed, and to determine the risk for each colour zone appropriately. Another potential update may be to incorporate the Not Allowed risk (NA). Currently, NA is only present for ZOS, given their unique high values. It is recognized that NA is not legally binding, since a DFO authorization could be sought to destroy fish habitat in a designated NA zone. However, if there was consensus among the lake partnership or management group, the FDG could incorporate a policy of NA for other high-value colour zones (conservation candidates) and/or for select activities. This was done at Kootenay Lake, whereby new groynes and residential boathouses were determined to be NA in any colour zone (Kootenay Lake Partnership 2019). Overall, the NA risk should be included in the ARM if significant and negative impacts will occur. The FDG would thus provide a science-based recommendation based on the risk, but the legal decision would lie with the agencies.]

6.2. General Mitigation Hierarchy

The general principles of shoreline development are to design in such a way that there is "No Net Loss" in the quantity or quality of existing habitat. These principles are supported by federal and provincial policy[6,7]). In general, they are achieved through application of the following mitigation options: (1) avoid environmental impacts; (2) minimize unavoidable impacts on environmental values; (3) restore on-site environmental values, and, (4) offset environmental and other residual impacts that cannot be minimized.

6.3. Very High and High-Risk Activities

Most instream works in Red and Orange shoreline zone areas are considered Very High and High Risk activities. All activities in a ZOS are considered Very High Risk. Development in these areas has the potential to cause long-term or irreparable disturbance to the highly sensitive/unique values present. It is difficult to mitigate impact on fish and/or wildlife from Very High Risk activities. For example, dredging is considered Very High Risk in all colour zones, since it results in a major disturbance to the substrate, aquatic vegetation that may be present, and has the potential for direct impacts on aquatic life, and processes (wave climate and sediment transport). There may also be indirect impacts, such as on water quality, if for example the dredge is to support a marina.

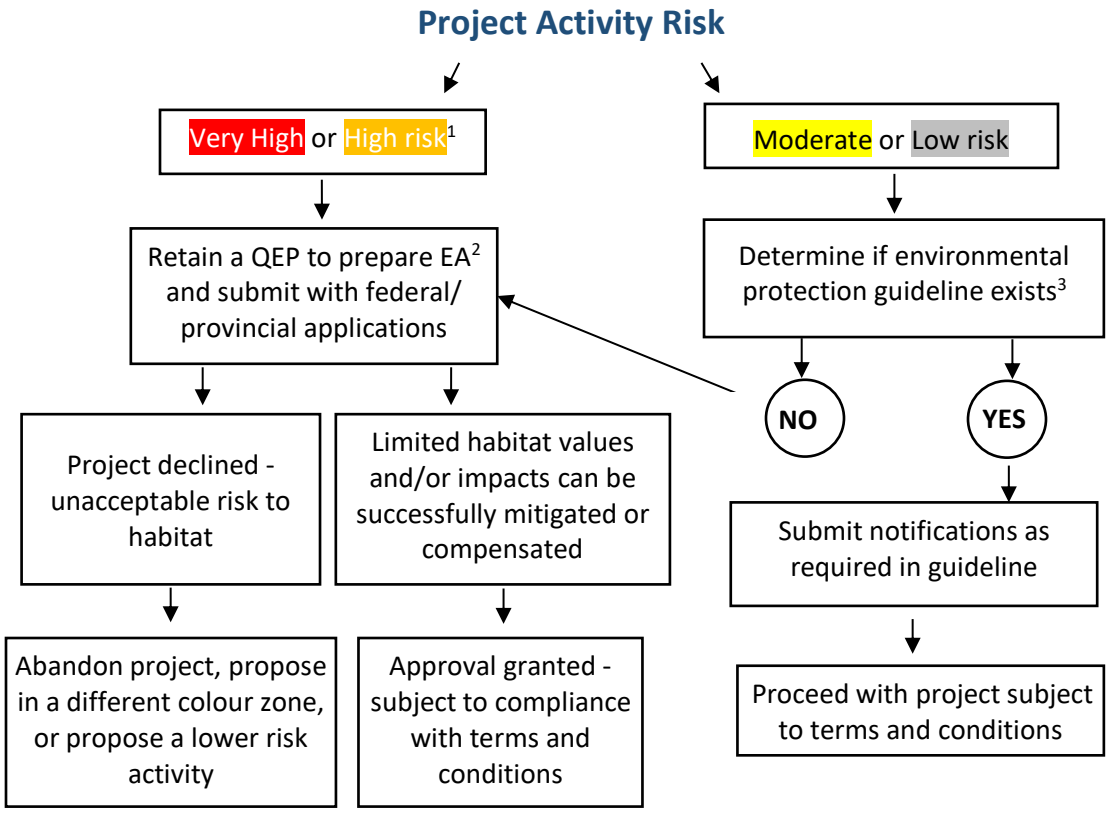
If your activity is identified as being Very High or High Risk, determine if you can modify the activity or location to reduce the risk. This may involve moving the project to a colour zone with less sensitive habitat, or selecting a lower risk activity (Figure 7). If reducing the risk is not possible by redesigning or relocating the project, there is a high likelihood that a detailed environmental assessment would be required to support the project application. In these areas, the high risks may trigger a request for a Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD) authorization under the federal *Fisheries Act*. If residual effects cannot

[6] DFO Projects Near Water website: https://dfo-mpo.gc.ca/pnw-ppe/index-eng.html
[7] BC Environmental Mitigation Policy website: https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/environmental-guidance-and-policy/environmental-mitigation-policy

be mitigated, compensation may be required. Acceptable mitigation and compensation measures would likely be very costly to implement. It is strongly recommended that a QEP be retained to assist with the project planning in all high and very high-risk areas. A QEP should be knowledgeable about both the permitting and application process for proposed activities and will be able to provide guidance on potential environmental risks and impacts. A QEP would likely conduct an environmental assessment within the project area, confirm risks, and make recommendations to reduce impacts to aid in the regulatory permitting process. Applications for these types of developments may not be supported by regulators and may not be approved, even if extensive and detailed information is provided as part of a permitting process.

As an example, the type of information that might be required to support an application for a proposed project located in a sensitive area could include: a detailed erosion control plan that might require a BC Legal Land Surveyor to determine the location of NB and property boundaries, a QEP to provide recommendations to mitigate construction works as part of an environmental assessment, or an engineer may be needed to provide a detailed design for submission of permits under regulatory processes.

Figure 7. Typical Environmental Regulatory Review Decision-Making Process



[1] Very High or High Risk activities have the potential to raise significant concerns. These activities have great challenges related to providing adequate mitigation or compensation to address the loss of fish and/or wildlife habitat values, and could be costly to implement (may require compensation).

[2] Environmental Assessment.

[3] BMP – Best Management Practice; ROS – Regional Operating Statement.

6.4. Moderate and Low-Risk Activities

With appropriate design and planning, Moderate and Low-Risk activities could be incorporated along the foreshore with fewer impacts on fish and wildlife habitat values. Where available, these activities should follow applicable Best Management Practices (BMP), Standards and Codes of Practice (collectively BMP; see next section). Where BMPs are not available, or a deviation from the BMP is proposed, a QEP should be retained to complete the application. The application will be reviewed by the applicable agencies.

7. Step 4 – Determine Regulatory Requirements and Submit Applications

The final step when planning a foreshore development project is to determine the regulatory requirements necessary for the project to proceed and to submit those applications. Regulatory applications are to be made to the federal, provincial, or local governments for necessary permits, authorizations, notifications and reviews etc. Essentially any shoreline development will require the preparation of at least one regulatory application. The regulatory application's acceptance will be required for the project to proceed legitimately. Commencing work without approval may be considered unlawful and result in infractions such as trespass. Work that has not been approved may also be subject to enforcement actions by the respective agencies, and may require additional effort to mitigate any undesired environmental impacts that occurred. Alternatively, the project proponent could be required to remove all infrastructure and restore the area.

Typical regulatory requirements for each activity listed in the ARM are provided in Appendix C of the template. As well, provincial BMPs have been listed in Appendix D of the template[8]. Although summarized here, the requirements at the time of planning the project will need to be confirmed, as regulatory changes might occur. Also, the DFO website should be reviewed for applicable Standards and Codes of Practice that may help guide planning and development[9]. Contact FrontCounter BC to determine which provincial permits, approvals or authorizations you need, or retain a QEP for guidance.

This document does not provide a full summary of all potential requirements for a particular project. Proponents must ensure that they have adequately considered, consulted, and determined the necessary approvals required for a project to proceed prior to undertaking any works.

[It is recommended that the author checks for updates to regulatory requirements at the time they prepare their own lake FDG. This should include closely reviewing the summaries in appendices below and updating accordingly:

1. Appendix C of the template – Table C1. Summary of typical legal environmental requirements for select development activities. An Excel version of this table should be available as part of this template, so that updates can be made easily.
    - Note: some lakes such as Windermere and Columbia have Lake Management Plans developed by local governments that address issues such as moorage.

[8] A current list of provincial BMPs is available at: https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices

[9] DFO Projects Near Water website: https://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html

These plans should be reviewed when updating the legal requirements table, with specifics added to the "Other" column.

2. Appendix D – Table D1. Summary of BMPs and guidelines that may be applicable to development in the Kootenay Region. A list of current BMPs is available at: https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices.]

7.1. Other Considerations to Facilitate Project Approvals

This FDG addresses both existing and proposed works. Sometimes there are concerns with the installation of past structures, which may include whether the structures:

- Resulted in extensive impacts along the shoreline;
- Were installed without appropriate permits or approvals in place; and/or,
- Were not compliant with standard BMPs.

If any of the above concerns are present on the property where work is planned, then follow these steps, so that new applications, or applications for maintenance or expansion on existing projects, can be reviewed more effectively:

1. Determine if the existing works are on private land or Crown land.
2. Determine if they are located in an Application Only Area/Reserve Area established under the *Land Act*.
3. Determine if the works were authorized by the appropriate authority. If yes, skip to step 5.
4. Seek approval from the appropriate authority. Approval may or may not be granted depending on the situation. Previous projects installed without appropriate permits or approvals may be required to be removed as part of an application process.
5. Plan and update existing works to current Best Management Practices.
6. Include other mitigation practices, such as landscape restoration (planting native riparian vegetation), substrate improvement (removing or mitigating existing groynes), and other habitat improvements.

8. References

BC Ministry of Environment (BC MoE). 2008. High Value Habitat Maps and Associated Protocol for Works Along the Foreshore of Large Lakes Within the Okanagan, Region 8. Government memorandum.

BC MoE. 2019. Natural Resource Best Management Practices. Retrieved from https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices

DFO. 2006. Habitat Management Program: Standard Operating Policies.

East Kootenay Integrated Lake Management Partnership (EKILMP), McPherson S. and D. Hlushak. 2009. Windermere Lake Shoreline Management Guidelines for Fish and Wildlife Habitats. Combined agency and consultant (Interior Reforestation Co. Ltd.) report.

Kootenay Lake Partnership. 2019. Kootenay Lake Shoreline Management Guidelines – A Living Document (Version 9). Prepared by: Ktunaxa Nation Council; Regional District of Central Kootenay; Ministry of Forests, Lands and Natural Resource Operations; Ecoscape Environmental Consultants Ltd.; Tipi Mountain Eco-Cultural Services Ltd.; The Firelight Group Ltd.; and Wayne Choquette.

McPherson[1] S.M., D.G. Paton[2] and M.D. Robinson[1]. 2012. Tie Lake Shoreline Management Guidelines of Fish and Wildlife Habitats. Consultant report prepared for Ministry of Forests Lands and Natural Resource Operations, Nelson, BC. Prepared by Lotic Environmental Ltd.[1], Anatum Ecological Consulting Ltd[2].

Schleppe, J. 2009. Moyie Lake Foreshore Inventory and Mapping. Ecoscape Environmental Consultants Ltd. Prepared for: East Kootenay Integrated Lake Management Partnership.

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Appendix A. Foreshore Guidance Document Map

[Make updates in the Excel spreadsheet and insert as a PDF here]

Appendix B. Activity Risk Matrix (Risk ratings: NA = Not Allowed, VH = Very High, H = High, M = Moderate, and L = Low)

[Make updates in the Excel spreadsheet and insert as a PDF here]

Appendix C. Legal Requirements and Policy

The following provides a brief summary of environment-related legislation that may be applicable to a proponent's project. While this list is fairly inclusive, other pieces of legislation may be applicable, and proponents are to ensure that they have identified all legislation that may apply to their project. The federal Projects Near Water website may be updated to reflect the integration of permitting under the *Species at Risk Act* and *Fisheries Act.* It is the proponent's responsibility to refer to the Projects Near Water website for any updates.

Federal Acts:

- *The Department of Environment Act*
- *Fisheries Act*
- *Species at Risk Act (SARA)*
- *Migratory Birds Convention Act*
- *Canada Wildlife Act*
- *Navigable Waters Protection Act*
- *Pesticides Act*
- *Canadian Environmental Assessment Act (CEAA)*
- *Indian Act*

Federal Regulations:

- *Canada Environmental Protection Act* Regulations
- *Migratory Birds* Regulations
- *Fisheries Act* Regulations
- *Wildlife Area* Regulations

Provincial Acts:

- *Water Sustainability Act*
- *Fish Protection Act*
- *Wildlife Act*
- *Land Act*
- *Weed Control Act*
- *Environmental Management Act*
- (Contaminated Sites Regulations)
- *Local Government Act*
- *Heritage Conservation Act*
- *Health Act* (e.g., Sewerage System Regulation)

Local Government:

- Development Permit Areas (DPAs)
- Subdivision Servicing Bylaw
- Official Community Plans
- Floodplain Management Bylaw
- Building Bylaw
- Zoning Bylaws

The Legal Requirements table provided below (Table C1) identifies the main regulatory requirements for typical foreshore activities that affect fish and wildlife habitat. These requirements involve three regulatory processes:

1. Obtaining a BC Crown land tenure – to request permission for use of provincial Crown land.

2. Obtaining a BC *Water Sustainability Act* Section 11 notification or approval for making changes in and about a stream.
3. Obtaining necessary DFO acceptance through a Project Review. Staff at DFO will review the project plans to identify the potential risks of the project to the conservation and protection of fish and fish habitat. During the review, it will be determined if the project will: a) impact an aquatic species at risk; b) result in the death of fish and the harmful alteration, disruption or destruction of fish habitat; or c) need authorization under the *Fisheries Act*.

Although potential regulatory requirements (e.g., permits) are listed, the requirements at the time of planning the project should be confirmed, as regulatory changes do occur. FrontCounter BC should be contacted to confirm these requirements.

The Legal Requirements table only provides direction related to protecting fish and wildlife habitat values, and as such, does not consider other development factors (such as erosion hazards, drinking water quality, or navigation considerations). Proposed works may be subject to requirements such as: local government zoning or permitting, BC *Water Sustainability Act* approvals or notifications (in addition to those noted above) and Water Licence applications, *Heritage Conservation Act* permits, *Land Act* permits, licences or permissions for occupation of Crown lands, or *Navigable Waters Protection Act* approvals. It remains the responsibility of the project proponent to verify this information and meet all regulatory requirements that may apply to their project.

Table C1. Summary of typical legal environmental requirements for select development activities

[Make updates in the Excel spreadsheet and insert as a PDF here]

Appendix D. Best Management Practices

The BC Ministry of Environment (MoE 2019) defines Best Management Practices (BMPs) as “guidelines that help development projects meet necessary legislation, regulations and policies. For example, legislation might dictate that projects cannot harm a stream, while Best Management Practices provide practical methods to avoid harming a stream.”

The table below provides a summary of potentially applicable environmental and archaeological BMPs. This list is not exhaustive; other applicable BMPs may be available for a given project, and updates occur regularly. Thus, it is recommended that the website at the following link be accessed for a current updated list: https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices.

FrontCounter BC or a QEP should be contacted for more information on recent provincial BMPs that may be specifically applicable to the project. For federal documents, the Projects Near Water website by Fisheries and Oceans Canada should also be referred to (https://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).

Table D1. Summary of BMPs and guidelines that may be applicable to development in the Ko (Source: Kootenay Lake Partnership 2019)

Provincial BMPs	Target-species habitat	Applicability	Web Link
Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (2014)	Sensitive Species Terrestrial Aquatic Riparian	Works involving any form of land development	https://www2.gov.bc.ca/ natural-resource-stewar standards-guidance/bes practices/develop-with-c
Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia (2014)	Amphibians and Reptiles	Ecosystems comprised of aquatic habitats, rocky outcrops and forested areas	https://www2.gov.bc.ca/ natural-resource-stewar practices/herptilebmp_c
Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia (2013)	Raptors	Terrestrial ecosystems comprised of mature coniferous and mixed woodlands	http://www.env.gov.bc.c ptor_conservation_guid
Best Management Practices Guidelines for Bats during Urban and Rural Land Development in British Columbia in BC (2016)	Bats	Terrestrial ecosystems, insect-rich riparian zones, as well as wetlands, forest edges and open woodland	http://a100.gov.bc.ca/pu ail.do?fromStatic=true&r ntId=12460
Standards and Best Practices for Instream Works (2004)	Aquatic	Works undertaken instream	http://www.env.gov.bc.c wstdsbpsmarch2004.pd
General BMPs and Standard Project Considerations	Aquatic	Any projects undertaken in and around a stream	http://www.env.gov.bc.c streamworks/generalBM
Bank Stabilization-Specific BMPs	Terrestrial Aquatic	Bank stabilization works that could impact fish or wildlife habitat	http://www.env.gov.bc.c streamworks/bankstabil
Best Management Practices for Hazard Tree and Non-Hazard Tree Limbing, Topping or Removal (2009)	Terrestrial Aquatic	Works involving tree removal.	https://www2.gov.bc.ca/ natural-resource-stewar practices/hazardtree_26
Standards and Best Practices for Instream Works	Terrestrial Aquatic	Wharves, piers, docks, boathouses, and small moorings in and about a stream	http://www.env.gov.bc.c streamworks/downloads
Best Management Practices for Boat Launch Construction & Maintenance on Lakes (2006)	Terrestrial Aquatic	Boat Launch Construction & Maintenance on Lakes (Okanagan-specific)	http://www.env.gov.bc.c BMPBoat_LaunchDraft.
Best Management Practices for Small Boat Moorage on Lakes (2006)	Terrestrial Aquatic	Small Boat Moorage on Lakes (Okanagan-specific)	http://www.env.gov.bc.c BMPSmallBoatMoorage
Best Management Practices for Installation and Maintenance of Water Line Intakes (2006)	Aquatic	Installation and Maintenance of Water Line Intakes (Okanagan-specific)	http://www.env.gov.bc.c BMPIntakes_WorkingDr

Table D1. Summary of BMPs and guidelines that may be applicable to development in the Ko (Source: Kootenay Lake Partnership 2019)

Provincial BMPs	Target-species habitat	Applicability	Web Link
Beaver Management Guidelines (2001)	Aquatic	Areas that support beaver communities.	http://www.env.gov.bc.c island/pa/pdf/Beaver-Gu
Tree replacement criteria (1996)	Terrestrial	Works involving tree removal and replacement.	http://www.env.gov.bc.c ereplcrit.pdf
Kootenay-Boundary Water Sustainability Regulation Terms and Conditions (2018)	Aquatic	Changes in and around a stream of the kind listed in Part 3 of the *Water Sustainability Regulation.*	https://www2.gov.bc.ca/ natural-resource-stewar practices/iswstdsbpsma
Fish Habitat Rehabilitation Procedures (1997)	Aquatic	Works with an erosion and sediment risk near water.	https://www.for.gov.bc.c PA1997_A.pdf
Guidelines for Wetland Protection and Conservation in British Columbia: Land Development (2009)	Wetlands	Wetland protection near development sites.	https://www2.gov.bc.ca/ natural-resource-stewar practices/wetland_ways
Land Development Guidelines for the Protection of Aquatic Habitat (1992)	Aquatic	Works undertaken in areas adjacent to riparian features.	http://www.dfo-mpo.gc.c
Ktunaxa Nation Council BMPs	**Target Area**	**Applicability**	**Web Link**
Guidelines for Conducting Archaeological Assessment in Ktunaxa Territory	Archaeology	Activities with moderate to high risk to archaeological values	https://www.ktunaxa.org resource-agency/archae guidelines/