Lake Survey Toolkit

Prepared by
Ministry of Sustainable Resource Management
Aquatic Branch
for the
Resources Information Standards Committee

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Version 1.0

Table of Contents: Lake Survey Toolkit

Introduction

Perspective

Good survey information becomes increasingly valuable as time passes and conditions change.

Standards have been developed to document the characteristics of BC's fish and fish habitat resources to provide a factual basis for fish and fish habitat assessment, planning, and management.

Using the Lake Survey Toolkit

This is one of six toolkits that provide the suite of information capture tools that are required for completing specific surveys.

It **elaborates** on information located in the **Lake Survey Form Field Guide**.

Bookmarks and the **Table of Contents** in this Lake Survey Toolkit provide quick access to three levels of description:

Level 1: The survey phase: data collection and recording, data entry, data reporting, and quality assurance.

Level 2: The category to be described for the survey. For example: **Waterbody**.

Level 3: The metric or supporting information. For example: **Waterbody Type**

There are **three types of tools** that practitioners can access directly from this toolkit: Forms, Databases and Manuals and Resources. Practitioners can also access these tools from the Quick Links located on the web page or from the **Appendix** in this toolkit.

Data Collection and Recording

Forms and Field Guides

Order air photos from LandData BC, Client Support (250) 952-4076.

Lake Survey Form front (pdf), Lake Survey Form back (pdf)

Lake Survey Form Field Guide, **Lake Survey Form Field Guide Errata**, **Lake Survey Form Errata #2**

The following **elaborates** on the information in the **Lake Survey Form Field Guide**.

Waterbody

The waterbody description provides identifying information about the lake including waterbody type, name, watershed code, waterbody ID, UTM coordinates, air photo reference, surface area, magnitude, elevation, and biogeoclimatic zone.

Waterbody Type

Streams, Lakes, Wetlands

Use air photo interpretation to determine initially whether an aquatic feature is a wetland, stream or lake, and to give a preliminary class for wetlands. Then verify the waterbody type and wetland class in the field. For a Reconnaissance Inventory, include all shallow open water wetlands as part of the lake inventory. If the wetlands have a distinct channel flowing through them include them in the stream inventory, rather than in the lake inventory.

Stream

In BC, a stream is defined as a reach, flowing on a perennial or seasonal basis having a continuous channel bed, whether or not the bed and banks of the reach are locally obscured by overhanging or bridging vegetation or soil mats, if the channel bed is scoured by water, or contains observable deposits of mineral alluvium.

The primary feature for determining whether a watercourse is a stream is the presence of a continuous channel bed. If a continuous channel bed exists, then either one of two other key features must be present demonstrating fluvial processes; that is, where flowing water has a scoured the channel bed, or deposited any amount of mineral alluvium within the channel.

Water flow in the channel may be perennial, ephemeral (seasonal), or intermittent (spatially discontinuous).

Lake

A lake is an open waterbody with a depth greater than 2 m and with less than 25% of its surface area covered with wetland vegetation. By default, any open waterbody less than 2 m deep is a wetland. In many cases it may not be possible to distinguish shallow, open wetlands from lakes using airphotos; therefore, review and complete your determination of lake/wetland status in the field.

Wetland

A wetland is an area where the water table is at, near, or above the surface, or where soils are water saturated for a sufficient time so that the principle determinants of vegetation and soil development are excess water and low oxygen. Five major types or classes of wetlands have been described in Canada based on vegetation physiognomy, environmental gradients of waterflow, hydrochemistry, and degree of water-level fluctuation.

Lake Name – Gazetted

The Minister of Sustainable Resource Management is responsible for naming geographical features in British Columbia. The Minister delegates this responsibility through the Director of Base Mapping and Geomatic Services Branch to the Geographical Names Unit. The official or gazetted name of a geographical feature in BC is the name that the Government has approved for use on current provincial and federal maps, and has listed as an official place name in Gazetteers of British Columbia and Canada. Coordination of geographical naming by one authority is an essential element in maintaining an effective system for identifying physical features.

The **Gazetteer of Canada** is an alphabetical listing of the official names of places in Canada (e.g. communities, parks, mountains, rivers, lakes and native reserves). Each line item provides the gazetted name, the NTS map number and the exact latitude and longitude of the place.

The **Canadian National Topographic System (NTS)** provides general-purpose topographic map coverage of Canada. These maps are produced by the Government of Canada and depict in detail ground relief (landforms and terrain), drainage (lakes and rivers), forest cover, administrative areas, populated areas, transportation routes and facilities (including roads and railways), and other man-made features. NTS maps are available at a scale of 1:50,000 and 1:250,000.

Terrain Resource Information Management (TRIM) mapping consists of 7027 mapsheets covering the province of British Columbia at a scale of 1:20,000. The Government of British Columbia produces TRIM maps. The cartographic framework for this mapping is the Universal Transverse Mercator coordinate system, based on NAD83 (1983 North American Datum). Each map sheet is precisely 12 minutes of longitude wide by 6 minutes of latitude high. These maps depict man-made features (such as roads, buildings and power lines), natural features (such as streams, lakes and wetlands), and elevations (20 m contours and point elevations).

If an official name exists for an aquatic feature, the name is printed on the **National Topographic Series (NTS)** 1:50,000 maps produced by the federal government. Official names are also printed on the Terrain Resource Information Management (TRIM) 1:20,000 maps produced by the British Columbia Ministry of Sustainable Resource Management, Base Mapping Services Branch. Hardcopy NTS and TRIM maps are available for purchase from private map dealers. To find map dealers in your area, consult the Yellow Pages under the heading of *Maps*. NTS maps can also be ordered on the Internet from *International Travel Maps and Books*. TRIM maps can be ordered in person from a Provincial Government Agent, or online from the LandData BC system.

To find official names for aquatic features from the BC Geographical Names Information System (BCGNIS), either search by name to confirm that the name you have is the official name, or search by location if you have the approximate latitude and longitude of the aquatic feature.

To obtain the gazetted name of an aquatic feature by using the Fish Wizard, you need to know the watershed code of the aquatic feature, or the location of the feature within the province of BC.

Lake Name - Local

Local names are given to many small lakes and streams in British Columbia. Many of these lakes and streams have only a local name and do not have an official government gazetted name or they have local or historic names that differ from the approved gazetted name.

Consult the Geographical Names Branch of the BC Ministry of Sustainable Resource Management, Base Mapping and Geomatic Services Branch to determine if a local or historic name exists for the aquatic feature in question.

Consult the regional or district offices of the BC Ministry of Sustainable Resource Management, the BC Ministry of Forests, and/or the BC Ministry of Water, Land and Air Protection to find local names. Ministry archives containing old lake summary reports could provide local names.

BC Forest Service, Forest Recreation maps often indicate local names for streams and lakes. Other recreation or community maps such as search and rescue maps may give local names.

The BC Ministry of Sustainable Resource Management, Fisheries Data Warehouse, manages the *BC Watershed Dictionary* as part of the *BC Watershed Atlas*. This dictionary lists aliases (local names) for aquatic features that are recognized by the Government. To find if an alias exists for an aquatic feature in the BC Watershed Dictionary, you need to know the official (gazetted) name, the Watershed code or the Waterbody ID of the aquatic feature.

Fish Wizard is a map display tool that allows you to locate an aquatic feature and obtain its official name and alias or local name, without GIS capability. This site can be used if you know the watershed code of the aquatic feature, or if you know where the feature is in the province. If the aquatic feature has a well known local name, it will be displayed as an “alias” on the next line below the official name.

Watershed Code and Waterbody Identifier

BC Watershed/Waterbody Identifier System

The BC Watershed/Waterbody Identifier System assigns every aquatic feature in BC a unique code for identification. This is necessary because many aquatic features are either unnamed, or have the same name as other aquatic features. Many private and public sector organizations gather qualitative and quantitative data that describes waterbodies and watersheds in BC. To ensure that organizations can combine and analyze these data, all data gathering methodologies should use the BC Watershed/Waterbody Identifier System. For additional information refer to the *User's Guide to the British Columbia Watershed/Waterbody Identifier System, Version 2.2*.

The Watershed/Waterbody Identifier System is a computer-generated coding system developed by the BC Government that uniquely identifies watersheds and waterbodies in BC. It is a component of the 1:50,000 *British Columbia Watershed Atlas*, a computerized base map of aquatic features in the province. Although it was originally designed for use at a scale of 1:50,000 as a component of the BC Watershed Atlas, it has been re-designed to allow for the identification of watersheds and waterbodies represented on 1:20,000 mapping, the TRIM Watershed Atlas.

The Watershed Atlas (WSA) is a digital representation of the stream network of British Columbia as depicted on 1:50,000 National Topographic Series maps along with watershed boundaries or 3rd order and larger watersheds. This atlas also contains the Watershed Dictionary.

The Trim Watershed Atlas is a digital representation of the stream network of BC as depicted on 1:20,000 TRIM maps. It is currently under development, with representations for the southern part of the province included.

Watershed Code and Waterbody Identifier

The Watershed/Waterbody Identifier System has two parts: a Watershed Code, and a Waterbody Identifier. The BC Government generates watershed codes and waterbody identifiers according to a system and does not randomly assign them. It is mandatory to follow proper procedures to obtain a watershed code from the Government.

Watershed Code

A Watershed Code is a computer generated 45-digit numeric label that uniquely identifies each stream in BC. The numbering system provides information about the location of a stream.

There are nine major watersheds in BC as shown on the map below. The first number in the watershed code indicates the major watershed that the stream is in. Each of the 9 major watersheds is divided into smaller watersheds, which are indicated by the second number in the watershed code. These watersheds can be subdivided further into smaller watersheds which are indicated by the third number in the code.

For example, the Mackenzie watershed identified by the integer 2 has three subsets, the Liard (210), the Hay (220) and the Peace (230). The Peace River watershed (230) has nine sub-divisions coded 231, 232, 233, 234, 235, 236, 237, 238, and 239.

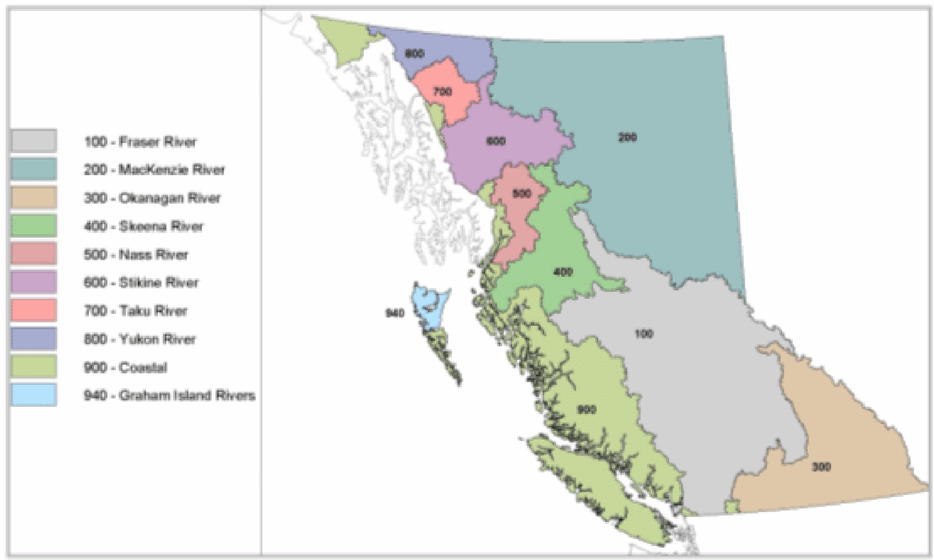


Figure 1- Watersheds in BC

The watershed code for the mainstem Peace River is 230-000000-00000-00000-0000-0000-000-000-000-000-000-000. Each subsequent group of numbers after the first group of three (which indicate the major watershed) represents a tributary to the previous group of numbers.

The remaining numbers in the code, after the first three, reflect the location of the mouth of a tributary along the length of the stream into which it flows. The location of the confluence of a tributary with its parent stream, measured as the proportional distance between the mouth and headwaters of the parent stream, determines the watershed code.

The example below describes the proportional length derivation of watershed codes for Gething Creek. A demonstration follows showing the use of proportional distances in generating the watershed code for Gething Creek.

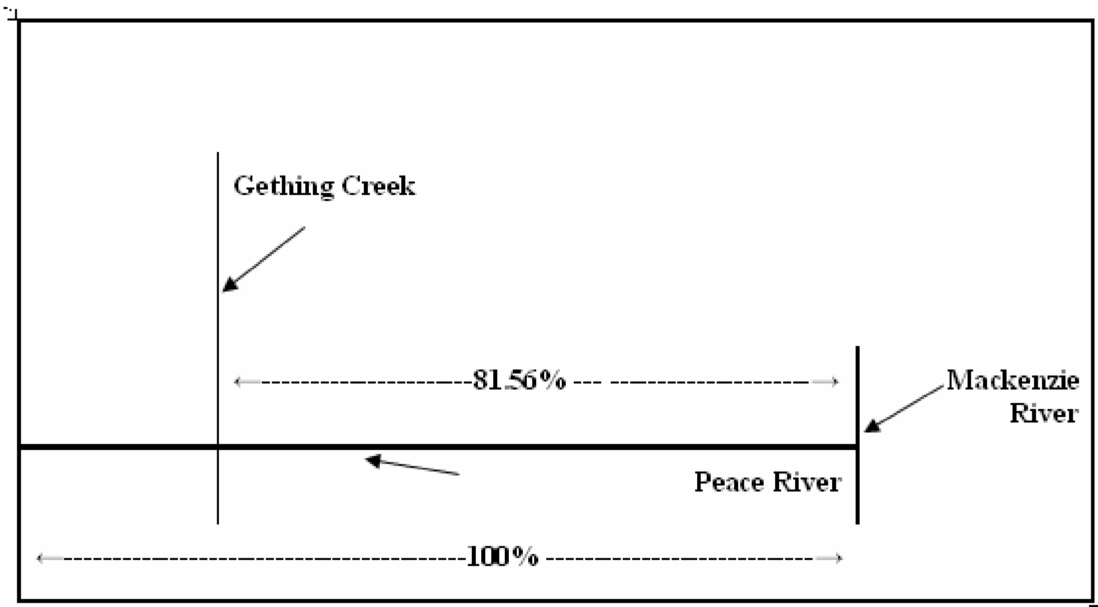


Figure 2 - Diagram of Proportional Length Derivation of Watershed Codes for Gething Creek

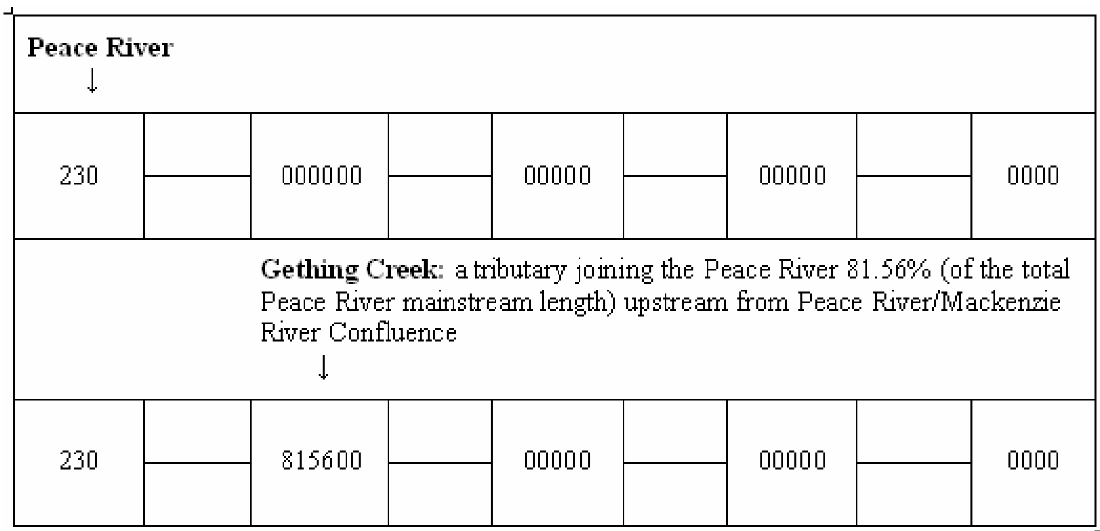


Figure 3 - Explanation of Gething Creek Watershed Code

The diagram below describes the proportional length derivation of watershed codes for Carbon Creek and Eleven Mile Creek. A demonstration of how the proportional distances are included in the watershed code for Eleven Mile Creek follows.

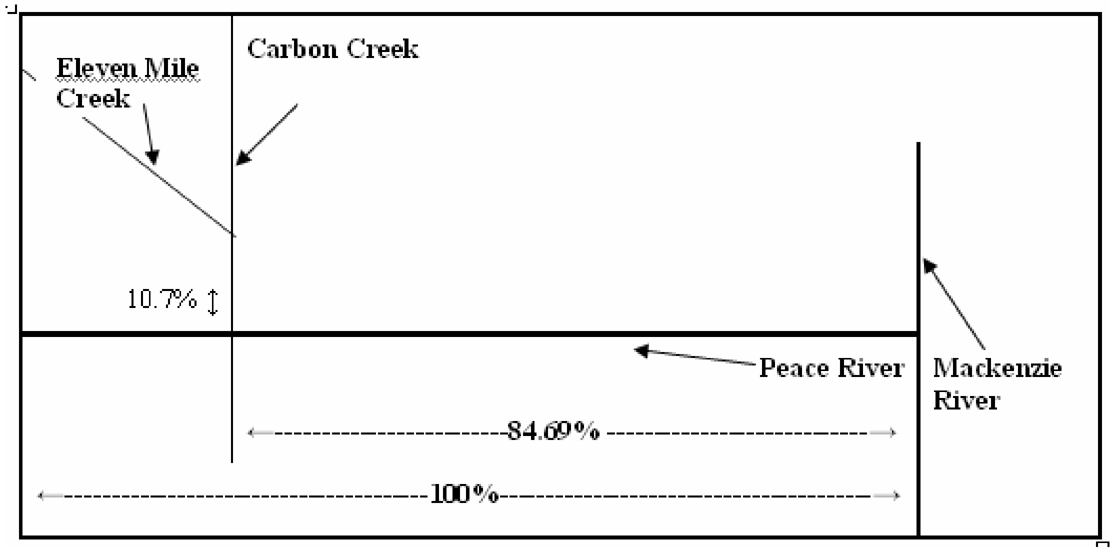


Figure 4 - Diagram of Proportional Length Derivation of Watershed Codes for Carbon Creek

Peace River: ↓								
230		000000		00000		00000		0000
		Carbon Creek: another tributary to Peace River located upstream of Gething Creek. It joins the Peace River 84.69% (of the total Peace River mainstem length) upstream for Peace River confluence with Mackenzie River						
		↓ ↓ ↓ ↓		**Eleven Mile Creek:** a tributary to Carbon Creek joining it 10.7% (of the total Carbon Creek mainstem length) upstream from Carbon Creek/Peace River confluence ↓				
230		846900		10700		00000		0000

Figure 5 - Explanation of the Eleven Mile Creek Watershed Code, a Tributary to Carbon Creek in the Peace River Watershed

Waterbody Identifier

A Waterbody Identifier is a computer generated alphanumeric label that uniquely identifies a waterbody within a watershed and within the Province of BC. A waterbody is a lake, pond, swamp, marsh, bog, reservoir, or canal or stream segment shown as double lines on 1:50,000 maps. The letters in the waterbody identifier indicate which of the 246 watersheds in BC that which the waterbody is located.

Figure 6 - The 246 Watersheds in BC

Reach Number (#)

Reach Delineation

A stream reach is a relatively homogeneous length of stream having a sequence of repeating structural characteristics (or processes) and fish habitat types. In a stream reach the channel morphology, channel dimension (and thus width and discharge), and gradient are uniform. Reaches are part of a hierarchical classification structure used for many purposes, such as identifying fish habitat.

Reach delineation is performed at the start of a fish and fish habitat inventory process to allow for selection of survey site locations. Dividing streams into homogeneous sections allows for sampling in a portion of a reach to collect information that is representative of the entire reach. For example, if a portion of each reach were surveyed, the fish habitat in the entire stream length could be described, providing an understanding of fish distribution and habitat capability for the whole stream.

A reach break marks the boundary between adjoining reaches. Each reach on a stream is assigned a unique number in an upstream-ascending order, the first being the reach closest to the mouth of the stream.

Reach delineation is initially performed in the office using maps and air photos, and then confirmed in the field. Identify reaches and reach breaks in the project area using all available data sources, including at a minimum, the most recent air photos and maps. Use the scale of maps and air photos that the inventory is based on. Use the following key physical factors to determine reaches:

- Channel pattern
- Channel confinement
- Gradient, and
- Streambed and bank materials.

A stream reach generally shows uniformity in these characteristics and in discharge.

Reach boundaries, called reach breaks, usually occur at:

- Significant changes in stream channel form or confinement (and/or coupling), such as the change from a single channel to braided, multiple channels, or at the change from a wide floodplain to a confined canyon
- Significant changes in gradient
- Significant changes in streambed and bank materials, such as a change from erodible to non-erodible materials and
- Significant tributary confluences

For a Reconnaissance inventory, obstructions or potential barriers to fish distribution are reach boundaries only if they meet both the following characteristics:

- Are less than 100 m or 10 bankfull widths (W_b) in length (if they are longer than these lengths, they are defined as a reach); and
- Are consistent with the changes in physical criteria listed above. For example, a steep bedrock falls, approximately 50 m long, with a cascade step pool reach upstream, and an entrenched gorge with an 8% gradient downstream (the falls characteristics are different from both the upstream and downstream reaches).

Stream Reach Numbering

Reach numbers start at 1 at the mouth and increase sequentially upstream (e.g. 1, 2, 3, etc.). If an additional reach is identified after reach delineation and numbering has been done (for instance during field sampling), and needs to be broken out within the existing reaches, the new reach can be numbered using decimals (e.g. 1, 2.1, 2.2, 2.3, 3, etc.). This will require changing only the numbers of the reaches directly adjacent to the new reach.

Like stream reaches, lakes and wetlands in the stream network are numbered. Assume that each lake or wetland is a single reach and assign each one a unique number in a sequential, upstream-ascending order, consistent with the stream reach numbering system.

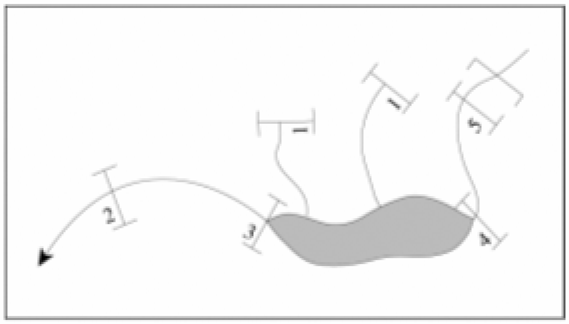


Figure 7 - Excerpt of map showing reach breaks and reach numbering for lakes and streams

Once all of the reaches in the project area have been delineated, collect general physical data for all reaches in the project area including watershed code, mapsheet number, UTM coordinates, and reach number..

Once reaches for field sampling have been chosen, determine the following characteristics for each reach to be surveyed, from maps and air photos: reach order, upstream elevation, downstream elevation, length, gradient, pattern, confinement, anastomosed/braided, basin type, and whether or not it is a wetland.

Reach Order

Reach order, magnitude and gradient are map-derived data. The reach order describes the relative size and topology of a stream in a drainage network. A first order stream has no tributaries. A second order stream results from the joining of two first order streams. A third order stream results from the joining of two second order streams.

Interim maps

Draw the reach break symbols at the stream reach boundaries. Write the reach numbers on the downstream side of the upstream reach break symbol.

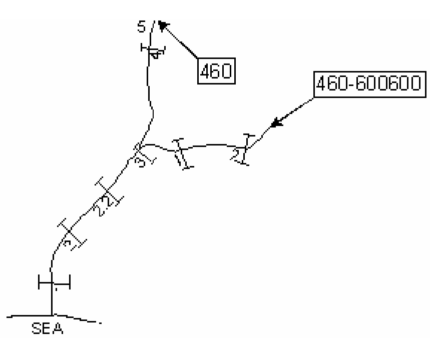


Figure 8 - Reach break and reach number placement

Magnitude

The lake magnitude is the total number of first-order streams that drain into the lake as determined from maps (using the scale of mapping that is to be used for the inventory).

The determination of order and magnitude should include all mapped channels, including intermittent channels.

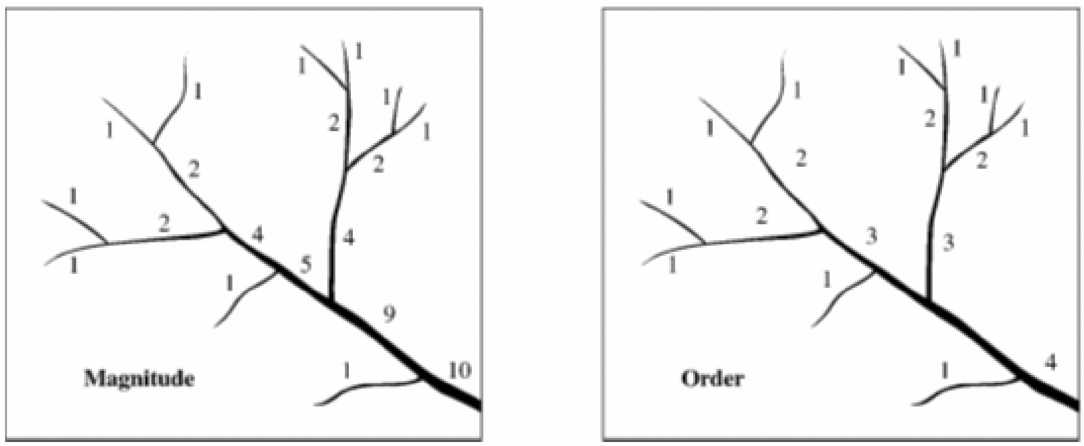


Figure 9 - Example stream networks showing magnitude and order

UTM (Universal Transverse Mercator) Coordinates

Universal Transverse Mercator Projection

The Universal Transverse Mercator (UTM) Projection is a projection of the earth onto a cylinder wrapped around it with contact along a meridian (or longitude). It allows the earth (a sphere) to be represented on a flat sheet of paper with minimal distortion.

The UTM projection divides the earth into 60 zones, each 6 degrees of longitude wide. The zones are numbered eastwards starting at the meridian 180 degrees from Greenwich. Four zones numbered 8, 9, 10, and 11 cover British Columbia.

UTM Rectangular Grid

The UTM Rectangular Grid is a system of squares superimposed on a map drawn on the UTM projection. The rectangular grid consists of straight vertical lines parallel to the central meridian, and at right angles to them, straight horizontal lines parallel to the equator. Horizontal lines are designated by the distance in metres from the equator and are called the “northings”. Over BC, the values of northings range from approximately 5,350,000 m at the south end of Vancouver Island, to 6,650,000 metres at the 60th parallel. Vertical lines are designated by the distance in metres from an imaginary point or “false origin” 500,000 metres west of each central meridian, and are called the “eastings”. In the latitude of BC, the values of eastings range from a minimum of 280,000 metres to a maximum of 720,000 metres. The false origin is used so that all eastings are positive.

UTM Coordinates

The UTM coordinates (easting and northing) are used to geographically reference (identify the location of) any point on the ground such as a lake, stream or sample site. Any locational point in a fish inventory must be geo-referenced with a UTM. This includes lakes, stream reach breaks, sample sites, stream features, and photo locations.

To record a unique location, include the UTM zone, the east coordinate and the north coordinate in that order. To record to a precision of 1 metre, record as a single string of characters separated by periods such as: 10.437823.5603104 which is zone 10, easting 437823 and northing 5603104.

Precision to 10 m has one less number in the easting and the northing, for example: 10.43782.560310.

The UTM always has one more digit in the northing than in the easting.

If precision to better than 1 metre is required, then the zone, easting and northing must be recorded separately and not as a single string, e.g. Zone 10 Easting 472703.900. Northing 5362806.990 indicates precision to 1 millimetre.

Obtain a listing of UTM coordinates from The BC Ministry of Sustainable Resource Management, Fisheries Data Warehouse, *BC Watershed Dictionary*.

If you know the name or watershed code of a stream this site will list the UTM coordinates for the mouth of the stream. If you know the name or waterbody identifier of a lake this site will list the UTM coordinates for the outlet of the lake (or the geographic centre of the lake if it has no outlet). UTMs for other locational points such as sample sites and reach breaks cannot be obtained from this web site. They must be determined using one of the other methods listed above in the Method section.

Geographic Information System (GIS)

A computer system capable of assembling, storing, manipulating and displaying geographically referenced information.

Global Positioning System (GPS)

The Global Positioning System is a US military satellite system that provides continuous, accurate, and instantaneous positioning anywhere on or above the earth.

Orthophoto

This is a uniform-scale photograph or a photographic map. It combines the image qualities of a photograph with the geometric qualities of a map. A digital orthophoto is a digital image of an aerial photograph in which distortion caused by the camera and the topography have been removed by a rectification process.

Methods for obtaining UTMs

There are two main methods for obtaining UTMs. The first is from maps or orthophotos as an office exercise, and the second is using a GPS unit in the field.

- UTMs can be obtained from hardcopy maps or orthophotos using the UTM grid numbers printed on the map surround or overlaid on the orthophoto. However, a more accurate method is to use GIS computer software such as ArcView or ArcInfo to pinpoint locations on the digital version of the map or orthophoto. To use this method, you need to have the digital TRIM maps which can be ordered from LandData BC, or digital orthophotos with the UTM grid overlaid.
- Global Positioning System units can be used in the field to obtain UTMs for locational points. Refer to the British Columbia Standards Specifications and Guidelines for Resource Surveys Using Global Positioning System Technology.

Obtain the correct UTM coordinates (easting and northing) for the locational point of interest (lake, stream, reach break, sample site etc.) from maps or orthophotos, or by using global positioning system (GPS) as follows:

- For Reconnaissance (1:20,000) and Overview (1:50,000) Fish and Fish Habitat Inventories UTMs must be to 1 metre accuracy.
- For stream reaches, use the UTM coordinates of the upstream reach break for geographical referencing.
- For sample sites in streams, use the UTM coordinates of the downstream end of the site.
- For lakes, use the UTM coordinates at the main outlet of the lake, unless there is no outlet present. In that case, use the geographic centre of the lake.
- For sample sites in lakes, use the UTM coordinates for the approximate centre of the site.

Terrain Characteristics

Lake terrain characteristics are the physical characteristics of the terrain surrounding the lake which includes setting, aspect, lake basin genesis, hillslope coupling and land use.

Setting

Correctly identify the lake setting visually on maps and air photos, and confirm in the field. The lake setting describes the major physiographic feature of the general area in which the lake occurs in the landscape. Six types of lake setting have been identified as described below: valley floor, valley wall, hanging valley, mountain plateau, plain/large plateau, or piedmont. Refer below for examples of each type of lake setting.

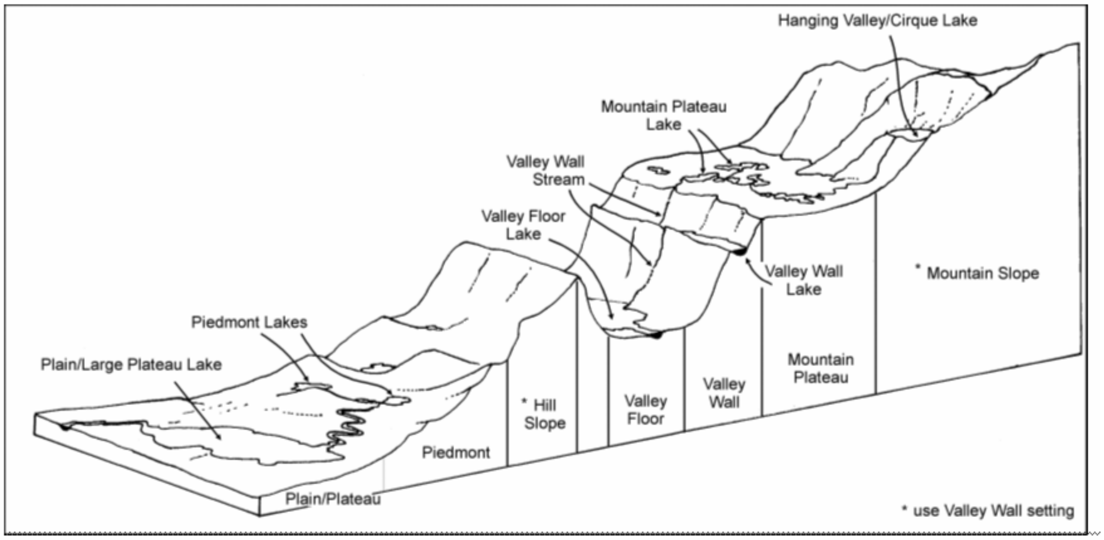


Figure 10 - Physiography of Lake Settings

Valley Floor: A lake situated on a valley floor. It is generally on the local erosional base level or close to it. A valley floor is a linear depression bounded on both sides by slopes that rise to substantially higher ground.

Valley Wall: A lake situated between a valley crest (i.e. the ridgeline of the hills or mountains flanking a valley) and the valley floor. Valley wall lakes are rare, and were usually formed by glacial meltwater running beside valley glaciers. They are usually small, steep-sided depressions that parallel the main valley, and have bedrock basins and are commonly partly blocked by fallen rock and debris flow fans.

Hanging Valley: A lake situated in a hanging valley or cirque.

Mountain Plateau: A lake situated on a high plateau. Typically mountain plateau have steep, clifflike edges.

Plain/Large Plateau: A lake situated on a plain or large plateau. A plain is an extensive tract of flat or gently undulating land, without prominent hills or marked depressions, and is generally lower than adjacent physiographic features. A large plateau is a broad tract of relatively flat land, higher than adjacent areas but without an abrupt slope break at its edge.

Piedmont: A lake situated on a piedmont. Piedmonts lie adjacent to mountain ranges, but comprise hilly topography (foothills). Piedmonts have less relief than a mountain range, but more than a large plateau; they are at a lower elevation than a mountain plateau, and do not have a scarp.

Table 1 - Lake Setting Types and Examples

Setting Type	***Example Lakes and 1:50,000 NTS mapsheets***
Valley Floor	Pitt, Harrison, Arrow, Kamloops
Valley Wall	Cougar Lake, north of Merritt, on 92I/7 is an example of a valley wall lake. Others are Leviathan on 82F/15, Monroe and Mineral above Moyie Lake on 82G/5, and Sukunka, north of a gas plant on 93P/5)
Hanging Valley	By looking at the smaller high altitude lakes along any mountain range in the province, one can locate hanging valleys with cirque lakes or tarns in them. For a good selection of tarns in hanging valleys between the upper Stein River and Lillooet Lake, see 92J/1. The headwaters of Lizzie Creek show a series of hanging valleys. Lizzie Lake is in a hanging valley, overlooked by Haven Lake, Long Lake, Whisky Lake and Arrowhead Lake, also all in hanging valleys. Then, above these, there are yet higher hanging valleys or cirques with lakes (tarns). Examples of these are Shields Lake above Haven Lake; the Crystal Tarns, Snake Lake, and Rainbow Lake above Long Lake; and Heart Lake above Arrowhead Lake.
Mountain Plateau	There are many small to medium sized lakes on high plateau in BC. Examples of mountain plateau lakes are found in St. Mary's Alpine, 82F/16; Forbidden Plateau, 92F/11; around Kasalka Butte, 93E/11; around Kawdy Mountain, 104J/14; Kawdy Plateau, 104O/3 & 6; and Spatsizi Plateau, 104H/10. It should be noted that in these plateaus, the settings of some lakes may be in hanging valleys or on valley floors.
Plain/Large Plateau	Examples of these areas are the Fraser Plateau, 92O, 92P, and 93B; the Nechako Plateau, 93F and 93K; the Liard Plateau, 94N; the Liard Plain, 94M; and the Eshto Plateau, 94P. The edge of the Alberta Plateau is an example of a plain, and covers much of the northern border area with Alberta. A large part of the east coast of Vancouver Island is a coastal plain, the Nanaimo Lowland, as is the east coast of Graham Island (the northernmost of the Queen Charlotte Islands), the Argonaut Plain. Also, a strip of the west coast of Vancouver Island is the Estevan Coastal Plain.
Piedmont	Piedmont areas are found along the eastern side of the Rockies, in the Rocky Mountain foothills, and the eastern side of the coast range, from the western edge of the Nechako and Fraser plateau. The Sunshine Coast, the Georgia Lowland, is largely piedmont.

Aspect

Correctly identify the lake axis and flow direction as north, northeast, east, southeast, south, southwest, west or northwest. Aspect of the lake refers to the orientation of its longitudinal axis and flow direction with respect to geographic north. In case the shape of the lake is ambiguous and no outlet can be determined, the most plausible aspect is determined.

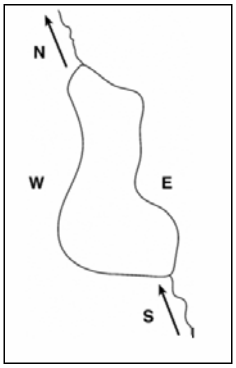


Figure 11 - Example of Lake with Northwest Aspect

Lake Basin Genesis

Lake basin genesis describes the origin of the lake.

There are eight major categories of lake basin genesis: volcanic, landslide, glacial, solution, fluvial, shoreline, organic, and anthropogenic.

Glacial, fluvial, organic and anthropogenic lakes are further divided into sub-categories:

- Nine types of glacial lakes are common in BC: glacial ice, glacial scour, cirque, fjord-like, piedmont, moraine/esker/outwash, ground moraine, glacial kettle, and dead ice complex.

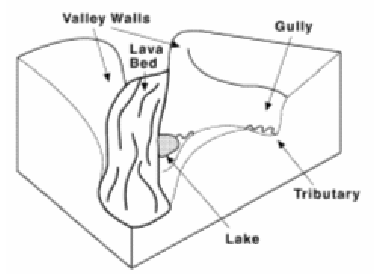
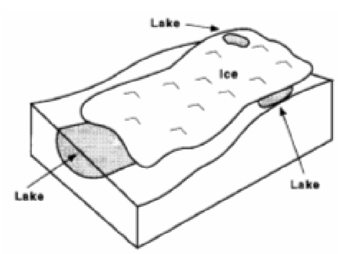
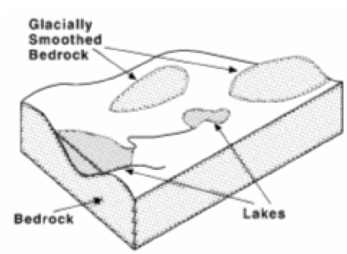
- Four types of fluvial lakes have been described: alluvial fan dam, abandoned fluvial channel, oxbow and levee.

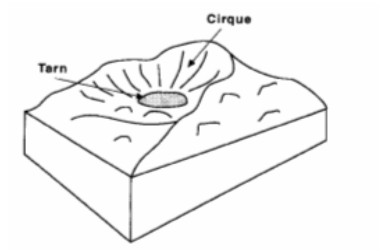
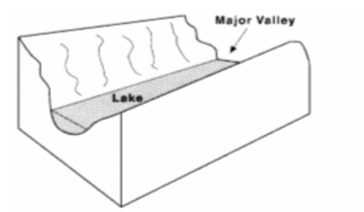
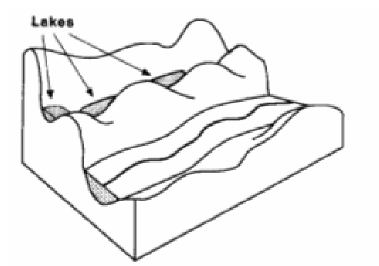
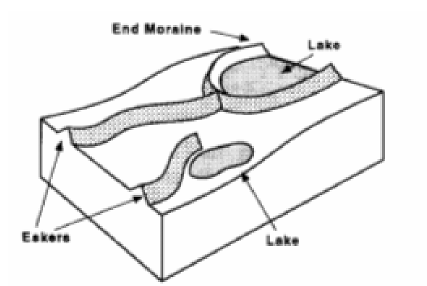
- Two types of organic lakes occur in BC: phytogenetic and beaver dam.

- Two types of anthropogenic lakes have been described: reservoir and quarry.

Refer below for lake basin genesis definitions.

Table 2 - Lake Basin Genesis Categories

Lake Basin Genesis Categories and Sub-Categories	*Illustration*
Volcanic Lakes: Lava-dammed lakes. Geology maps indicate volcanic rock at or near the surface where these lakes occur.	 Figure 12 - Volcanic Lake
Landslide Lakes: Lakes formed by mass movement dams usually from rockslides or rock avalanches. These lakes are often seen in steep sided mountain valleys in which the surface flow may be discontinuous.	 Figure 13 - Landslide Lake
Glacial Lakes: Lakes that occupy basins created by glacial processes.	
Glacial Ice Lakes: Lakes in direct contact with glacier ice or dammed by moraines in direct contact with ice.	 Figure 14 - Glacial Ice Lake
Glacial Scour Lakes: Lakes that occupy basins scoured into rock by glaciers. They are usually relatively small, irregularly shaped and have several basins.	 Figure 15 - Glacial Scour Lake

Lake Basin Genesis Categories and Sub-Categories	*Illustration*
Cirque Lakes: A cirque is a half-open, steep-sided hollow in a mountain region that has been or is being glaciated. Cirque lakes (or tarns) are lakes that are situated in a cirque.	 Figure 16 - Cirque Lake
Fjord-like Lakes: Fjord-like lakes are usually long, sinuous valley floor lakes that run to bedrock valley walls on either side. They are often extremely deep with a low ratio of littoral area and are over 400 ha in size.	 Figure 17 - Fjord-like Lake
Piedmont Lakes: Lakes located in the foothills of mountain ranges or on coastal plains formed when the large valley glaciers spread out from their feeder valleys.	 Figure 18 - Piedmont Lake
Moraine, Esker and Outwash Lakes: These are lakes formed by unconsolidated, glacially derived materials (e.g., esker, moraine) that are deposited in a narrow point, in a valley or other depression and act as a dam. Eskers are sinuous ridges (metres to tens of metres high) of sand and gravel deposited by meltwater in a tunnel beneath or within a glacier or ice sheet. Moraines are ridges that consist of till deposited along the edge of a glacier or icesheet.	 Figure 19 - Moraine, Esker Lakes

Lake Basin Genesis Categories and Sub-Categories	*Illustration*

Outwash lakes are formed by fluvial erosion of glaciofluvial sediments that are deposited by glacial meltwater downstream from a glacier.

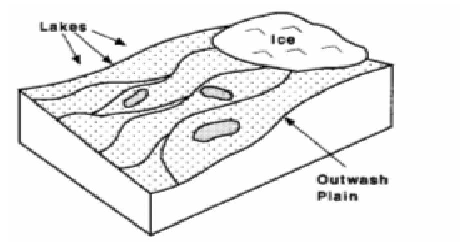


Figure 20 - Outwash Lake

Ground Moraine Lakes: Lakes filling basins created on the till surface by continental glaciers. The topography is typically gently undulating, or irregular; underlain by relatively thick basal till; usually in areas of low relief. Till is usually basal till, and slopes are gentle, thereby distinguishing these lakes from those in dead ice topography.

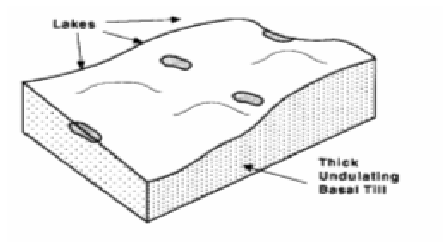


Figure 21 - Ground Moraine Lake

Glacial Kettle Lakes: Glacial kettle lakes, often known as 'pothole' lakes, are formed when outwash (gravels and sands) deposited around a large block of glacial ice forms a basin after the ice has melted. Kettle lakes can be identified by the following:

- Enclosed depressions (either dry, or partly, or wholly filled by lakes).
- A sharp slope-break between the steep sides of the kettle and adjacent terrain.
- Small kettles (tens of meters in diameter) are typically near circular in shape; typically located on level or gently undulating outwash plains and terraces (glaciofluvial sands and gravels), and less commonly in glaciolacustrine sediments.
- The kame terrace is at the same general level around the lake

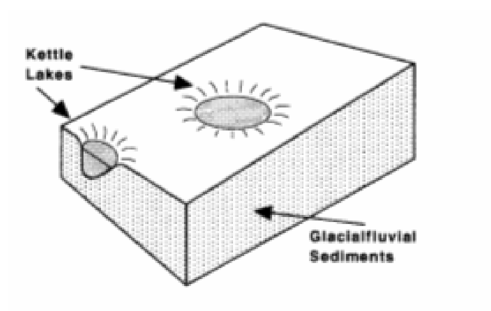
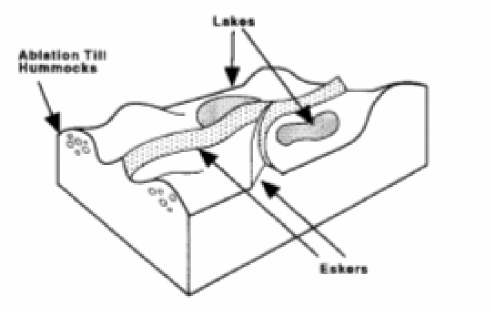
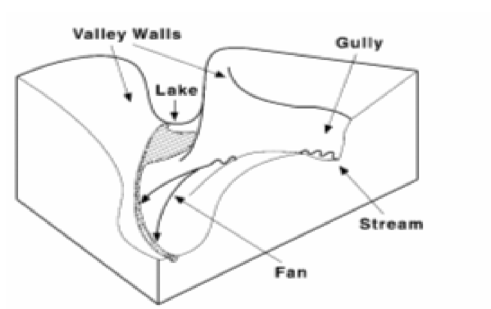
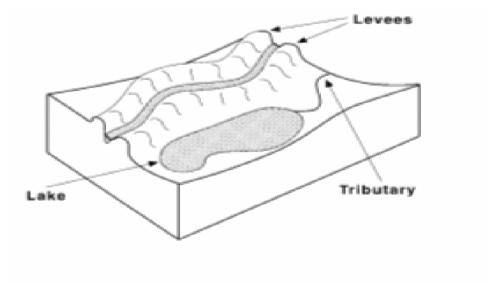
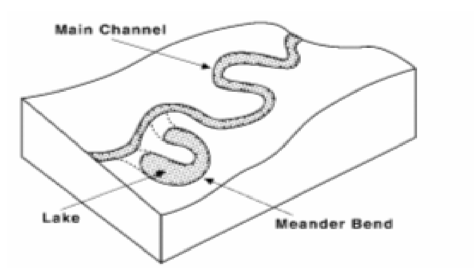
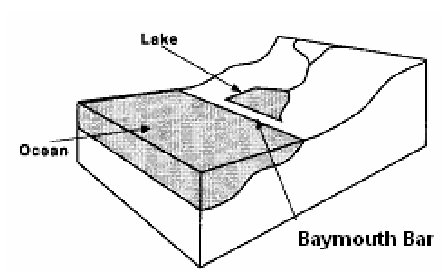
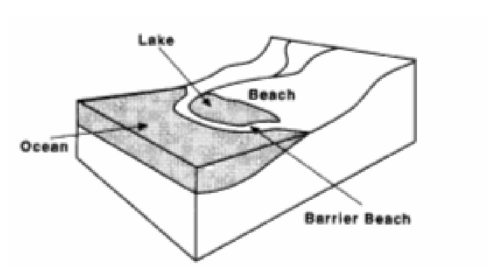


Figure 22 - Glacial Kettle Lake

Lake Basin Genesis Categories and Sub-Categories	*Illustration*
Dead Ice Complex Lakes: These are lakes formed as a large section of continental or very large section of valley glacier melts. However, compared to kettle lakes, the kame terrace surrounding the lake may be of more variable height, they may have eskers running across them, and they always have multiple basins.	 Figure 23 - Dead Ice Complex Lake
Solution Lakes: Solution lakes are created when dissolution of soluble bedrock forms a basin. Bedrock geology maps provide rock type information. The main rock types associated with solution lakes in BC are carbonate (limestone, dolomite, gypsum and halite-rich rocks).	
Fluvial Lakes: Lakes formed by river flow.	
Abandoned Fluvial Channel Lakes: Fluvial channels, most of them outwash channels left by glacial meltwater during deglaciation, often have small lakes in them. Some of these channels are in valley walls, as the main part of the valley was occupied by ice at the time of their formation. If the lake basin and immediate surroundings appear to be part of an old river system, a check of the aerial photography should clarify if the lake is in an abandoned riverbed or not.	
Alluvial Fan Dam Lakes: Alluvial fan dam lakes are formed when a stream deposits an alluvial or colluvial fan across a valley, damming it and forming a lake. Alluvial fans develop where steep streams with high sediment load enter a trunk valley. Colluvial fans form where debris flows occur repeatedly.	 Figure 24 - Alluvial Fan Dam Lake

Lake Basin Genesis Categories and Sub-Categories	*Illustration*
Levee Lakes: Levee lakes are formed when a levee deposit, along the banks of the main channel, traps water. A levee it a natural dyke that forms alongside low gradient rivers from the deposition of overbank sediments during floods. These low ridges may prevent tributary streams from entering a trunk river, resulting in the development of shallow lake on the floodplain. Typically, such lakes are fairly quickly filled with sediments and transformed into wetlands.	 Figure 25 - Levee Lake
Oxbow Lakes: Oxbow lakes are formed when an avulsion cuts off a portion of the meandering channel between two bends. These lakes are typically crescent-shaped and deeper than levee lakes.	 Figure 26 - Oxbow Lake
Shoreline or Barrier Lakes, Lagoons: These lakes are formed by spits, baymouth bars, or barrier beaches and are always beside a larger body of water with a gravel and sand berm separating the lake from the larger waterbody. If by the sea, there may be saltwater intrusions.	 Figure 27 - Shoreline or Barrier Lakes, Lagoon with Baymouth Bar  Figure 28 - Shoreline or Barrier Lakes, Lagoon with Barrier Beach

Lake Basin Genesis Categories and Sub-Categories	*Illustration*
Organic Lakes: Lakes formed by organic processes include phytogenetic lakes, beaver dam lakes and coral lakes. There are no coral lakes in BC. Phytogenetic Lakes: Most of these water bodies will be wetlands and are formed as a result of damming by vegetation. Phytogenetic lakes are found in northeastern BC, in coastal areas of high rainfall, and in alpine areas. Beaver Dam Lakes: Lakes formed as a result of beaver dams. Anthropogenic Lakes: Lakes formed as a result human action. Reservoir Lakes: These are lakes formed when water is impounded by a man-made dam, for example, for electric power or water supply for industry, agriculture, domestic use, or wildlife.	
Quarry Lakes: These are lakes formed when retired gravel, sand, and rock quarries fill with water and are large and deep enough to be called lakes.	

Table 3 - Lake Basin Genesis Categories and Examples

Lake Basin Genesis	*Hutchinson's Type*[1]	*Examples*
Volcanic Lakes	19, 19a	Ray, Clearwater, Kostal, Stevens, and Murtle lakes in Wells Gray Provincial Park, Tuya Lake in the Dease Lake area.
Landslide Lakes	20, 20a, 20b, 20c, 21, 22	Foley Lake in the Chilliwack area, and Cerulean Lake in Strathcona Provincial Park
Glacial Ice Lakes	23, 23a, 23b, 23c, 24, 24a, 24b, 24c, 24d, 24e, 25, 25a	Summit and Tide lakes on the Bowser River
Glacial Scour Lakes	26	Helen Mackenzie and Kwai lakes on Forbidden Plateau, Roche and Sheridan lakes in the Cariboo
Cirque Lakes	27, 27a, 27b, 28, 28a	Widgeon Lake near Mission, Lake Louise in Banff National Park, and Sunrise Lake in Strathcona Provincial Park
Fjord-like Lakes	28b	Adams, Kinaskan, Tum-Tum, Brown, Buttle, Upper Campbell, and Azure lakes
Piedmont Lakes	28c	Ruby Lake near Sechelt, Kennedy Lake on the west coast of Vancouver Island
Glacial Moraine, Esker, and Outwash Lakes	30, 30a, 30b, 31, 32a, 32b, 33	An example of a moraine lake is Empheron Lake at the snout of the Tellot Glacier, an example of an esker lake is Esker Lake on the Yukon border, and an example of an outwash lake is Barney Lake on the Yukon border.
Ground Moraine Lakes	34	Swan lake near Dawson Creek
Glacial Kettle Lakes	35, 36, 37, 39, 40	Crater, Alleyne, and Kentucky lakes near Aspen Grove
Dead Ice Complex Lakes		Jennings Lake
Solution Lakes	43a, 43b, 44, 45, 46, and 47 *some types*	Devil's Punchbowl near Victoria Lake on Vancouver Island
Abandoned Fluvial Channel Lakes		

Alluvial Fan Dam Lakes	49, 50, 51	Estero Basin on the coast, Canty in the Rockies north of Mackenzie, and Upper Tuchodi north of Kwadacha Park
Levee Lakes	52, 53a, 53b, 54, 58, 59	Duck and Leach lakes adjacent to the Kootenay River near Creston
Oxbow Lakes	55, 56, 57	Hatzic Slough near Mission
Shoreline or Barrier Lakes, Lagoons	64, 65, 66, 67, 68	Sherwood Pond, Albert Head Lagoon, both near Victoria
Phytogenetic Lakes	47 (most of the BC examples), 69, 70, 71	Parker Lake, near Fort Nelson
Beaver Dam Lakes	72	Foley Creek Pond
Reservoir Lakes	73	Koocanusa, McNaughton, Williston, and Capilano lakes
Quarry Lakes	74	Kingzett Lake near Cobble Hill, Allan Lake in the Fraser Valley

[1] source: Hutchinson, G.E. (1957) A Treatise on Limnology.

For additional information refer to the *Forest Practices Code of British Columbia Channel Assessment Procedures Field Guidebook* and Hutchinson, G.E. (1957) A Treatise on Limnology. Volume 1: Geography, Physics and Chemistry. New York: John Wiley & Sons Inc.

Lake Shoreline Characteristics

The shoreline characteristics of the lake describe the immediate shoreline of the lake which comprises shoreline type, shoreline cover and the recreational facilities present around the lake.

Shoreline Type and Percentage of Type

The lake shoreline is the terrestrial surface directly affected by the lake. It includes all the area affected by the lake margin from the low water mark to the average annual high water mark, and the riparian zone around the lake. Five types of lake shoreline are described: sand or gravel beach, low rocky shore, cliffed or bluff shore, wetland shore, and vegetated shore.

Lake Inlet and Outlet Streams

The inlet and outlet streams or tributaries of a lake provide essential habitat for fish spawning and rearing. For a lake inventory, all inlet and outlet streams must be located and surveyed for fish habitat quality and barriers to fish movement. The first reach adjacent to the lake in each lake tributary should be surveyed and sampled for fish as per the standards described in the *Reconnaissance Level Stream Survey Toolkit* and the *Reconnaissance Level Fish Collection Toolkit.*

Write the watershed code of each tributary, to the first set of zeros, in the Watershed Code field, left justified. To the left of the appropriate watershed code, in the I/O field, write an ***I*** for each inlet stream, and an ***O*** for each outlet stream.

Record the ILP Map # and ILP # for each watershed code where applicable.

Permanent/Intermittent Inlets

At each inlet stream, determine if it is permanent or intermittent. A permanent stream flows year round. An intermittent stream dries up partially during seasonal periods of low rainfall, only retaining water in separated pools along the channel.

Perform a stream survey and fish sampling in the first reach adjacent to the lake in each inlet and outlet stream using a Site Card front (pdf) Site Card back (pdf) and Fish Collection Form front (pdf) Fish Collection Form back (pdf) as described for the Stream Survey and Fish Sampling. If the lake influence continues beyond the first reach, extend the tributary survey to include this section of stream.

Aquatic Flora

Aquatic plants are an essential component of the lake community. They are non-woody plants, larger than microscopic size, that grow in habitats that are submerged for at least part of the year. Aquatic plants may be free-floating or rooted in the bottom sediment, and may be submerged (submergent) or protrude from the water (emergent). They constitute the basis of the entire aquatic food chain and provide valuable habitat to many organisms both aquatic and terrestrial (Pojar and Mackinnon, 1994). As well, they influence the chemistry of the open water. Changes over time in type and abundance of aquatic plants in the lake environment are important indicators of disturbances in the watershed.

Emergent and Submergent Aquatic Plant Species

Identify the dominant emergent and submergent aquatic plant species at the lake to the genus level, or the species level if possible. Emergent plants are rooted in water and have most of their vegetative growth above water. Submergent aquatic plants are rooted or free-floating and have all of their vegetative growth underwater.

Collect and preserve representative specimens of all aquatic plants that cannot be identified in the field (see Warrington, 1994). Mount the specimens in the field and label them with the date, name of collector, lake name (if available), waterbody identifier, and watershed code.

List associated plant species and describe the location in the lake where the specimen was found.

Visually estimate the percentage of the lake surface area (to the nearest 10%) that is covered by emergent and submergent vegetation.

Take photographs of representative examples of dominant aquatic plant communities at the lake.

For additional information, refer to:

- Pojar J, Mackinnon A. *Plants of Coastal British Columbia*. 1994. Vancouver, BC: BC Ministry of Forests and Lone Pine Publishing.
- *Photodocumentation for Aquatic Inventory*.
- *Collecting and Preserving Aquatic Plants, Draft. May 1994*.

Lake Bathymetry

A bathymetric survey is the depth sounding of a lake along two axes, an E-line and transverse transects.

The bathymetric survey is a complex method of gathering and recording data that is used to prepare bathymetric maps.

Refer to the Bathymetric Standards for Lake Inventories.

Photodocumentation

Photodocumentation is the process of taking photographs and recording information about those photographs; producing images; and labeling, referencing, cataloguing and storing the images.

Photo documentation is a major part of fish and fish habitat inventories for several reasons:

- In the field, taking photographs is quick relative to other forms of note-taking.
- Photos provide a visual record of the site characteristics at the time of the survey.
- Photos can be stored and retrieved for reference.
- Photos provide visual information that aids field data evaluation for the purposes of report production and management decisions.
- A detailed photographic record provides a collection of visual data to supplement all other records, and to assist in accurate description and evaluation of a lake and its surroundings. Photodocumentation of a lake is essential as a visual baseline reference.

All photographic images must be of high quality for archival purposes. Slides, prints and negatives must be properly referenced and labeled with useful information.

Only high quality digital cameras capable of producing images that will meet reconnaissance inventory standards will be accepted.

Take the following colour photographs at the lake:

- Panoramic view of surrounding area (taken from the centre of the lake if possible)
- Representative shoreline and riparian conditions
- Inlet and outlet streams (also refer to the Stream Survey Photodocumentation metric)
- Representative fish captured in the lake (also refer to Fish Survey metric);
- Any unidentified or diseased fish (also refer to Fish Survey metric)
- Dominant aquatic plant communities
- Benchmark (*if set*) close-up and from lake centre and
- Any other important and relevant features at the lake.

If possible, include a scale item in all photographs.

In the inlet and outlet streams, take one upstream-oriented and one downstream-oriented photograph at each site to show general stream characteristics including channel morphology, riparian vegetation, and both banks. Photos are also required of any feature of concern to fish populations, fish habitat, or the inventory that is identified on the Site Card (e.g. obstructions to fish passage, culverts, and effluent outfalls).

It is recommended that labels be incorporated into the photos. There are two options for photo labeling: one is to incorporate the label into the photograph when it is taken; the other is to add the label to the photo digitally after it has been processed (refer to data recording). To incorporate the label into the photo when it is taken place a whiteboard in the field of the photo with referencing information written on it including the waterbody name, date, roll number, frame number, watershed code, reach number and site number.

Aquatic Wildlife Observations

Aquatic wildlife refers to wildlife that inhabits lakes or the associated riparian habitat. Aquatic wildlife reflects the health of the lake environment. For example, an obvious lack of aquatic life or an over abundance of one type of organism over another may suggest changes in water quality. Some aquatic wildlife species may have a substantial impact on fish populations in a lake, and can act as indicators of fish habitation. For example observations of diving ducks (e.g. mergansers) or fresh water shrimp (e.g. skuds) may suggest fish presence. Aquatic wildlife observations provide baseline data on type and abundance of aquatic wildlife, which can be compared with future surveys to elucidate temporal changes in the lake ecosystem.

Identify any observations or signs of invertebrates, reptiles, amphibians, birds and mammals that may directly affect the fish and fish habitat, to the lowest taxonomic level possible. Refer to the table below.

Give special attention to any species listed on the BC Conservation Data Centre (CDC) rare or endangered lists.

Ensure that all relevant reference material is provided as part of the survey crew's field equipment.

Table 4 - Observations or Signs of Aquatic Wildlife

Aquatic Wildlife Type	Comments
Invertebrates	Special emphasis on aquatic insect hatches and freshwater molluscs that form a major component of fish diet.
Reptiles	Probably the least abundant of all aquatic wildlife in BC waters. Although snakes and turtles are not direct fish predators they may compete with fish for food resources.
Amphibians	Refers to animals like salamanders or newts that prey directly on fish eggs / juveniles or amphibians which constitute fish food (frogs).
Birds	Refers to birds like kingfishers, mergansers or loons that are direct predators on fish. It is not necessary to note observations on transient predators like crows or seagulls.
Mammals	Refers to animals like mink, raccoons and otters that prey on fish or beavers and muskrats that modify aquatic habitats affecting fish. Observations on opportunistic fish predators like bears or cougars may be omitted.

The BC Conservation Data Centre lists of rare and endangered organisms in BC.

Limnological Station – Water Quality

Two types of sampling may be performed at the limnological station: field water chemistry measurements, and lab water chemistry sample collection. Field water chemistry measurements include secchi depth, water colour, pH, dissolved oxygen/temperature profile, conductivity and hydrogen sulphide. Lab water samples are collected if required. Refer to the BC Resources Inventory Committee *Ambient Fresh Water and Effluent Sampling Manual*, for minimum requirements and procedures for water data collection in BC.

EMS Number

Obtain an Environmental Monitoring System (EMS number) for each limnological station from the Water, Air and Climate Change Branch BC Ministry of Water, Land and Air Protection prior to conducting water quality sampling. The latitude and longitude of the limnology station must be known to obtain an EMS number. Obtain the latitude and longitude from 1:50,000 mapping.

Each limnology station is assigned an Environmental Monitoring System (EMS) number by the BC Government. The Environmental Monitoring System is the primary monitoring data repository for the BC Ministry of Water Land and Air Protection. The system was designed to capture data covering physical/chemical and biological analyses performed on water, air, solid waste discharges and ambient monitoring sites throughout the province. Samples are collected by either Ministry staff or permittees under the Waste Management Act and then analyzed in public or private sector laboratories.

Write the limnological station number in the Station No. field. The limnological stations at each lake are numbered sequentially starting with ‘1’. If there is only one limnological station, it is numbered ‘1’.

pH

pH is a measure of the hydrogen–ion concentration in water which indicates the acidity or alkalinity of the water. It operates on a scale of 0 (highly acidic) to 14 (highly basic or alkaline), with pH of 7 being neutral.

At the limnological station, measure the pH just at the surface (at 0.5 m) and the bottom of the lake (1 m above the bottom) to the nearest 0.1, using a hand-held pH meter.

Calibrate the pH metre prior to sampling. Use a low ionic strength electrode in water of low ionic strength.

If the cable on the pH meter is not long enough to reach the bottom of the lake, collect a water sample from the bottom with a vertical sampling bottle, and immediately measure the pH of the sample.

Water Sample (for lab analysis)

The essential tasks in water sampling are to obtain a sample from the correct location that meets the requirements of the lab, and to prevent deterioration and contamination of the sample before analysis.

Collect the water samples and send to a laboratory with Environmental Data Quality Assurance (EDQA) lab certification for analysis. Contact the laboratory before the survey to obtain their sampling protocol requirements and requisition forms. The sampling protocol requirements will include time frames, sample quantities, preservation protocols and hold time criteria that may vary for different analyses. If required, collect water samples with a vertical water sampler for lab analysis.

Store water samples in specially cleaned, standard sample collection bottles, and add preservatives as required to ensure chemical reactions do not occur in the sample prior to laboratory analysis. The laboratories may provide the appropriate bottle types, labels and preservatives provided arrangements are made prior to initiating any field sampling. Obtain ice packs and coolers from the laboratory for transporting samples. The laboratory is responsible for transferring all water sample analysis data to the EMS database.

For lakes less than 6 m deep, collect a surface water sample only. For lakes deeper than 6 m, collect a surface and a bottom water sample. A second bottom water sample is required if the metals package is requested.

Take the surface water sample from a depth of 0.5 m using a vertical water sampler. Take care not to collect any surface film contaminant. Collect the bottom water sample 1 m above the lake bottom using a vertical water sampler. Take care not to overshoot the depth, as disturbance of the sediments would necessitate moving to another site.

If a total metals package analysis is required a separate sample must be collected and preserved in the field. Guidelines for all such procedures, and contingencies, are explained in the *Ambient Freshwater and Effluent Sampling Manual*. Again, contact the laboratory before the survey to obtain their sampling protocol requirements for metals analysis.

Clearly label all water sample bottles with the following, in water-proof ink:

- Date (and time) of sample collection
- Lake name and station number
- EMS number
- Sample depth (optional) and
- Name of contracting firm (optional)

Note: the laboratory will likely provide labels to be completed and attached onto the sample bottles in the field.

The laboratory will analyze the water sample for concentrations of the following parameters (as per Standard Environment Canada Laboratory Form):

Acidity: pH 4.5	pH
Acidity: pH 8.3	Phosphorus: Total dissolved
Alkalinity: Total pH 4.5	Phosphorus: Total
Nitrogen: Ammonia	Residue: Filterable (TDS)
Nitrogen: Nitrate	Specific Conductance
Nitrogen: Nitrite	Metals package (if required)*
Nitrogen total	

Description of water sample analysis parameters

Total alkalinity. Alkalinity provides a measure of the water's buffering capability (i.e. the capability to withstand rapid changes in the water's pH level). It is expressed in mg/L $CaCO_3$ equivalent, and is measured in the laboratory. Prior to initiating field sampling, obtain the appropriate sample container from the laboratory. Maximum sample holding time is 72 h at 4°C.

Total dissolved solids. Related to electrical conductivity, total dissolved solids (TDS) is a measure of the concentration of dissolved salts in the water. TDS is expressed in mg/L, and is measured in the laboratory. Prior to initiating field sampling, obtain the appropriate sample container from the laboratory. Maximum sample holding time is 72 h at 4°C. TDS is often referred to as filterable residue (FR), or total filterable residue (TFR). Electrical conductivity can be roughly converted to total dissolved solids by multiplying conductivity by approximately 0.65.

Total nitrogen and dissolved phosphorus. Total nitrogen and dissolved phosphorus are nutrients used by aquatic algae and macrophytes for growth. Levels of nitrogen and phosphorus thus provide information that can be used to estimate natural productivity and identify reaches subject to enrichment from human activities. Total nitrogen and dissolved phosphorus are both expressed in mg/L and are measured in the laboratory. Prior to initiating field sampling, obtain the appropriate sample container from the laboratory. Also ask the laboratory for their filtering requirements for the dissolved phosphorus sample. Maximum sample holding time is 72 h at 4°C.

Low level nutrients, nitrate-N and ortho-P. Low-level nutrient concentrations provide information for estimating stream productivity in lakes where nutrient levels are near or below the detection level of conventional analytical methods. Low level nutrients include low-level nitrate-nitrogen and low-level ortho-phosphate. These two variables are both expressed in mg/L (or μg/L) and are measured in the laboratory. Prior to initiating field sampling, obtain the appropriate sample container from the laboratory. Also ask the laboratory for their filtering requirements for the dissolved phosphorus sample. Maximum sample holding time is 72 h.

Dissolved Oxygen, Temperature Profile

Dissolved oxygen is a measure of the concentration of oxygen dissolved in water expressed in mg/L.

Take the vertical dissolved oxygen (DO) and temperature profiles simultaneously with one instrument (e.g. YSI, Hydrolab). Readings commence at the surface and should terminate approximately 1 m from the lake bottom. Depth intervals are discretionary, but should be 0.5 to 1.0 m for accurate delineation of the epilimnion and the thermocline in stratified lakes. In the hypolimnion, and in unstratified lakes, larger intervals may be adequate. For deep lakes, a cable length of 30 m is usually adequate for the purposes of a lake survey.

Calibrate the metre prior to measuring the temp/DO profile.

Take two sets of readings at each depth interval: one during descent and the other during ascent, to minimize bias due to adjustment of the meter to the water conditions at the subsequent depths.

Measure DO to the nearest mg/l and measure temperature to the nearest 0.1°C

Note: If hydrogen sulphide (see below) is present, it can ‘poison’ the DO membrane and electrode. Therefore, take care in lowering the probe. In such cases, do not drop the probe below the 0.5 mg/l oxygen level.

Conductivity

Electrical conductivity is dependent on the total dissolved salts concentration (TDS) in the water; the higher the salt (e.g. sodium, calcium, sulphate) concentration, the higher the conductivity.

Measure conductivity in the field using a portable conductivity meter (e.g. YSI, Hydrolab). Most conductivity meters automatically convert conductivity measurements to 25°C (specific conductance). If your meter does not automatically standardize to 25°C, record the water temperature at the same time as conductivity and use a conductivity nomograph to convert the reading to 25°C.

Measure conductivity at the surface (at 0.5 m) and the bottom of the lake (1 m above the bottom) to the nearest µS/cm. The metre must be calibrated prior to sampling. If the cable on the meter is not long enough to reach the bottom of the lake, collect a water sample from the bottom with a vertical sampling bottle, and immediately measure the conductivity of the sample.

Hydrogen Sulphide

When DO values are very low, and the characteristic 'rotten egg' smell of hydrogen sulphide (H_2S) can be detected easily, measure the H_2S concentration in the water sample collected from the bottom of the lake.

Make field measurements in parts per million using a Hach kit (ppm). Since H_2S is volatile and easily oxidized, complete tests using the Hach hydrogen sulphide test kit quickly. Care must be taken not to aerate the sample by agitation.

Definitions

Epilimnion: The upper, warm layer of a thermally stratified lake in which the temperature is virtually uniform.

Thermocline: The stratum of a thermally stratified lake between the epilimnion and the hypolimnion where there is a marked drop in temperature per unit of depth. This layer acts as a barrier preventing the interchange of nutrients between the epilimnion and the hypolimnion, and thus creating two separate environments in the lake.

Hypolimnion: The cold, lowermost layer of a thermally stratified lake in which the temperature is nearly uniform. This layer is prevented from warming by the thermocline.

On each line in the Dissolved Oxygen, Temperature Profile and Conductivity field, write the depth that the measurement was taken at in metres, the dissolved oxygen value in mg/L, the temperature in °C, and the conductivity in µS. Both descending (🡇) and ascending (🡅) dissolved oxygen and temperature profiles must be recorded at the same depth intervals. Record conductivity measurements taken at the surface and bottom only, in the box corresponding to the recording depth.

Data Entry

Databases

Enter the data into the Field Data Information System (FDIS).

FDIS is a data capture, storage and reporting system that is devoted to field information as it is collected on the standard provincial field cards. It is a two part system where the first part is an MS Access tool to allow contractors and staff to enter, verify and edit data. The second part is the Oracle based components where all the data is eventually loaded. The Oracle components provide for data storage, some data editing, summary of the data to other systems (FISS), integration and access to the data for other systems and data reporting.

For instructions for using FDIS, link to FDIS Getting Started.

The following provides some additional hints.

FDIS software automatically inserts the gazetted name into the tables when the watershed code and/or waterbody ID is entered.

Data Reporting

Manuals and Resources

This lists the data reporting deliverables and their associated reference manuals and resources.

The **Annotated Aerial Photograph** is required in the final lake report and exhibits location information about the field survey. It allows the reader to visualize the lake and its surrounding terrain, as well as the field survey site locations. Refer to **Final Lake Report**.

Bathymetric maps represent depth soundings plotted within lake outlines. These maps are used to calculate area, perimeter, and volume and to illustrate depth contours for a lake (Balkwill, 1991). Refer to Bathymetric Standards for Lake Inventories

Lake Outline maps are a deliverable of Bathymetric maps. They are made by making an outline of lake from an air photo, and marking additional information including tributaries and outlets. Lake Outline maps require additional information including lake name, watershed code, waterbody ID, source, shoreline features, north arrow, and direction of flow and reach breaks on tributaries. Refer to Bathymetric Standards for Lake Inventories.

Overview maps show the entire project area (with boundary lines. They show the TRIM/Forest Cover (FIC) and aquatic features as background. In addition they show the location of all sample sites. Refer to **Fisheries Overview Map**

Final Lake Reports provide a concise summary of all inventory information available for a lake. Refer to **Final Lake Report**.

The following highlights selected information regarding data reporting.

Bathymetric Map

Gazetted and Local Names

Report the correctly spelled gazetted lake name in the textbox in the bottom right corner of the map. Refer to Bathymetric Standards for Lake Inventories.

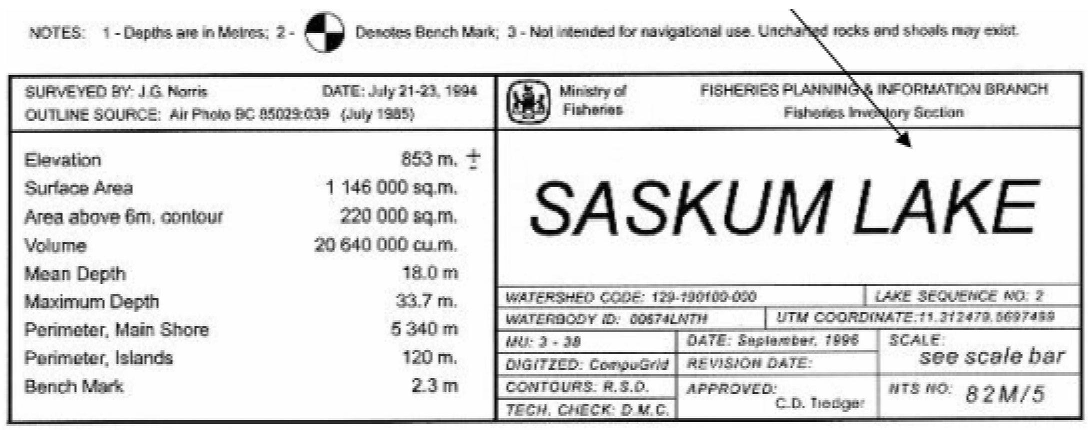


Figure 29 - Bathymetric Map Textbox Gazetted Lake Name

Report the local lake name in the textbox only if there is no gazetted name for that lake. To indicate that it is a local name and not an officially gazetted name, include an asterisk following the local name. Refer to Bathymetric Standards for Lake Inventories.

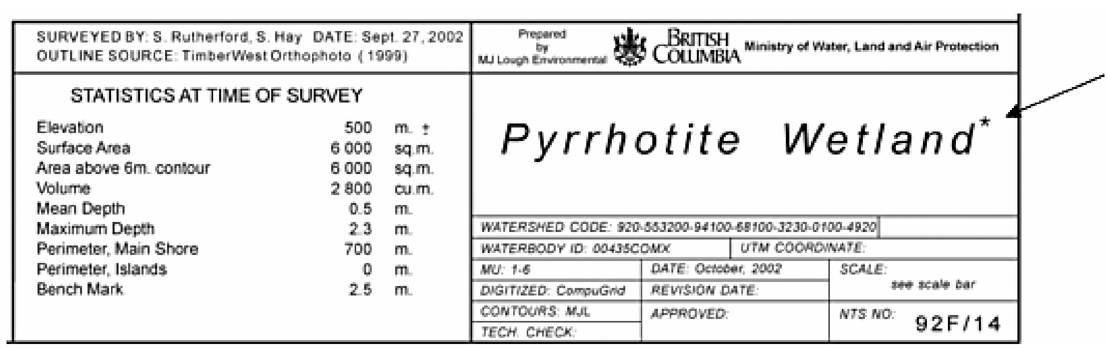


Figure 30 - – Bathymetric Map Textbox showing Local Name of a lake that does not have a Gazetted Name

Watershed Code and Waterbody Identifier

Display the Watershed Code and Waterbody Identifier correctly in the textbox in the bottom right corner of the map. Refer to Bathymetric Standards for Lake Inventories.

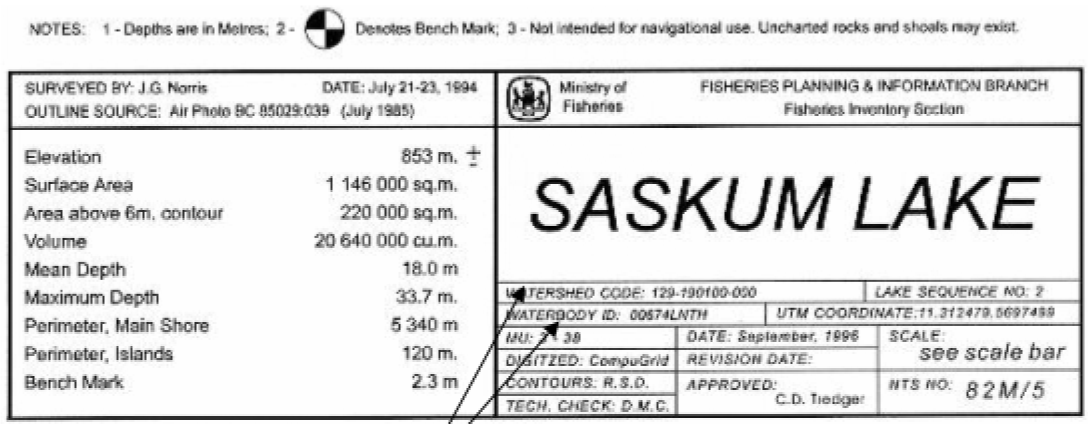


Figure 31 - Bathymetric Map Textbox Watershed Code and Waterbody ID

Streamline direction

Display the streamline of all lake tributaries with the direction of flow indicated by an arrow adjacent to the stream.

Lake Outline map

Reach breaks

For the lake tributaries shown on the map, draw the reach break symbols at the stream reach boundaries. Write the reach numbers on the downstream side of the upstream reach break symbol. Refer to Bathymetric Standards for Lake Inventories.

Quality Assurance

Manals and Resources

Refer to Reconnaissance (1:20,000) Fish and Fish Habitat Inventory ***Quality Assurance Procedures Version 1.0***.

Appendix 1

Forms

- Fish Collection Form front (pdf) Fish Collection Form back (pdf)
- Individual Fish Form front (pdf) Individual Fish Form back (pdf)
- Lake Survey Form front (pdf) Lake Survey Form back (pdf)
- Site Card front (pdf) Site Card back (pdf)
- SLAM Boat (Air) form (pdf), SLAM Boat (Ground) form (pdf), SLAM Creel form (pdf), SLAM Fish Data form (pdf)
- SLAM Instructions: SLAM Boat (Air) form (pdf), SLAM Boat (Ground) form (pdf), SLAM Creel form (pdf), SLAM Fish Data form (pdf)

Field Guides

- Fish Collection Form Field Guide, Fish Collection Form Field Guide Errata, Fish Collection Form Field guide Errata #2
- Lake Survey Form Field Guide, Lake Survey Form Field Guide Errata, Lake Survey Form Errata #2
- Site Card Field Guide, Site Card Field Guide Errata, Site Card Field Guide Errata #2

Data Entry Tools

AquaCat

AquaCat is a searchable catalogue and storage system for fisheries and water reports, maps and datasets. It is a two tiered system that is browser based, built with JAVA and stores data to an Oracle database. The first tier allows staff and contractors to use the government's intranet to upload reports, datasets and maps into the catalogue and store the information in Oracle. The second tier produces a searchable browser based catalogue on the Internet site that the public may use to discover information and download their own copies of the reports, datasets and maps.

FDIS (Field Data Information System)

FDIS is a data capture, storage and reporting system that is devoted to field information as it is collected on the standard provincial field cards. It is a two part system where the first part is an MS Access tool to allow contractors and staff to enter, verify and edit data. The second part is the Oracle based components where all the data is eventually loaded. The Oracle components provide for data storage, some data editing, summary of the data to other systems (FISS), integration and access to the data for other systems and data reporting. For instructions for using FDIS, link to FDIS Getting Started.

FISS (Fisheries information Summary System)

FISS is a comprehensive Oracle database providing summary level fish and fish habitat data for water bodies throughout the province of British Columbia that allows the data to be entered, stored, geo-referenced (mapped), distributed (accessed) and reported on. It is a main source of information to many other systems and data products.

FPR (Fisheries Project Registry)

FPR is a joint effort between BC Fisheries and the federal Department of Fisheries ad Oceans to compile an ongoing list of all projects within the province that focus on fish and fish habitats including habitat restoration, biological enhancement, stock and habitat inventories and monitoring, stream mapping, and fish farming to name a few.

Manuals and Resources

- **A Guide to Photodocumentation for Aquatic Inventory**
- **Ambient Fresh Water and Effluent Sampling Manual**
- **Bathymetric Standards for Lake Inventories**
- **BC Conservation Data Centre**
- **British Columbia Standards Specifications and Guidelines for Resource Surveys Using Global Positioning System Technology**
- **British Columbia Watershed Atlas**
- **British Columbia Watershed Dictionary**
- **Channel Assessment Procedures Guidebook**
- **Example Products – Fisheries Overview Map, Fisheries Project Map, Fisheries Interpretive Map, Final Lake Report**
- **Field Key to the Freshwater Fishes of British Columbia**

- **Fish Collection Methods and Standards Version 4.0**
- **Fish Collection Methods and Standards Version 4.0 Errata #1**
- **User's Guide to the Fish and Fish Habitat Assessment Tool (FHAT20) Version 2.0**
- **Fish Inventory Mapping System (FishMap) For 2000 Fish Inventory Data, User Manual, Version 1.0.**
- **Fish Stream Identification Guidebook**
- **FISS Fisheries Information Summary System Data Compilation and Mapping Procedures**
- **LandData BC**
- **Overview Fish and Fish Habitat Inventory Methodology**
- **Riparian Management Area Guidebook**
- **Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Quality Assurance Procedures Version 1.0**
- **Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Reach Information Guide Version 1.0**
- **Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures Version 2.0**
- **Standards for Fish and Fish Habitat Maps Version 3.0**
- **User's Guide to the BC Watershed/Waterbody Identifier System**