

Reconnaissance Inventory of Higgins Lake

Watershed Code: 920-627900-29500
Waterbody ID: 00033CAMB

Prepared for:

BC Ministry of Environment, Lands and Parks

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Project Reference Information

MELP Project Number:	IVNOI103N
FRBC Project Number:	PA96163 IN/TR
FRBC Region:	Vancouver Region
MELP Region:	01
MELP District:	Campbell River
FW Management Unit:	1-10
Fisheries Planning Unit:	Campbell Oyster
Forest Region:	01
Forest District:	Campbell River

Watershed Information

Watershed Group:	Campbell
Watershed Code:	920-627900-29500
Sequence Number:	02
Waterbody Identifier:	00033CAMB
UTM at Lake Outlet:	10.320503.5549413
Number of Tributaries:	1 TRIM inlet
Magnitude:	1
Elevation:	230m
NTS Map:	92K/4
TRIM Map:	92K.003
Biogeoclimatic Zone:	CWHxm2
Air Photos:	BCB91031:92,93

Lake Sampling Summary

Lake Survey Type:	Primary (97 RIC Standards)
EMS #:	E225633
Water Surface Area:	113,978 m ²
Maximum Depth:	13 m
Mean Depth:	4.3 m
Secchi Depth:	4.5 m
Volume:	372,184 m ³
Area above 6 m Contour:	73,603 m ²
Shoreline Perimeter:	2,464 m
Lake Length:	600 m
Number of Islands:	0

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Disclaimer

The Province of BC has not accepted the contents of this product for the purposes of the Forest Practices Code, and reserves the right to dispute the validity of summarized results. The Province of BC does not necessarily agree with the classification, assigned to any individual stream reach, for use in logging plans, silviculture prescriptions or any other application.

Acknowledgments

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- Attachment 1 Photo documentation
- Attachment 2 Digital data
- Attachment 3 Copies of original reference material for historical data
- Attachment 4 Planning document for Sayward Lake biophysical inventory
- Attachment 5 Original field data forms and notes
- Attachment 6 Aerial photographs
- Attachment 7 Microfiche prints of fish scales
- Attachment 8 Voucher, DNA and otolith sample data
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1.0 Introduction

1.1 Project Scope / Objectives

This report documents the findings of a Reconnaissance Lake Survey conducted on Higgins Lake (Waterbody Identifier 00033CAMB), a gazetted lake in the Campbell River Watershed. MJ Lough and Associates surveyed Higgins Lake on September 24-25, 1996 and August 15-16, 1997 as part of the Sayward Landscape Unit Fish and Fish Habitat Inventory Project that was conducted between 1996 and 1998. The primary objectives of this fish and fish habitat inventory project are:

- To provide fish and fish habitat information required for resource planning. This includes information that will be used to guide fisheries management decisions and assist in the lake classification process according to the Forest Practices Code.
- To establish the "normal high water mark" of lakes for use in identifying and mapping the Riparian Reserve Zone adjacent to lakes in the study area.

1.2 Location

- Higgins Lake is located in the Sayward Provincial Forest on Vancouver Island, approximately 16 kilometers (km) northwest of the town of Campbell River. It flows into Gosling Lake, which drains into Campbell Lake and then into Campbell River, which enters the Pacific Ocean in Discovery Passage (Figure 1).

1.2.1 Access

Directions to Higgins Lake from Campbell River are as follows:

- From the Campbell River Bridge in Campbellton, travel west on Highway 28, the Gold River Highway (paved 2-lane highway).
- At 4.3 km keep right onto the road that crosses the John Hart Dam and drive across the dam (paved 2-lane road).
- At 1.9 km turn left (west) onto Brewster Lake Road (also called the Camp 5 Road), a 2-wheel drive gravel mainline.
- Continue on the Brewster Lake Road through the 4-way intersection at 10.7 km.
- At 16 km, Brewster Lake Road crosses the outlet of Higgins Lake and Higgins Lake is on the north side of the road at this point.

There are 3 access points to Higgins Lake:

- At the south end where the Brewster Lake Road crosses Higgins Lake outlet.
- At the east side of the lake where a gravel spur road off the Gosling lake Road ends at the Higgins Lake shore.
- At the north end of the lake where the canoe portage trail to Lawier Lake meets Higgins Lake.

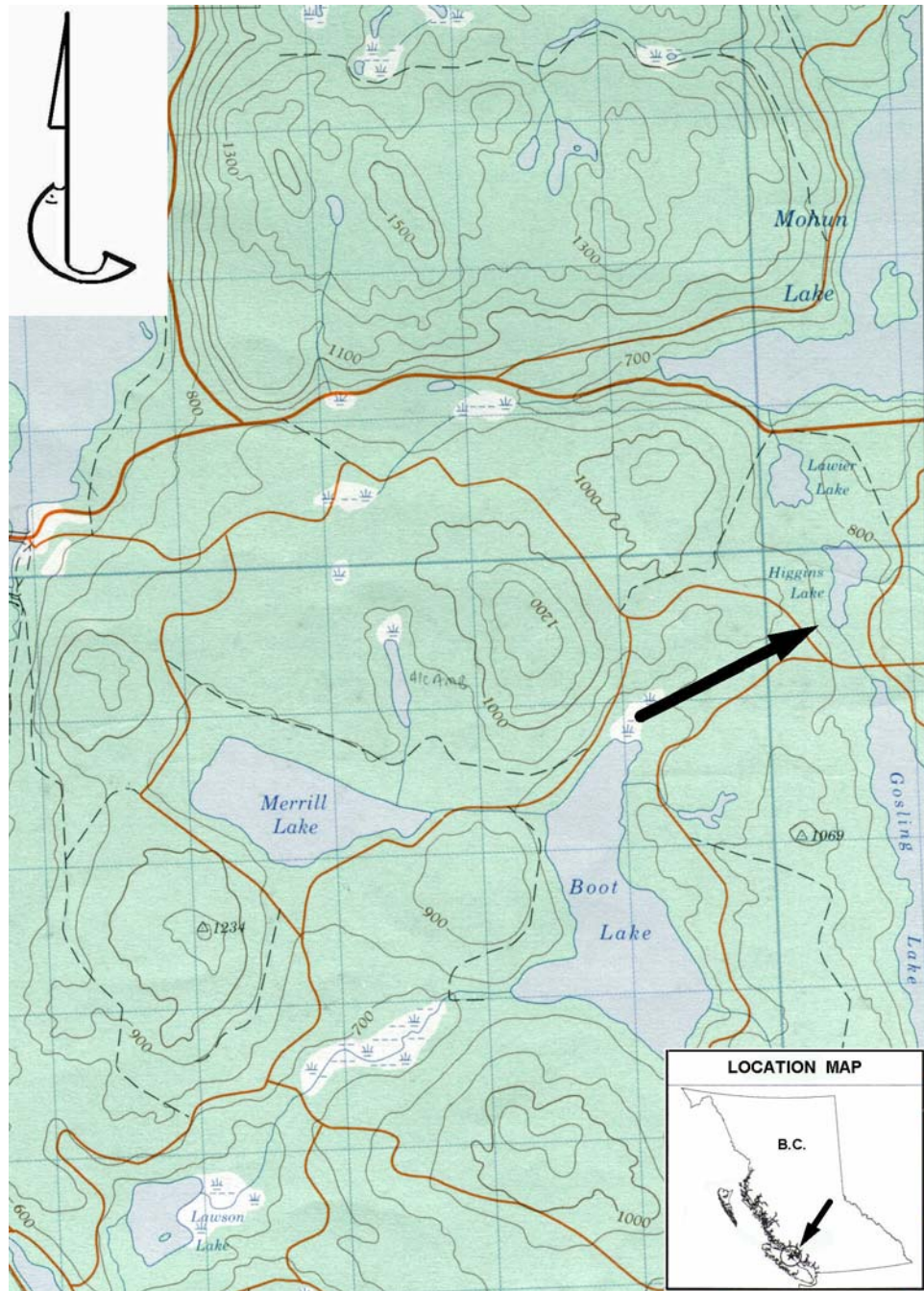


Figure 1 Arrow indicates the location of Higgins Lake on excerpt from NTS map 92K/4, scale 1 : 50,000

2.0 Resource Information

2.1 Native Issues

- The Sayward Forest is included in the traditional claims to land title by the Campbell River and Cape Mudge Bands. The Kwakiutl Laich-kwill-Tach Council of Chiefs represents these and other bands in land claim issues, and have included the area in their *Statement of Intent* documents which were accepted by the BC Treaty Commission in February, 1997. Negotiations with the Federal and Provincial governments are currently proceeding through the BC Treaty Commission (Armstrong, pers. comm.).

2.2 Development and Land Use

2.2.1 Logging

- Higgins Lake is in the Sayward Provincial Forest, which is a public forest managed by the British Columbia Ministry of Forests (MOF), Campbell River District. The primary resource based activity in the region is logging. The MOF Small Business Forest Enterprise Program (SBFEP) develops and oversees the 5-year forest development plans for the Sayward Provincial Forest.
- Most of the Sayward Forest was logged in the early 1900's (BCMOF-CRD Undated). The extensive logging resulted in a network of old railway grades and gravel roads throughout the Sayward Forest particularly in the area of Higgins Lake.
- In 1938, 38,000 hectares of forest from Campbell River to Courtenay was destroyed in the Bloedel Forest Fire (BCMOF-CRD Undated). Also burned were approximately 5,200 ha of the Sayward Provincial Forest, between Boot Lake and the north shore of what is now John Hart Lake. Higgins Lake is on the northern edge of the area that burned.
- The land surrounding Higgins Lake has regenerated with coniferous forest that is now in the 40 to 60 year age class. Many of these trees have reached merchantable size and are slated for harvest in the next 10 years, either as commercial thins or clear-cuts.
- Sixty-four ha of forest land on the west side of Higgins Lake was planted with Douglas fir (*Pseudotsuga menziesii* ssp. *menziesii*) in 1949, and fertilized in 1981 and 1992 (Sayward Forest 1998). The MOF SBFEP Sayward Provincial Forest 5-year Forest Development Plan maps show that 16 ha of this area, 200 m southwest of Higgins Lake, is slated for commercial thinning in 1998 (BCMOF-CRD 1998).
- Seventeen ha of 40 to 60 year old Douglas fir, 100 m east of Higgins Lake (on the other side of the Gosling Lake Road), is also slated for commercial thinning in 1998 (BCMOF-CRD 1998).
- Another 24 ha of 40 to 60 year old Douglas fir 100 m north of Higgins Lake will be thinned in 1998 (BCMOF-CRD 1998).

2.2.2 Recreation

- There are no formal camping facilities at Higgins Lake but there is a BC Forest Service campsite on the south end of Mohun Lake, 1 km north of Higgins Lake (Campbell River Forest District 1995).
- Higgins Lake is part of the Sayward Canoe Route. This is a popular circular canoe route through several lakes in the Sayward Forest, which takes about one week to complete. Canoeists can camp at the north end of Higgins Lake where there is a flat, cleared area with a stone fire pit. Short portage trails (0.3 km) lead from Higgins Lake north to Lawier Lake and south to Gosling Lake (Sayward Forest 1995).
- The biophysical feature code for Higgins Lake and the surrounding area, from the MOF Recreation Resource Inventory Map 92K/3, is M² T E³ cia (C1). This classification describes the terrain as containing common features such as small surface waters, trails and coniferous vegetation, which have a moderate ability to attract recreational use. It further stipulates that consultation with MOF Recreation staff is mandatory prior to implementation of resource decisions that affect the land unit. Angling, camping, and canoeing are major recreational pursuits in the area (Brewster Lake 1987).

2.3 Water Quality

- British Columbia Ministry of Environment, Lands and Parks (MELP) Lake Inventory files show no record of any previous inventories on Higgins Lake (BCMELP-FB-VIR 1996).

2.4 Wildlife

- Higgins Lake is in the Coastal Western Hemlock Biogeoclimatic Zone (British Columbia 1996) which is reported to be potentially the most productive region on Vancouver Island for Columbia blacktail deer (*Odocoileus hemionus columbianus*) and Roosevelt elk (*Cervus canadensis roosevelti*) (Diggle and Addison 1977).
- The MOF 1:20,000 Forest Cover Map 92K.003 shows that the forested land bordering the north, east and south shores of Higgins Lake is an Environmentally Sensitive Area (ESA) with a rating of E2W (Sayward Forest 1998). This flags the area as being of high value for wildlife.

2.5 Fisheries

- MELP Lake Inventory files show no record of any previous fish inventories on Higgins Lake (BCMELP-FB-VIR 1996).

2.6 Inlets and Outlets

- MELP Lake Inventory files show no record of any previous surveys on Higgins Lake tributaries (BCMELP-FB-VIR 1996).

3.0 Methods

3.1 Standards

This survey was conducted according to standards described in MELP's *Lake and Stream Inventory Standards and Procedures (DRAFT)* (BCMELP-FB-IU 1995). The service contract details changes made to these standards for the inventory of Higgins Lake which include the following:

- The lake and stream sample sites were specified in the service contract, and were not selected randomly.
- This lake was larger than 5 hectares and was therefore surveyed to a level similar to a primary lake survey as described in the Resource Inventory Committee (RIC) Manual *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (BCMELP-FB-IU 1997).
- Reach surveys were conducted at the first reach of the inlet streams and the reach of the outlet stream immediately below the lake.
- Mapping standards stipulate that only the streams that are indicated on Terrain Resource Information Management 1:20,000 (TRIM) maps should be mapped in the provincial GIS database. Any non-TRIM streams that were located in the field, appear in this report, but are only indicated on the GIS maps with a “tributary” symbol and stream summary symbol at the sample site location (BCMOF-FIS 1998).
- The 1996 DFO/MOE Stream Survey Form Site Cards were used for stream data collection. The MELP Lake Biophysical Data Form was used to record Lake Survey data. The Fish Collection Method and Data Form was used to record Fish data. The Photo Survey Form 1 and Form 2 were used to record photographic information. Field data was subsequently entered into Excel spreadsheets provided by MELP, except for the Site Card data which was entered into the DFO/MOE Stream Survey Data Entry Tool (Nelson version).
- A single, integrated water sample for laboratory analysis was collected on March 11, 1997, prior to thermal stratification of the lake. Field limnology data was measured when the laboratory samples were collected and during the lake survey on September 25, 1996.

The *Sayward Landscape Unit Fish and Fish Habitat Inventory Phase 2 Report* refines the project objectives and describes the project plan (Attachment 4).

3.2 Procedures

3.2.1 Bathymetry

- A 4 m aluminum skiff with a 6 horse-power outboard motor was used to conduct sounding transects for bathymetric mapping. A Lowrance X-16 recording depth sounder (Lowrance Electronics Inc., Tulsa, OK) was used at a boat speed of one meter/second to record sounding plots of the lake. Field data was then digitized and plotted by Pacific Spatial Systems Limited, using PC ARC/INFO and an ARCVIEW custom developed extension program.

3.2.2 Limnology

- EMS number E225633 was assigned to the limnology station at Higgins Lake by MELP in Nanaimo.
- Water chemistry samples were collected on March 11, 1997 in order to sample the lake during the period when lake nutrients were expected to be evenly mixed and most representative of the lake's character. To further minimize any effects of stratification, a single incremental water sample was collected at the deepest part of the lake. A hose (2.5 cm in diameter) was lowered from a boat to within 1 m of the lake bottom, sealed, then brought to the surface. The contents were then emptied into a bucket, and the water samples collected from the bucket. Water samples were immediately shipped via courier to Philip Analytical Services (Vancouver) for lab analysis.
- Field water chemistry measurements were collected during the lake survey on September 22, 1996 and again when the lab water sample was collected (Appendix 1). A Hanna Instruments Model HI 9024C pH meter (Hanna Instruments Inc., Wainscocket, RI) was used to measure pH at the surface; and a YSI Model 85-10 temperature/dissolved oxygen (temp/DO) meter with a 30 m probe (YSI Inc., Yellow Springs, OH) was used to measure the temperature, dissolved oxygen and specific conductance profile in the lake. Total alkalinity was measured using a Lamotte field titration kit (Lamotte Co, Chestertown, MD). A standard limnology Secchi disc (Wildco, Saginaw, MI) was used to obtain turbidity and water color information.

3.2.3 Stream Fish Samples

- A 2-person field crew electrofished the tributaries to collect fish information. Open-site electrofishing was conducted using a Smith-Root Model 12B Backpack Electrofisher (Smith-Root Inc, Vancouver, WA).
- Sampled fish were anesthetized using Alka Seltzer, measured and weighed to 0.1 grams (g) using an Acculab PP-159B (Newtown, PA) portable electronic balance, then released at the capture site.

3.2.4 Lake Fish Samples

- Fish samples were collected from the lake using a combination of gillnetting and minnow trapping. A 91.2m long by 2.4m deep sinking gillnet made up of standard variable-mesh gillnet gangs was set in the deepest basin during the day, although overnight sets were used if a larger sample was required. Baited minnow traps were set in a variety of lake habitats and left overnight.
- Fish collected by gillnet were weighed to 1 g using an Ohaus Model LS 2000 portable electronic balance (Ohaus Industries, Florham, NJ), fork length measured with a ruler, inspected for gonad maturation and photographed.
- Representative fish were kept as voucher specimens. Voucher specimens were submitted to Liparis Biological Services for confirmation of species identification (Attachment 8).

3.2.5 Fish Age and Growth

- Scale samples and length/weight data were collected from all fish up to a maximum of 30 fish. When the sample size exceeded the required 30 fish, a representative sub-sample of 30 was selected from the catch for scale samples, length and weight measurements, and fork length measurements were recorded for the remaining fish.
- Fish age was determined through scale analysis or in the case of small juveniles, through length-frequency distribution methods described in *MELP Lake and Stream Inventory Standards and Procedures (DRAFT)* (BCMELP-FB-IU 1995).
- Scale samples were aged and archived using a 3M Microfiche Viewer/Printer to produce enlarged printed images of the scales. The original scales were then replaced in the scale envelopes after the reading and attached to the photocopy enlargements for archival storage (Attachment 7).

3.2.6 Photodocumentation

- Photography information was recorded on the Photo Survey Forms 1 and 2 (Appendix). Original photographs and negatives were catalogued in binders (Attachment 1).
- Photographs were taken with a Pentax ME 35 mm single lens reflex camera (cameras #1 and #3), an Olympus AF-10, 35 mm camera (camera #2), and a Yashica Microtec 35 mm camera (camera #4).

3.2.7 Stream Reach Site Sampling

- A 50 m tape, meter stick and hip chain were used for all depth and length measurements of stream channels and obstructions. A Suunto clinometer was used for measuring stream gradients. Field water chemistry measurements included temperature, dissolved oxygen, specific conductance (YSI 85-10), pH (Hanna 9024C), and total alkalinity (Lamotte Titration Kit).

3.2.8 Digital Mapping

- GIS Interpretive Maps were produced by SRM-Levelton according to *MELP Standards for Fish and Fish Habitat Mapping Version 2.0* (BCMOF-FIS 1998) (Attachment 9).
- These digital 1:20,000 maps were created from the DFO/MOE (1996), FDIS and FISHCOLL (1997-1998) databases plotted on TRIM linework.

4.0 Results and Discussion

4.1 Logistics

- Reach identification and numbers were not available for the Campbell Watershed when this lake survey was conducted. Reach breaks for the reaches adjacent to Higgins Lake were established using TRIM maps and air photos, then verified in the field. The reach numbering however is independent of the rest of the watershed.

The sample site furthest downstream (in this case Higgins Lake) was labeled as Reach 101. The first reach of the main inlet stream (Site 13) was Reach 102. The first reach of the remaining tributary was labeled Reach 1. The Interpretive Maps (Attachment 9) indicate the correct reach numbers for the Campbell Watershed which are different from the ones used for the Higgins Lake Survey, therefore, the reach numbers are not referred to in this report. Sites are identified by watershed code and site number only.

- The DFO/MOE Stream Survey Form and Data Entry Tool used in this survey were designed for use with the old 37 digit watershed code. However, the Data Entry Tool stores the watershed codes without the hyphens between the number sequences (Spence pers. com.). Since the 45 digit watershed codes were used for stream identification during this project, they were used on the field cards and entered into the Data Entry Tool. The Stream Survey Reports in Appendix 1 appear to display 37 digit watershed codes, however, they contain the 45 digit watershed codes with the hyphens in the wrong places.
- During the field survey of Higgins Lake on September 24, 1996, a dry non-TRIM inlet stream on north shore of the lake was found. This stream was revisited on August 15, 1997 and although it was again dry, a DFO/MOE Stream Survey Form was completed for this inlet.
- The TRIM inlet on the east side of Higgins lake was dry during the initial survey on September 24-25, 1996 and therefor was not surveyed. This stream was revisited on August 15, 1997 and although it was dry again, it was surveyed. Due to inadequate flows, no fish sampling was performed in this inlet.
- The depiction of the outlet of Higgins Lake on TRIM map 92K.003 is not accurate. The Brewster Lake Road has backed the outlet stream up, so that the lake actually extends all the way to the road, and there is no longer an outlet stream. Therefor, a site card was not completed for the outlet stream. The culvert under the Brewster Lake Road connects the high water level of Higgins Lake to the high water level of Gosling Lake. During this survey the culvert was dry (Appendix 5).
- Because the outlet of Higgins Lake is mapped incorrectly, the UTM for the actual outlet differs from the UTM for the outlet derived from TRIM.
- Higgins Lake is frequented by canoe route users and several groups of paddlers moved through the lake during the field survey. Gillnetting effort was minimized (3 hours) to avoid interference with the canoeists.
- No voucher specimens of the unusually large threespine stickleback (*Gasterosteus aculeatus*) (TSB) were kept from Higgins Lake during the initial survey in 1996. On August 15-16, 1997 additional gillnetting was done to obtain TSB vouchers and to increase the sample size of coastal cutthroat trout (*Oncorhynchus clarki clarki*) (CCT).

4.2 Immediate Shoreline

- Higgins Lake is shaped like the letter “P” with a deep basin at the north end and a long narrow outlet bay at the south end.
- The lake edge is a low shoreline covered with coniferous forest.
- Logs floating out from shore are scattered around the lake edge.
- The lake shore drops off gradually to a gently sloping, soft bottom composed of organic fines, except in the north basin where the drop off is steep.

4.3 Terrain

- Higgins Lake has a glacial piedmont setting and is surrounded by gently rolling hills covered with a mixed second growth coniferous forest (40 to 60 year age class). The forest is predominantly Douglas fir except along the east side of the lake where western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) predominate.
- At the north end of the lake, there is a slight rise onto a rocky outcropping where the portage trail runs. There is a rustic camping area at the top of this rise.

4.4 Aquatic Flora

- The entire perimeter of the lake was rimmed with a 2 to 4 m band of sweet gale (*Myrica gale*) growing in the shallows to 0.5 m depths (Figure 2).
- Sedges (*Carex* spp.) were found along the lake edge, with heavier concentrations in the outlet bay at the south end of the lake.
- Yellow pond-lily (*Nuphar polysepalum*) and three-way sedge (*Dulichium arundinaceum*) grew sparsely along the lake edge.
- Watershield (*Brasenia schreberi*) and greater bladderwort (*Utricularia vulgaris*) predominated in the south outlet arm of the lake.

4.5 Site Location Summary

- Higgins Lake sample sites are summarized in Table 1 and located on the annotated air photograph of Higgins Lake (Figure 3). The Lake Biophysical Data Form is included in Appendix 1.

Table 1 Location and description of sample sites at Higgins Lake

Site #	Date	Location	Description
1	1996/09/24-25	Higgins Lake south outlet arm	Minnow trap #1
2	1996/09/24-25	Higgins Lake south outlet arm	Minnow trap #2
3	1997/08/15	Higgins Lake north inlet	DFO/MOE Stream Survey Form, electrofishing
4	1996/09/24	Higgins Lake south outlet arm	Minnow trap #3
5	1996/09/24-25	Higgins Lake south outlet arm	Minnow trap #4
6	1996/09/24-25	Higgins Lake south outlet arm	Minnow trap #5
8	1996/09/25	Higgins Lake deepest basin	Limnology station #1
9	1996/09/25	Higgins Lake north basin	Sinking gillnet #1
10	1996/09/25	Higgins Lake north basin	Sinking gillnet #2
11	1996/09/25	Douglas fir on north shore	Benchmark
12	1996/09/25	Centre of Higgins Lake	4-way lake panorama photographs
13	1997/08/15	Higgins Lake east inlet	DFO/MOE Stream Survey Form
14	1997/08/15	Higgins Lake north basin	Sinking gillnet #3
15	1997/08/15-16	Higgins Lake north basin	Sinking gillnet #4

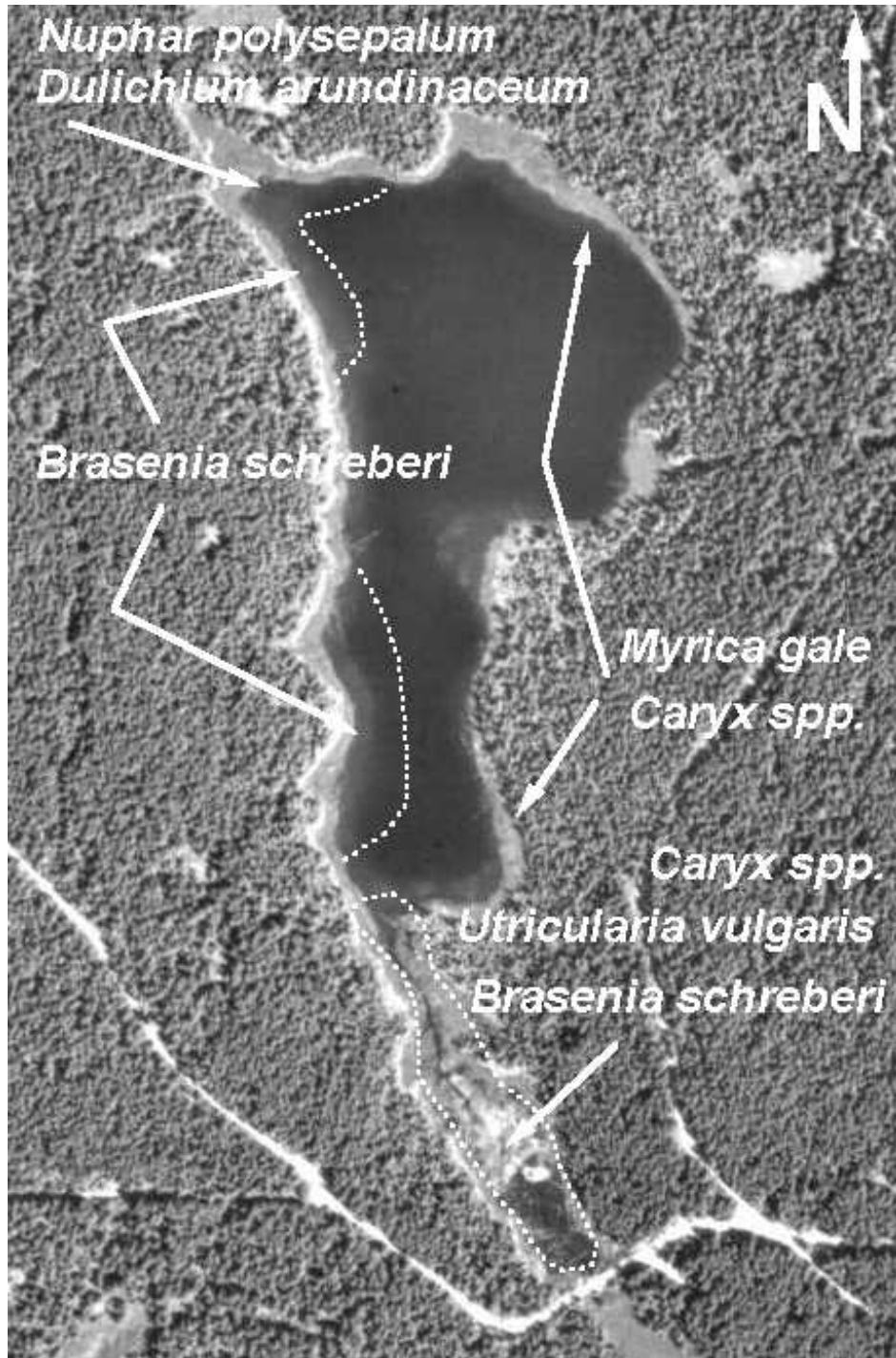


Figure 2 Location of macrophyte communities at Higgins Lake on 1996/09/22 shown on enlargement from air photo BCB 91031 #92, scale approximately 1:5,000

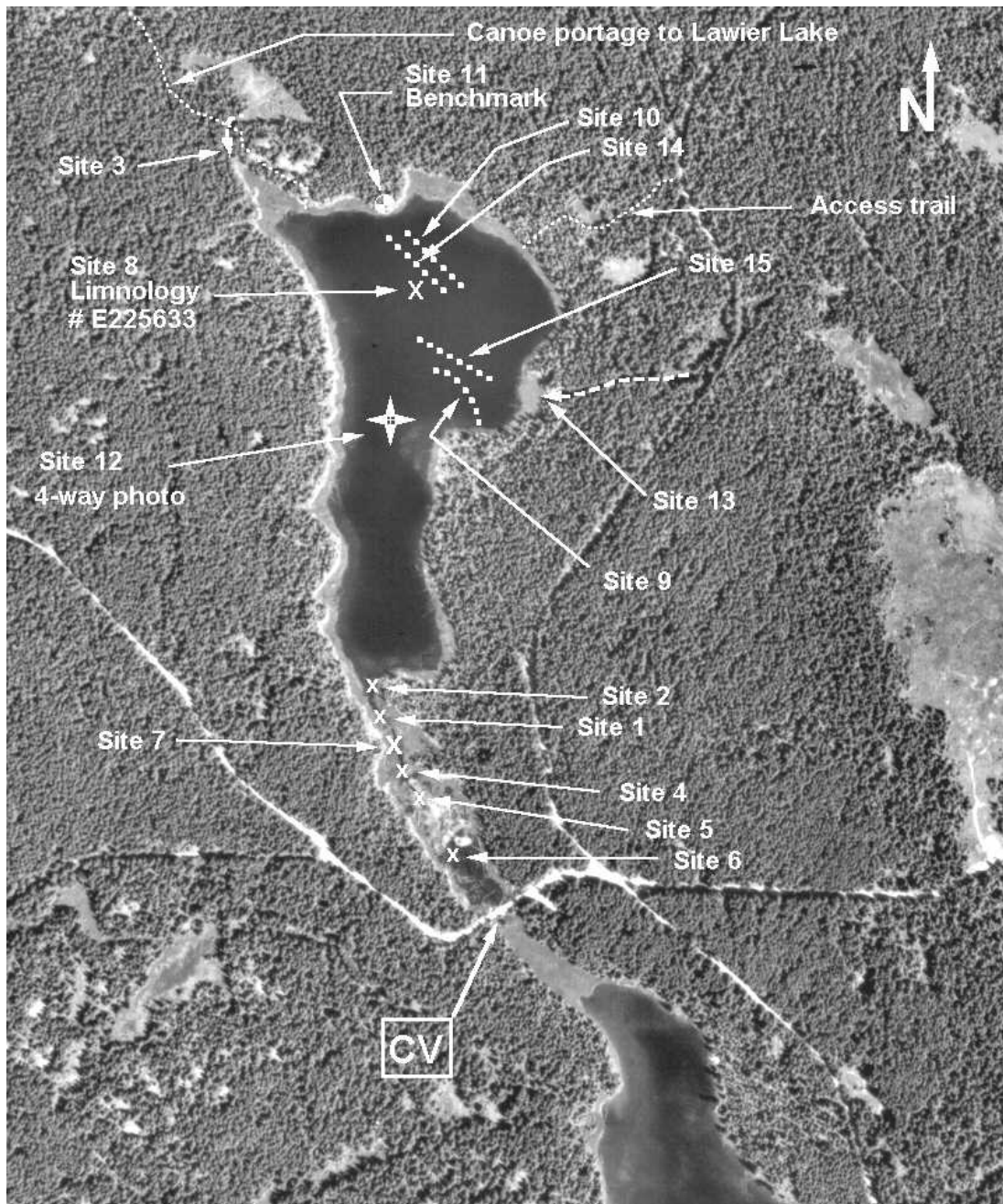


Figure 3 Location of sample sites and features at Higgins Lake on 1996/09/22 shown on enlargement from air photo BCB 91031 #92, scale approximately 1:8,000

4.6 Bathymetry

- The Higgins Lake bathymetric map, generated from the sounding transects shown in Figure 4, is shown in Figure 5 (“A” size) and Appendix 5 (“E” size).

4.7 Limnological Sampling

- Higgins Lake was still frozen during the week prior to March 11, 1997. The temperature profile found that the lake was isothermic during the collection of integrated water samples on this date varying only from 4.3 to 4.7°C.
- Water temperature and dissolved oxygen profiles for Higgins Lake were measured on September 25, 1996 and March 11, 1997. On September 25, 1996 the lake was stratified with the thermocline between 6 and 9m and was found to be anoxic below the 8m depth.
- Anoxic layers in the hypolimnion were encountered at numerous small lakes in the Sayward Forest during late-summer sampling (Lough and others 1999). The robust fish population in Higgins Lake indicates that these conditions do not have a pronounced effect on fish production.
- Results of the laboratory analysis of the water samples collected from Higgins Lake on March 11, 1997 are included in Appendix 2.

4.8 Inlets and Outlets

- Higgins Lake has 2 ephemeral inlets (1 is mapped on TRIM), and 1 ephemeral outlet (Table 2).
- The outlet stream of Higgins Lake is only the length of the culvert under the Brewster Lake Road, since the high water marks of Higgins and Gosling Lakes are on either side of this road. Therefor, the outlet was not surveyed. The culvert connecting Higgins and Gosling Lake (under the Brewster Lake Road) was dry on September 24-25, 1996. It is possible that there may have been some seepage through the road grade that was not evident by visible inspection.
- The north inlet (Site 3) was almost dry on September 24, 1996. On August 15, 1997 it was again dry, but a DFO/MOE Stream Survey was completed for this inlet on this date (Appendix 5).
- The east inlet (Site 13) was dry on September 24, 1996 and was not surveyed. On August 15, 1997 it was again dry, but a DFO/MOE Stream Survey was completed for this stream on this date. This intermittent stream connects Higgins Lake with Higgins Bog, 600m east of Higgins Lake (Lough and others 1999).

Table 2 Higgins Lake inlet and outlet streams

Stream Type	Site	Date	Mapped on TRIM	Flow Regime	Watershed Code	Order ¹
east inlet	13	1997/08/15	yes	intermittent	920-627900-29500	1
north inlet	3	1997/08/15	no	intermittent	920-627900-29500-85210	1

¹stream order is based on 1:20,000 TRIM map 92K.003

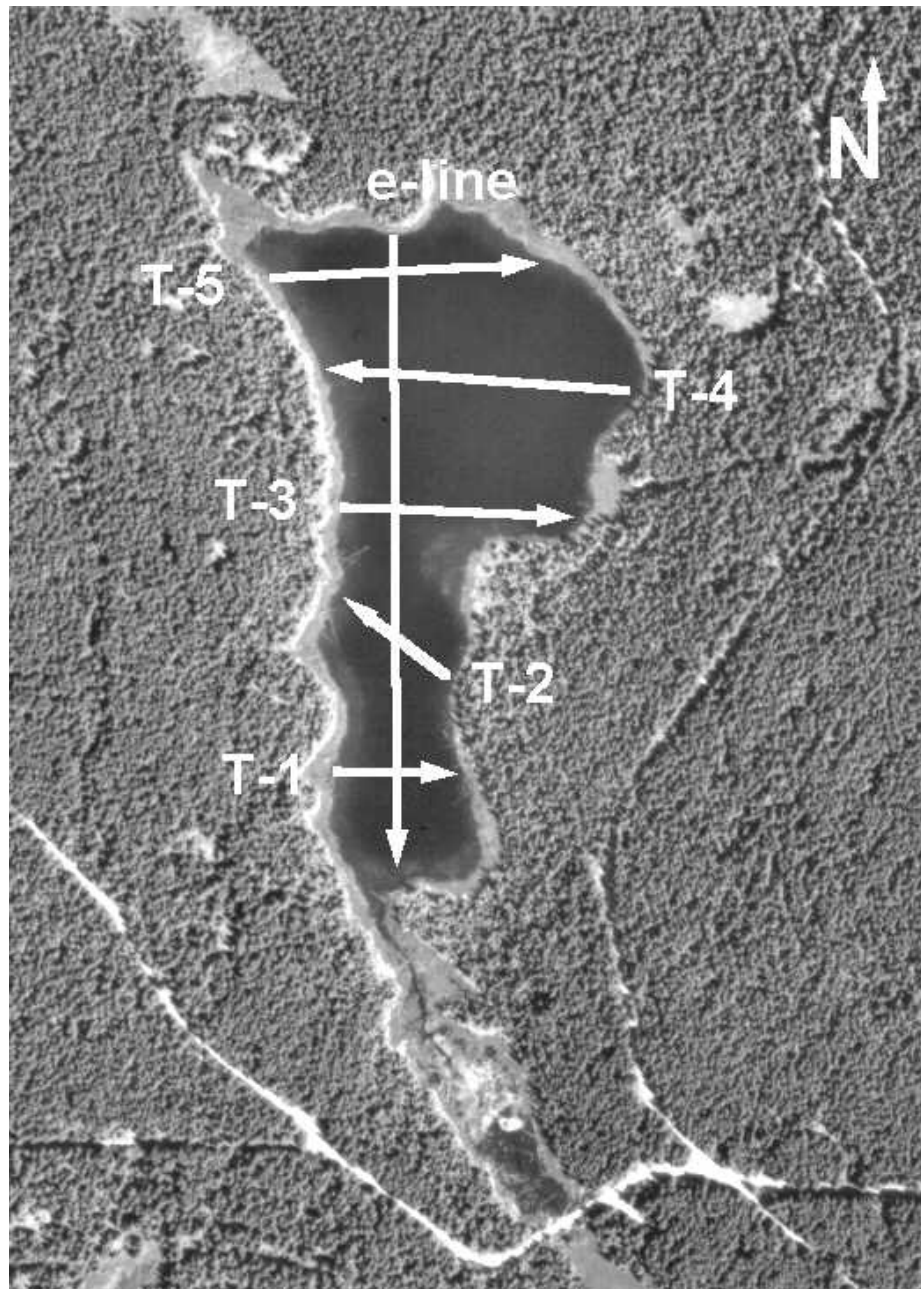


Figure 4 Location of depth sounding transects at Higgins lake on 1996/09/22 shown on enlargement from air photo BCB 91031 #92, scale approximately 1:5,000

4.9 Fish

4.9.1 Fish Sample Summary

- Overnight sets were made with 5 minnow traps in the south arm of Higgins Lake on September 24, 1996, which produced 7 threespine stickleback.
- A sinking gillnet was initially set for 2 hours (Site 9) on September 25, 1996 and 6 coastal cutthroat trout were caught. The net was reset in a different location (Site 10) in the deep north basin for 50 minutes and 28 threespine stickleback were caught in the small mesh of the net. Gillnetting effort was abbreviated because several recreational canoe groups were on Higgins Lake during the survey period.
- Higgins Lake was re-sampled on August 15-16, 1997 to obtain threespine stickleback vouchers from the lake and to increase the cutthroat trout sample size for a more robust age and growth analysis. A sinking gillnet was initially set for 5 hours and 10 cutthroat trout were caught (Site 14). The net was reset overnight (Site 15) and 31 additional cutthroat and 2 stickleback were caught.
- The 2 threespine stickleback were kept as voucher specimens which were submitted to Dr. McPhail at UBC (Attachment 8).
- The results of fish sampling at Higgins Lake are summarized in Table 3.

Table 3 Summary of fish sampling at Higgins Lake

Site #	Method	Date	Duration (hours)	# Fish	Species
1	minnow trap #1	September 24-25, 1996	19.6	4	TSB
2	minnow trap #2	September 24-25, 1996	19.6	0	--
4	minnow trap #3	September 24-25, 1996	17.3	2	TSB
5	minnow trap #4	September 24-25, 1996	17.1	1	TSB
6	minnow trap #5	September 24-25, 1996	17.0	0	--
9	sinking gillnet	September 25, 1996	2.0	6	CCT
10	sinking gillnet	September 25, 1996	0.9	28	TSB
14	sinking gillnet	August 15, 1997	4.8	10	CCT
15	sinking gillnet	August 15-16, 1997	30.2	2	TSB
				31	CCT

- On September 24, 1996 the north inlet stream (Site 5) was almost dry, and electrofishing produced no fish (Table 4).
- The east inlet could not be sampled for fish because it was dry both times it was visited (September 24, 1996 and August 15, 1997).

Table 4 Summary of fish sampling in Higgins Lake inlet streams

Site #	Watershed Code	Inlet/Outlet	Method	Date (Y/M/D)	Length sampled (m)	# Fish Caught	Species
3	920-627900-29500-85210	north inlet	electrofishing	1996/09/24	70	0	--

4.9.2 Fish Age, Size and Life History

- Table 5 summarizes the length and weight data for cutthroat trout sampled at Higgins Lake. The age of smaller fish that were not determined through scale analysis was determined from the length frequency distribution (Figure 6).

Table 5 Summary of age and growth data for fish sampled from Higgins Lake on September 24-25, 1996 and August 15-16, 1997

Species	Age	# Fish	Mean Fork Length (mm)	Fork Length Range (mm)	Mean Weight (g)	Weight Range (g)
CCT	1+	2	146	134 – 158	31	23 – 39
CCT	2+	4	212	179 – 229	91	43 – 118
CCT	3+	8	240	215 – 254	135	88 – 171
CCT	4+	13	273	241 – 334	212	141 – 377
CCT	5+	2	392	378 – 405	684	494 – 873

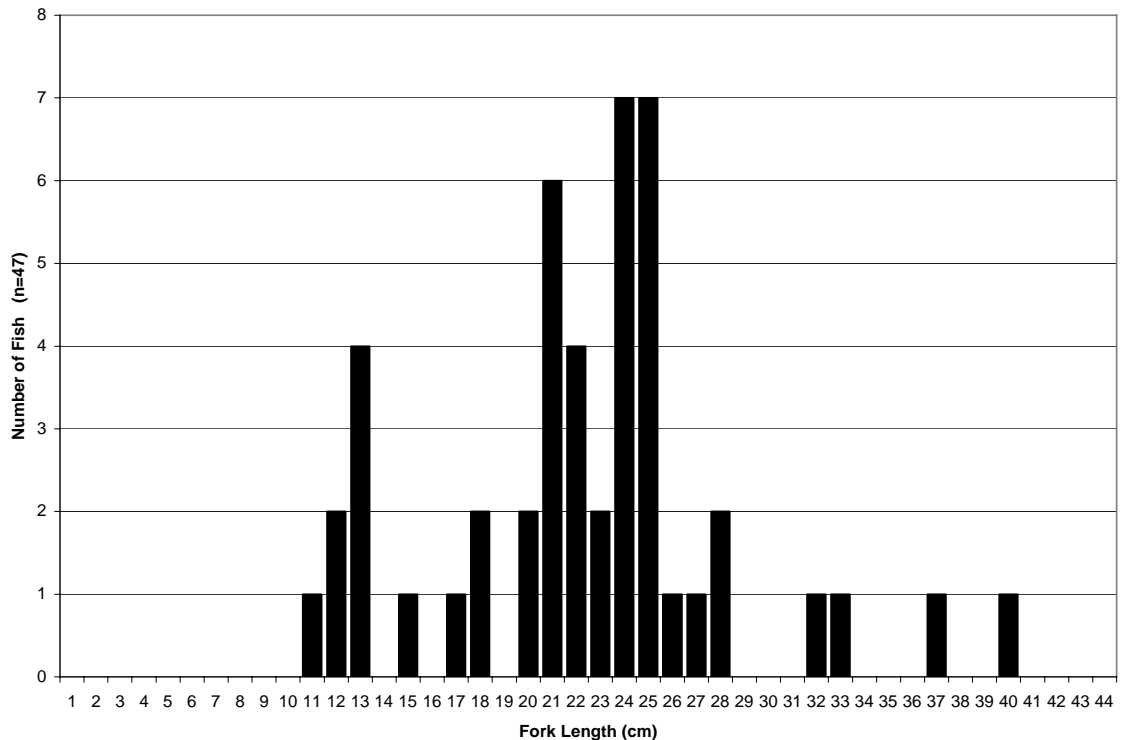


Figure 6 Length-frequency histogram of coastal cutthroat trout sampled at Higgins Lake in September 1996 and August 1997

- No cutthroat fry were captured at Higgins Lake.
- The threespine stickleback sampled from Higgins Lake attained lengths of 110 mm, and are therefore among the largest threespine documented to date (McPhail pers. comm.). The mean length of threespine sampled from Higgins Lake was 85.8mm, as compared to the 51.1mm average from all other lakes surveyed in the Campbell Watershed during this project combined (Lough and others 1999) (Table 6, Figure 7).
- The smaller stickleback were captured primarily with minnow traps in the shallows near shore, and the larger stickleback were captured in sinking gillnets near the middle of the lake. This suggests that there may be 2 separate populations of threespine stickleback in Higgins Lake, a smaller littoral form and the large limnetic form.

Table 6 Comparison of standard lengths of threespine stickleback sampled from Higgins Lake to a combined sample from elsewhere in the Campbell Watershed from 1996 to 1998

Sample Source	n	mean standard length (mm)	range (mm)
Higgins Lake	40	85.8	36-110
Campbell Watershed (excluding Higgins Lake)	37	51.1	28-79

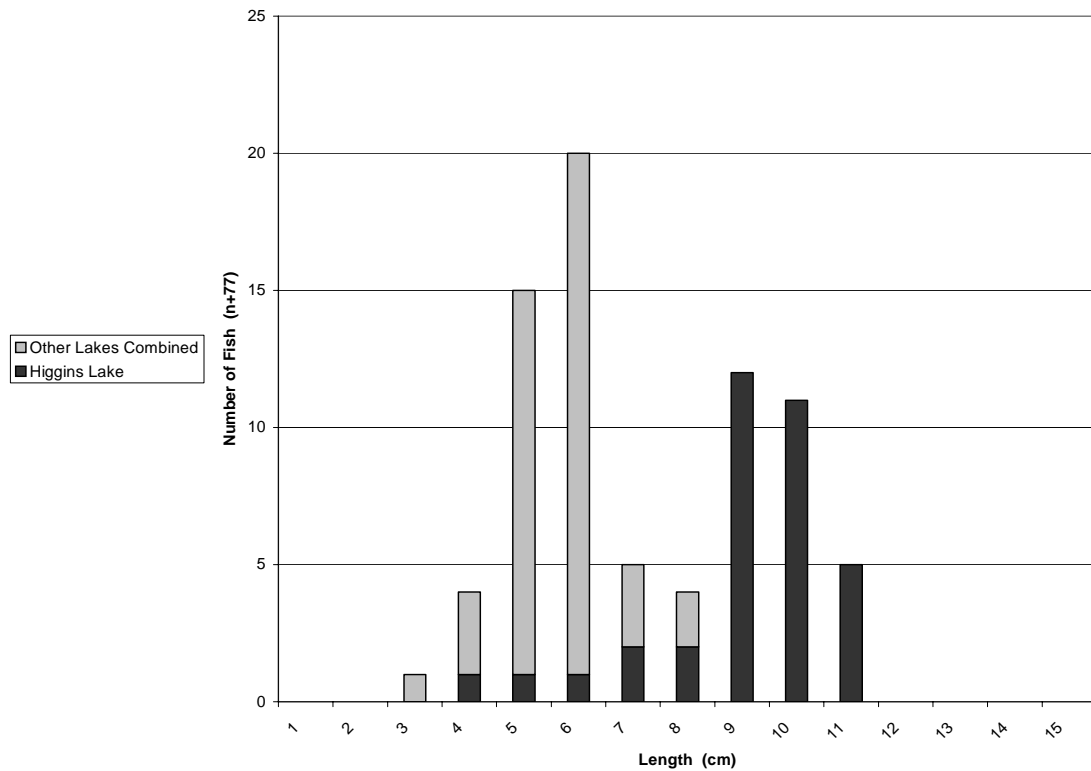


Figure 7 Length-frequency histogram of threespine stickleback sampled at Higgins Lake, and combined samples from elsewhere in the Campbell Watershed during 1996-1998

- During freshette conditions there is nothing to prevent the stickleback from Higgins Lake from moving downstream and into Gosling and Campbell Lakes. Therefore, the distribution of these unusually large stickleback may not be confined to just Higgins Lake.

4.9.3 Fish and Fish Habitat Comments

- Higgins Lake is inhabited by coastal cutthroat trout and threespine stickleback.
- The cutthroat trout populations in Higgins and Gosling Lake probably move back and forth between the 2 lakes during high flows (BCMELP-VFB-VIR 1996).
- Both of the inlet streams to Higgins Lake are intermittent and do not appear to provide significant trout spawning habitat. Higgins Lake may be dependent on Gosling Lake for the recruitment of juvenile trout.
- The stomach contents of the cutthroat trout gillnetted from Higgins Lake consisted of 52% threespine stickleback, 13% snails and clams and 4% aquatic insects.

4.9.3.1 Fisheries Sensitive Zones

- No fisheries sensitive zones were identified at Higgins Lake during this survey.

4.9.3.2 Restoration and Rehabilitation Opportunities

- The Brewster Lake Road backs up the outlet of Higgins Lake and appears to have raised the level of the lake. The culvert under this road crossing could be lowered to return flows in the outlet stream to pre-road construction levels, however, this would draw down Higgins Lake. Further investigation is recommended before any actions are implemented.

4.9.4 Sport Fishery Comments

- Higgins Lake has the potential to provide a high quality cutthroat trout sport fishery. It is near Campbell River and is situated in an appealing setting. Even though most of the lake is not visible from the road crossing at the outlet, a small boat can be launched from the 2-wheel drive road.
- Two sport anglers were present at Higgins Lake during the lake survey.
- The presence of older cutthroat trout in Higgins Lake may indicate that the harvest rate is not excessive in the present sport fishery.

4.10 Wildlife

- Bald eagles (*Haliaeetus leucocephalus*) and mallards (*Anas platyrhynchos*) were observed at Higgins Lake.

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APPENDIX 1

Lake Biophysical Data Form

APPENDIX 2

Water Chemistry Analysis

APPENDIX 3

Fish Collection Data and Method Forms

APPENDIX 4

DFO/MELP Stream Survey Reports and Site Photos

APPENDIX 5

Lake Photographs

APPENDIX 6

Bathymetric Map (E Size)