A reconnaissance survey of

# UNNAMED LAKE (L1)

## Marble River Watershed

(Watershed code 930-8652-100-299)
(Sequence no. 01)

Prepared for
MINISTRY OF ENVIRONMENT, LANDS AND PARKS
Region 1
Nanaimo, B.C.

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## EXECUTIVE SUMMARY

The British Columbia Ministry of Environment, Lands and Parks contracted Aquatic Resources Limited in 1996 to conduct standard MELP style reconnaissance surveys of five small unnamed lakes and two marshes located in the lower part of the Marble River watershed. The Marble River is located on northern Vancouver Island. Unnamed lake L1 is situated 19 km south of Port Hardy. It is accessible by two wheel drive vehicle with good ground clearance. The lake was surveyed on October 6 and 7, 1996.

Unnamed lake L1 is a small 240,000 $m^2$ lake with a drainage area of 2.6 $km^2$. The lake has a maximum depth of 22.4 m and a mean depth of 6.8 m. It is drained by a small unnamed creek (watershed code 930-8652-100-299) that flows southeast for 400 m before joining a larger creek, which drains three other lakes and two marshes that were also surveyed. This creek flows southeast for 1.4 km to the lower Marble River. There are two small tributaries flowing into the lake.

The lake lies within Tree Farm License #6 managed by Western Forest Products Ltd. The area to the north of the lake was logged in the late 1980's. This area was replanted with Douglas fir in 1990. Western hemlock and red cedar have regenerated naturally. The area to the south of the lake has not been logged. This area is forested mainly by 90 year old western hemlock.

Fish in the lake were sampled by gillnet and Gee traps. Threespine stickleback, cutthroat trout, kokanee and prickly sculpins were captured. Cutthroat trout juveniles were captured in one tributary to the lake. The lake may be inaccessible to anadromous fish as no coho were captured in the system. Cutthroat trout densities and sizes were moderate compared to cutthroat trout in the other lakes that were surveyed in the area.

An oxygen - temperature profile of the lake was made and water samples were collected and sent to a laboratory for analysis. Total phosphorus levels at the surface indicated the lake is oligo-mesotrophic. The pH is close to neutral.

There were signs of black bear, beaver, blacktail deer, ruffed grouse, marten and Stellar's jay in the area. Aquatic plants observed in the lake included *Utricularia vulgaris*, *Potamogeton natans*, *Potamogeton robbinsi*, *Nuphar polyseppalum* and *Nymphaea odorata*.

Of the five lakes and two marshes examined in the area, lake L1 has seen the most human activity in the form of sport fishing and logging. The lack of spawning and rearing habitat for cutthroat trout may be the greatest factor constraining the population.

Spawning and rearing habitat was only observed in one small tributary which has been impacted by logging. No spawning habitat was observed in the outlet which flows through marsh for at least 400 m. Logging of the remaining timber to the south of the lake will probably have no impact on fish populations as no tributary fish habitat was found in this area.

## ACKNOWLEDGEMENTS

This project was funded by Forest Renewal British Columbia through the Ministry of Environment, Lands and Parks. Arlene Tompkins of MELP was the contract authority and Tim Slaney of Aquatic Resources was the project manager. The field work was conducted by Rob Fielden and Rick Fielden. Stephanie Eagen and Rob Fielden aged the fish. Tracy Cardinal did the bathymetric mapping. Stephanie Eagen, Dan Gebhart, Bronwen Lewis and Arlene Tompkins reviewed and improved the report.

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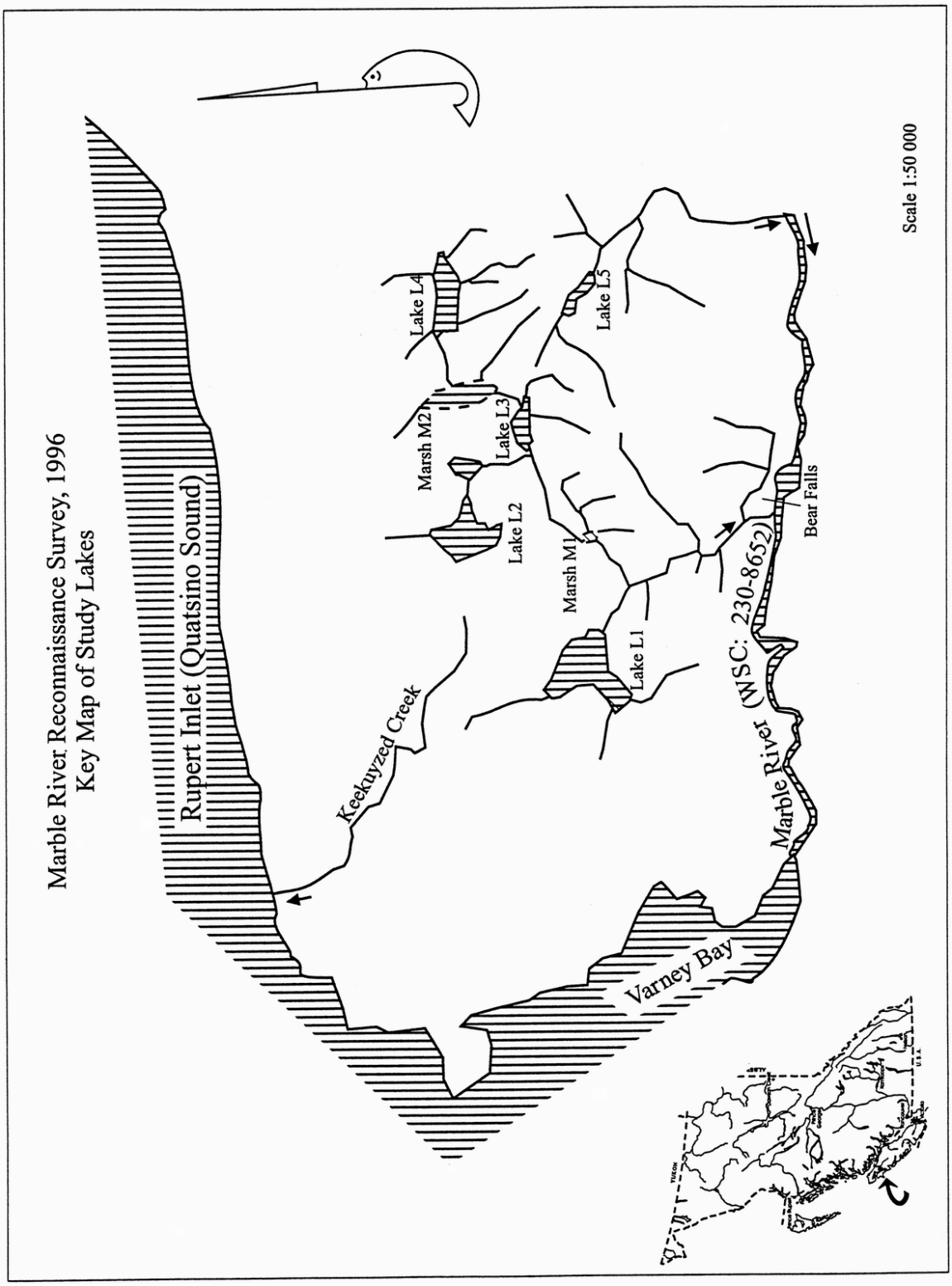
## 1.0 INTRODUCTION

The British Columbia Ministry of Environment, Lands and Parks (MELP) contracted Aquatic Resources Limited in 1996 to conduct standard MELP style reconnaissance surveys of five small unnamed lakes and two marshes located in the lower part of the Marble River watershed (Figure 1; Fielden 1997a-f). The Marble River is located on northern Vancouver Island south of Port Hardy. The lakes and marshes are all located within four kilometres of one another. The lakes were labelled unnamed lake L1, L2, L3, etc. in order from west to east and the marshes were labelled as unnamed marsh M1 and M2. All the waterbodies except lake L5 flow into a tributary of the Marble River which flows into the Marble River from the north, 3.2 km upstream from the mouth. Unnamed lake L5 flows into a separate tributary that flows into the Marble River from the north, 1.5 km downstream of Alice Lake. The surveys were conducted between October 6, 1996 and October 17, 1996, by Rob Fielden and Rick Fielden of Aquatic Resources Limited. Unnamed lake L1 was surveyed on October 6 and 7. The primary objective of the study was to collect information for fisheries and resource management. The procedures followed those outlined in in the B.C. Forest Practices Code and MELP Resource Inventory Committee standards and guidelines (RIC, 1995).

The Terms of Reference list the following tasks to be completed:

1) Inventory the lakes and their tributaries using standard MELP survey methods to collect baseline information.

2) Analyse the information and prepare standard reports with photographic documentation, bathymetric maps, baseline fisheries statistics and recreation opportunities.


Marble River Reconnaissance Survey, 1996
Key Map of Study Lakes
Rupert Inlet (Quatsino Sound)
Keekuyzed Creek
Varney Bay
Marble River (WSC: 230-8652)
Lake L1
Marsh M1
Lake L2
Marsh M2
Lake L3
Lake L4
Lake L5
Bear Falls
Scale 1:50 000

## 2.0 GEOGRAPHIC AND MORPHOLOGIC INFORMATION

### 2.1 Location

| | |
|---|---|
| Location: | 19 km south of Port Hardy, B.C. |
| Watershed name: | Unnamed lake L1 |
| Watershed code: | 930-8652-100-299 |
| Gazetted lake name: | none |
| Lake elevation: | 46 m +/- (TRIM map no. 92L.053) |
| Latitude/ longitude: | 50°33.02 N: 127°29.25 W |
| UTM at outlet: | 09.607505.5600649 |
| Sequence no.: | 01 |
| NTS map no.: | 92 L/11 |
| BCGS map no. | 92 L 053 |
| TRIM map no.: | 92L.053 (1994) |
| Biogeoclimatic zone: | Submontaine variant of the very wet maritime subzone in the Coastal Western Hemlock biogeoclimatic zone (CWHvm1). |
| MOE Region, district: | 1, Vancouver Island |
| Management units: | 1-13 |
| Fisheries planning unit: | West Coast Planning Unit |
| Native land claim areas: | none |
| MOF region, district: | Vancouver Region, Port McNeill District |
| Aerial photo survey no.: | 30 BC800066 No. 191 (year 1980) |

A Garmin 45 handheld GPS was used to determine the location of sample sites and lake features in the field. The map datum was NAD 83.

### 2.2 Data on file

The following sources were reviewed for information on lake L1:

1) Aerial photographs.

2) NTS 1:50,000 maps, TRIM 1:20,000 maps, Aquatic and biophysical maps, MINFILE maps and MoF forest cover maps.

3) The DFO-MELP Stream Information Summary System (SISS) and the DFO Salmon Escapement Database and Report System (SEDS) was reviewed for information. These two databases contained no information on lake L1 or it's tributaries.

4) DFO habitat management in Nanaimo had no information on file (Rick Higgins, DFO, pers. comm.).

5) Nanaimo and Port Hardy MELP files were examined. The files contained no information on lake L1.

6) A logging road map was obtained from Western Forest Products.

7) Western Forest Products (Port McNeill) was contacted for stream classification information and information on the five year logging plan. WFP has no new stream classification information for lake L1.

## 2.3 Lake drainage

Unnamed lake L1 is a small 239,700 $m^2$ lake with a drainage area of 2.6 $km^2$ (TRIM map no. 92L.053). The lake lies north of the Marble River and south of Rupert Inlet at an elevation of 46 m. The second order (based on the 1:20,000 TRIM map) outlet to the lake (watershed code 930-8652-100-299) flows southeast for 400 m to another second order unnamed creek (watershed code 930-8652-100). This creek flows for 1.4 km to the Marble River. It drains the unnamed marshes and lakes M1, M2, L2, L3 and L4. The confluence of the lake outlet creek with the Marble River is located 3.2 km upstream from the river mouth and approximately 200 m downstream of Bear Falls on the Marble River. The Marble River flows into Varney Bay in Rupert Inlet located on the west coast of Vancouver Island. There are three small first order tributaries flowing into the lake.

There were no areas of mass wasting in the lake L1 watershed and there are no other lakes or ponds in the watershed. Marsh habitat is prevelant around the perimeter of the lake, particularly around the outlet and near the mouth of tributary L1-T1 (Appendix E). Tributary L1-T2 drains a small marsh.

### 2.3.1 Stream habitat

The 1:20,000 TRIM (92L.053) map shows four tributaries to lake L1. Only two of these tributaries were found to exist. An unmarked tributary was found flowing into the northeast side of the lake. No coho were captured in the outlet creek, the tributaries or the lake which could indicate that the outlet creek has an obstruction.

#### 2.3.1.1 Assessment methods

Stream habitat was assessed following the Fish Habitat Inventory and Information Program format (FHIIP 1987). Ground estimates were made on habitat proportion, substrate composition, fish cover, bank height, bank stability, flood signs and amount of channel debris. Gradient was measured with a Suunto

clinometer. Channel widths were measured with a tape and stream depths under 1 m were measured with a metre stick. Six channel widths were generally taken at the sampling sites in accordance with Forest Practices Code procedures (BC Environment 1995). Depths over 1 m deep were visually estimated.

A Garmin 45 GPS was used to determine the positions of various features and samples sites. Water temperatures were measured with a hand held alcohol thermometer. Conductivity was measured with a Hanna CONMET 3291 ATC conductivity probe. pH was measured with a bromothymol blue freshwater pH test kit. Total alkalinity was measured with a Hanna 4811 alkalinity test kit.

Fish presence and absence were determined using a Smith-Root model 15-D backpack electrofisher. The shocking time, indicated by the electroshocker timer, was recorded for each site to provide a rough indication of relative abundance (catch per seconds shocked).

2.3.1.2 Outlet (watershed code 930-8652-100299)

The second order outlet to lake L1 is a low gradient creek (≈0%) that flows through marsh habitat for at least 600 m below the lake (Appendix E). A site 300 m below the lake was surveyed on October 7, 1996 (Table 1). The channel width averages 7.4 m in width and 110 cm in depth at this site (Table 1). The banks are composed entirely of fines, average 30 cm in height, and are stable. The creek had no detectable flow at the time of the survey. Sedge (*Cyperaceae*), hardhack (*Spiraea douglasii*) and small red cedar trees (*Thuja plicata*) grow in marsh habitat that is 10 to 15 m wide on either side of the creek. Aquatic vegetation is prevalent in the channel. No fish were captured when the site was shocked for 133 s (Tables 3 and 4), although the creek is deep (1 m) and not ideal for electroshocking. It is likely that some fish were present, possibly stickleback (*Gasterosteus aculeatus*), prickly sculpin (*Cottus asper*) and cutthroat trout (*Oncorhynchus clarkii*) but the deep pool habitat could not be effectively electroshocked. No other sampling technique was attempted. This reach appears to have little salmonid spawning habitat due to the fine substrate and the habitat is probably poor juvenile salmonid rearing habitat due to the lack of flow.

2.3.1.3 Tributary L1-T1 (watershed code -*930-8652-100-299*)

Tributary L1-T1 is a small creek that meanders through marsh habitat before flowing into the northwest corner of the lake (Appendix E). The riparian vegetation is dominated by hardhack and sedge. The creek has a channel width of 0.9 m and a depth of 0.3 m at a point 150 m upstream of the lake. It appeared

to have no discharge on October 7, 1996. The creek was choked with sedges which made it difficult to see the channel in some areas. A few stickleback were captured by electroshocker (Tables 3 and 4). The creek appears to have little salmonid spawning habitat due to the fine substrate and it is probably poor juvenile salmonid rearing habitat due to the lack of flow.

2.3.1.4 Tributary L1-T2 (watershed code - 930-865200-10000-29900-4383)

Tributary L1-T2, located on the southwestern shore of the lake, was dry when examined on October 7, 1996 and probably only has flow after periods of very heavy rain. The channel is not very distinct, as flows have been insufficient to create a well-defined channel in all areas. The area surrounding this tributary has not been logged. The riparian vegetation primarily is 90 year old western hemlock (*Tsuga heterophylla*) forest. The tributary does not appear to have any fisheries potential.

2.3.1.5 Tributary L1-T5 (watershed code - 930-865200-10000-29900-3495)

Tributary L1-T5 is not marked on the 1:20,000 TRIM map. This creek flows west through six year old second growth to the northeast side of the lake. The creek has a channel width of 2.6 m at the stream survey site and had a flow of 0.004 $m^3 \cdot sec^{-1}$ on October 13, 1996 (Table 1). The channel is confined and has flood signs 0.20 m above the water level. The banks are composed of fines and average 3 m in height. The stream channel is choked with grass, sedge and ferns and contains an abundance of LOD from logging. The substrate is mainly fines with some gravel. This tributary was the only creek draining into lake L1 where cutthroat juveniles were captured (Table 3 and 4).

Table 1. Summary of habitat characteristics of tributaries to unnamed lake L1.

| | Outlet | L1-T1 | L1-T5 |
|---|---|---|---|
| Site number | 1 | 1 | 1 |
| Length (km) | 0.6 | 0.6 | 0.3 |
| Channel width (m) | 7.4 | 0.9 | 2.6 |
| Wetted width (m) | 7.4 | 0.6 | 1.9 |
| Riffle depth (cm) | - | - | 5 |
| Pool depth (cm) | 110 | 32 | 21 |
| % pool | 100 | 100 | 80 |
| % riffle | 0 | 0 | 20 |
| % glide | 0 | 0 | 0 |
| % cascades | 0 | 0 | 0 |
| % rapids | 0 | 0 | 0 |
| Gradient (%) | 0 | 0 | 10 |
| Debris area (%) | 5 | 0-5 | 20 |
| % stable | 100 | 100 | 100 |
| % fines | 100 | 100 | 80 |
| % small gravel | 0 | 0 | 10 |
| % large gravel | 0 | 0 | 10 |
| % small cobble | 0 | 0 | 0 |
| % large cobble | 0 | 0 | 0 |
| % boulder | 0 | 0 | 0 |
| % bedrock | 0 | 0 | 0 |
| D90 (cm) | <0.2 | <0.2 | 5 |
| Total cover (%) | 80 | 80 | 100 |
| % deep pool | 0 | 0 | 0 |
| % LOD | 0 | 0 | 20 |
| % boulder | 0 | 0 | 0 |
| % instream veg. | 70 | 70 | 80 |
| % overstream veg. | 20 | 20 | 0 |
| % cutbank | 10 | 10 | 0 |

## 2.4 Access

The lake is a 45 minute (38 km) drive from Port Hardy. The lake can be reached by following the Varney Mainline running along the south shore of Rupert Inlet to Branch V500. Road V500 is a gravel road that has been cross-ditched. Because of this, it is open to two wheel drive vehicles with good ground clearance. Road V500 comes to within 100 m of the northeast side of the lake and is 30 m in

elevation above the lake. A rough trail runs down through the slash to the lake shore.

The lake is 15 km due southwest of the Port Hardy airport. A helicopter can land on the road next to the lake. The lake is too small for a float plane to land.

## 2.5 Physical data

| | | | |
|---|---|---|---|
| Lake drainage area: | 2.6 $km^2$ | Volume: | 1,621,500 $m^3$ |
| Water surface area: | 239,700 $m^2$ | *Flushing rate: | 0.2 years |
| Area above 6 m contour: | 109,000 $m^2$ | Perimeter of islands: | n/a |
| Shoreline perimeter: | 2800 m | Number of islands: | 0 |
| Maximum depth: | 22.4 m | Mean depth: | 6.77 m |
| Filterable residue (T.D.S.): | 39 - 60 $mg \cdot L^{-1}$ | Secchi disc: | 5.4 m |
| Sounding device: | Furuno FE 4300 | | |
| Elevation source: | TRIM map 92L.053 (1994) | | |

*The flushing rate is based on the long term mean annual rainfall at Port Alice = 3345.7 mm 1924 - 1990 (Environment Canada) and was calculated by dividing volume of the lake by the volume of water falling in the watershed per year. Lake water surface area, area above the 6 m contour, shoreline perimeter and lake volume was calculated by a computer program called Lakestat.

## 2.6 Benchmark

For a benchmark, a 20 cm long spike was driven into a 1 m diameter red cedar tree at UTM co-ordinates 09.606882.5600469, located at the south end of the lake. A Suunto clinometer and a measuring tape were used to determine the height of the benchmark above the water. The clinometer was placed on the bench mark and was used to site the level of the bench mark on the measuring tape which was held up from the edge of the water. The spike was 1.52 m above the water level. The spike was circled with red tree marking paint and a piece of aluminium flashing was nailed to the tree near the spike.

## 2.7 High water mark

The high water mark was 10 cm higher than the lake level and 1.42 m below the benchmark on October 6, 1996. The high water mark was determined from signs of erosion of the shore of the lake and from marks left on the vegetation and logs by high water levels.

## 2.8 Terrain and vegetation

### 2.8.1 Immediate shoreline

In most areas hardhack and sedge grow along the shore of the lake in a band that varies in width between 5 and 10 m. The vegetation grows right down to the lake shore all around the lake. There are no beaches. Salal (*Gaultheria ovatifolia*) and small red cedar trees grow thickly beyond the hardhack at the edge of the coniferous forest.

The lake is a T-shape. There are no islands. The bottom of the lake slopes down from the shore in most areas at between 10 and 20 °. The shores along the northwestern and southeastern arms slope more gradually and have a more extensive zone (50 m wide) of aquatic macrophytes. Cedar windfalls extend out into the lake all along the shore.

The bottom of the lake is uncompacted, fine organic sediment in all areas. This sediment extends up to the vegetation along the lake shore.

All along the shore is an abundance of cover for fish in the form of large woody debris and emergant, floating leaved and submergant vegetation. Stickleback appear to make the greatest use of the vegetative cover.

### 2.8.2 Surrounding country

Unnamed lake L1 lies in an area of relatively low relief with the highest hill in the watershed, 1 km to the northwest, rising to only 130 m above the lake. The lake lies in the coastal westen hemlock biogeoclimatic zone. The drainage area of the lake is 2.6 $km^2$. The area to the north has been extensively logged. This area was replanted in 1990 with Douglas fir (*Pseudotsuga menziesii*). Hemlock and red cedar have reseeded naturally and are also numerous. Fireweed and salal dominate the underbrush. A 10 m wide greenstrip of red cedar and hemlock trees to 0.7 m in diameter was left along the northeast side of the lake when the area was logged.

The rest of the area around the lake is unlogged and forested by a mixture of conifers that reflect two events. A forest fire swept through the area 180 years ago and then a storm knocked down 15,000 ha of timber in the Varney Bay area in 1906 (Kerry McGourlick, WFP, pers. comm.). Most of the timber around the lake is 90 year old western hemlock that grew up after the storm. Mixed in with the hemlock are numerous cedar snags and windfalls that are the remains of trees

killed in the fire. There are also a few 400 year old cedar and Douglas fir that survived the fire and the storm. As well, there are scattered 180 year old Douglas firs that grew up after the fire and survived the 1906 storm, and scattered 90 -180 year old sitka spruce (*Picea sitchensis*) and amabilis fir (*Abies amabilis*). There are few understory plants in the areas dominated by 90 year old hemlock because of the dense canopy. The understory is thick at the edges of the coniferous forest along the larger creeks, around the lakes and marshes. The understory in these areas is dominated by salal and salmonberry. The understory is also quite thick in some areas which are dominated by older trees that survived the 1906 storm. One such area is at the southwest end of the lake, where the side hill slopes up at 27° and is overgrown with larger red cedar, hemlock and scattered Douglas fir trees.

There are small bogs around the lower reaches of tributary L1-T2 and between tributary L1-T5 and the outlet. Labrador tea, sphagnum moss, salal, crowberry, ferns and scattered small cedars are dominant in the bogs.

## 3.0 DEVELOPMENTS

### 3.1 Land status

The area surrounding lake L1 is crown land and is part of Tree Farm License (TFL) #6 managed by Western Forest Products Ltd. The lake is within the Kwakiutl Tribal Group - Quatsino Band consultation area. Logging around the lake has opened up the lake and surrounding area for recreation but it has negatively changed the aesthetics of the lake through the construction of roads and the removal of timber in the northeastern side of the watershed.

### 3.2 Development and land use

#### 3.2.1 Resorts and campsites

There are no resorts or camping facilities on the lake. The remains of campfires along the road above the lake indicate that some people may have been camping there, but the lake does not appear to be heavily used by campers. At one time people camped in the bog near the mouth of tributary L1-T5. Campers built an elevated tent platform, wharf and a few other structures in the bog near the mouth of tributary L1-T5. This site has not been used for several years.

### 3.2.2 Timber harvest

Unnamed lake L1 lies within Tree Farm License #6 managed by Western Forest Products. The area to the north of the lake has been logged and was replanted in 1990. The rest of the area around the lake is unlogged. No logging is planned for the area around lake L1 in the 1996 -2000 five year logging plan (Phillip Wainwright, WFP, pers. comm.).

### 3.2.3 Traplines

Unnamed lake L5 lies within licence TR0113T807 (Trapline map 92L NW/SW) Marten (*Martes americana*) is the main species of interest, although river otter (*Lontra canadensis*), raccoon (*Procyon lotor*), and mink (*Mustela vison*) are also likely present (Karen Morrison, pers. comm.).

### 3.2.4 Waste permits

There are no waste permits for the area around lake L1.

### 3.2.5 Water permits

There are no water permits for lake L1.

### 3.2.6 Mining claims

The mineral occurrence map (1:250,000 Minfile Map 092L - updated May 1996, B.C. Ministry of Energy, Mines and Petroleum Resources) indicates that the area surrounding unnamed lake L1 is comprised of a variety of rock laid down in the upper Triassic period called the Vancouver group. The area to the east of the lake and the eastern half of the lake is of the Karmutsen formation which is comprised of basaltic lava, pillow lava, breccia, aquagene tuff, greenstone and minor limestone.

There are no producing mines, past producing mines, developed prospects, prospects or showings in the unnamed lake L1 watershed. There are several prospects and showings and one mine within 5 km of the lake mainly involving copper. The mine is a large open pit mine called Island Copper, owned by BHP Minerals. It is situated along the northern shore of Rupert Inlet, 5 km to the north of Unnamed lake L1. This mine is in the process of being deactivated and will be shut down in 1997.

3.2.7 Recreation resource inventory

The lake is regularly used for fishing. It has a population of cutthroat trout that are of moderate size but not as numerous as other lakes surveyed in the area.

The soft muddy bottom along the shore makes the lake less suitable for swimming, however there are the remains of several rafts and a diving platform that people have been using. Only small boats such as canoes are used on the lake as boats have to be packed into the lake along the 100 m long trail.

Several hunters were noticed in the area during the survey. Black bears (*Ursus americanus*) appear to be prevalent but few deer (*Odocoileus sp.*) or grouse were observed.

Logging has negatively impacted the aesthetics of the lake through the removal of timber and the construction of roads along the northeast side. The area around the rest of the lake is unlogged and is moderately scenic.

3.2.8 Special regulations and restrictions

No special restrictions are listed in the April 1, 1996, to March 31, 1997, British Columbia Freshwater Fishing Regulations Synopsis. The general regulations and daily catch/possession quotas apply to this lake.

## 4.0 FISH POPULATION SAMPLING

### 4.1 Fish capture methods

4.1.1 Gillnets

Two standard BC MELP gillnets (RIC 1995) were used to sample fish in the lake. These nets, a sinking net and a floating net, were each 91.2 m long, 2.4 m deep and consisted of 6, 15 m long panels of different mesh sizes (25, 76, 51, 89, 38 and 64 mm stretch mesh). The nets were set during the day at two sites. The nets were pulled in the evening and reset the following day for a few hours to avoid over fishing this small lake.

Sinking gillnet:

| | | | |
|---|---|---|---|
| Site 6 | | Site UTM: | 09.607324.5601014 |
| Date set: | Oct. 6, 1996 | Time set: | 14:00 |
| Date lifted: | Oct. 6, 1996 | Time lifted: | 17:00 |
| Date set: | Oct. 7, 1996 | Time set: | 09:00 |
| Date lifted: | Oct. 7, 1996 | Time lifted: | 11:00 |
| Total soak time: | 5 h | Distance from shore: | 15 m |
| Shallow end depth: | 7 m | Shallow end substrate: | organic ooze |
| Deep end depth: | 17 m | Deep end substrate: | organic ooze |
| Deep end mesh size: | 89 mm | Shallow end mesh size: | 25 mm |

Floating gillnet:

| | | | |
|---|---|---|---|
| Site 7 | | Site UTM: | 09.607363.5600682 |
| Date set: | Oct. 6, 1996 | Time set: | 14:00 |
| Date lifted: | Oct. 6, 1996 | Time lifted: | 17:00 |
| Date set: | Oct. 7, 1996 | Time set: | 09:00 |
| Date lifted: | Oct. 7, 1996 | Time lifted: | 11:00 |
| Total soak time: | 5 h | Distance from shore: | 6 m |
| Shallow end depth: | 2 m | Shallow end substrate: | organic ooze |
| Deep end depth: | 9 m | Deep end substrate: | organic ooze |
| Deep end mesh size: | 89 mm | Shallow end mesh size: | 25 mm |

### 4.1.2 Gee traps

Ten Gee minnow traps were set along the shore of the lake at two sites (Appendix E; Table 2). The traps were baited with salmon roe and left to fish over night.

| | | | |
|---|---|---|---|
| Site 1 | | Site UTM: | 09. 60861.35601846 |
| Date set: | Oct. 6, 1996 | Time set: | 16:10 |
| Date lifted: | Oct. 7, 1996 | Time lifted: | 09:15 |
| Total soak time: | 16.5 h | Number of traps: | 4 |

| | | | |
|---|---|---|---|
| Site 2 | | Site UTM: | 09. 606973.5601093 |
| Date set: | Oct. 6, 1996 | Time set: | 16:20 |
| Date lifted: | Oct. 7, 1996 | Time lifted: | 09:15 |
| Total soak time: | 16.5 h | Number of traps: | 6 |

Table 2. Habitat characteristics of the areas where Gee traps were set in lake L1.

| Trap no. | Depth (m) | Substrate | Cover type | Distance to shore (m) | Distance to cover (m) |
|---|---|---|---|---|---|
| 1 | 1 | fine | brush | 4 | 3 |
| 2 | 1 | fine | LOD | 1 | 0 |
| 3 | 0.5 | fine | brush | 0 | 0 |
| 4 | 1.5 | fine | LOD | 10 | 0 |
| 5 | 0.8 | fine | brush | 1 | 0 |
| 6 | 0.8 | fine | brush | 1 | 0 |
| 7 | 0.8 | fine | brush | 1 | 0 |
| 8 | 0.8 | fine | brush | 1 | 0 |
| 9 | N/R | fine | brush | 1 | 0 |
| 10 | N/R | fine | brush | 1 | 0 |

N/R - not recorded; LOD - large organic debris

4.1.3 Electrofishing

A Smith-Root model 15-D backpack electrofisher was used to determine fish presence and species composition in two lake tributaries and the lake outlet (Table 3).

Table 3. Electrofishing data for the outlet and tributaries of lake L1, October 7 and 13, 1996.

| Location | Site no. | UTM | Shocking time (sec) | Area shocked ($m^2$) | Temp. (°C) | Cond. ($\mu S \cdot cm^{-1}$) | Shocker settings |
|---|---|---|---|---|---|---|---|
| L1-T1 | 5 | 09. 606851.5601189 | 344 | N/R | 10.5 | | L4, 500V |
| Outlet | 3 | 09.607736.5600520 | 133 | N/R | 14.0 | 73 | L4, 500V |
| L1-T5 | 4 | 09.607730.5600930 | 305 | 13 | 11.0 | 135 | L5, 500V |

N/R - not recorded

## 4.2 Catch summary/species composition

Threespine stickleback (*Gasterosteus aculeatus*), cutthroat trout, kokanee (*Oncorhynchus nerka*) and prickly sculpin (*Cottus asper*) were the species of fish that were captured in the lake and its tributaries (Table 4, Appendix A). The lack of coho may indicate that the lake is inaccessible to anadromous fish.

Table 4. Unnamed lake L1 and lake L1 inlets and outlet fish catch summary, October 1996.

| Location | Site | Capture technique | Stickleback | Cutthroat trout | Prickly sculpin | Kokanee |
|---|---|---|---|---|---|---|
| L1-T1 | 5 | EL | 2 | 0 | 0 | 0 |
| L1-T5 | 4 | EL | 0 | 9 | 0 | 0 |
| Outlet | 3 | EL | 0 | 0 | 0 | 0 |
| Lake | 7 | F-GN set 1 | 0 | 8 | 0 | 0 |
| Lake | 7 | F-GN set 2 | 0 | 10 | 0 | 2 |
| Lake | 2 | MT | 0 | 0 | 3 | 0 |
| Lake | 1 | MT | 40 | 0 | 9 | 0 |
| Lake | 6 | S-GN set 1 | 0 | 1 | 0 | 0 |
| Lake | 6 | S-GN set 2 | 0 | 0 | 0 | 1 |

EL - electroshocker F-GN - floating gillnet MT - minnow trap S-GN - sinking gillnet

## 4.3 Relative abundance

The two gillnets set in the lake averaged 1.9 trout·$h^{-1}$·$net^{-1}$ and 0.3 kokanee·$h^{-1}$·$net^{-1}$ during day light hours (Tables 5 and 6). Most of the fish were captured in the floating net. The minnow traps caught 4.0 stickleback and 1.2 prickly sculpins per trap per overnight set. Most of these fish were captured at one site (Table 4).

Table 5. Average size and weight, by cohort, of salmonids caught in lake L1 floating and sinking gillnets.

| Species | Age | Total catch | Average length (mm) | Average weight (g) | Length range (mm) |
|---|---|---|---|---|---|
| CT | 1 | 1 | 147 | 28.9 | - |
| CT | 2 | 2 | 188 | 61.4 | 185-191 |
| CT | 3 | 14 | 217 | 103.9 | 189-262 |
| CT | 4 | 1 | 258 | 173.8 | - |
| CT | 5 | 1 | 286 | 254.3 | - |
| KO | 2 | 2 | 167 | 57.0 | 164-170 |

CT - cutthroat KO - kokanee

Table 6. Catch per unit effort for gillnets set in lake L1 on October 6-7, 1996.

| Gear type | Time (h) | Catch per unit effort (fish·h$^{-1}$·net$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cutthroat trout | | | Kokanee | | |
| | | age | # of fish | CPUE | age | # of fish | CPUE |
| F-GN | 5 | 1 | 1 | 0.2 | 1 | 0 | 0.0 |
| F-GN | 5 | 2 | 4 | 0.4 | 2 | 2 | 0.4 |
| F-GN | 5 | 3 | 8 | 2.6 | 3 | 0 | 0.0 |
| F-GN | 5 | 4 | 4 | 0.2 | 4 | 0 | 0.0 |
| F-GN | 5 | 5 | 1 | 0.2 | 5 | 0 | 0.0 |
| S-GN | 5 | 3 | 1 | 0.2 | 2 | 1 | 0.2 |
| Both GN | 5 | all | 19 | 1.9 | 2 | 3 | 0.3 |

F-GN - floating gillnet S-GN - sinking gillnet

Compared to other systems sampled in the area, catches of trout per unit effort were low (Table 7). Lake L3 and marsh M1 had catch rates of 21.3-22.0 fish·h$^{-1}$·net$^{-1}$ compared to 1.9 fish·h$^{-1}$·net$^{-1}$ in lake L1.

Table 7. Catch per unit effort (fish·h$^{-1}$·net$^{-1}$) for gillnets set in various lakes in the lower Marble River area, October 6-17, 1996.

| System | Dolly Varden | Cutthroat trout | Coho | Kokanee |
|---|---|---|---|---|
| Lake L1 | 0 | 1.9 | 0 | 0.3 |
| Lake L2 | 0 | 0.0 | 0 | 0 |
| Lake L3 | 0 | 21.3 | 0 | 0 |
| Lake L4 | 0 | 1.7 | 0 | 0 |
| Lake L5 | 0.2 | 0.9 | 0.7 | 0 |
| Marsh M1 | 0 | 22.0 | 0 | 0 |
| Marsh M2 | 0 | 0.6 | 0 | 0 |

### 4.4 Size, age, growth, sexual maturity and condition

Fish fork lengths were measured on a measuring board (±0.5 mm) and then the fish were weighed on an Ohaus C305 portable electronic scale (±0.1 g.). Scale samples were taken from a sample of sport fish from each size class. The scales were placed between labeled microscope slides and read using a microscope. The ages of the fish that were sampled were used to extrapolate the ages of the rest of the fish measured so that mean sizes for each age group could be calculated. The scales were read by Stephanie Eagen and Rob Fielden who have read scales over the past few years for Aquatic Resources. When age discrepancies occurred

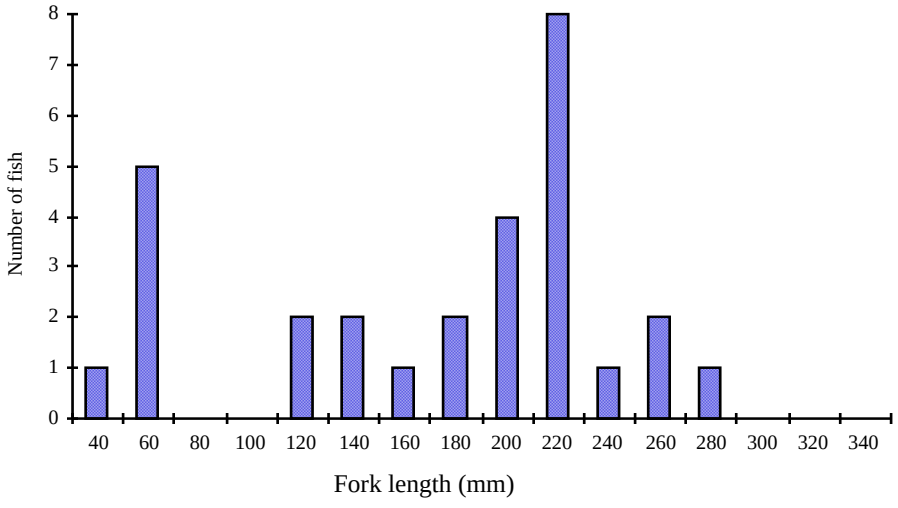
between the two readers, the scales were reassessed a third time by Rob Fielden and given a final age.

Condition factor (K) was calculated for cutthroat trout and the other species of fish where $K = 100(W)\cdot(L)^{-3}$ (W = weight in grams and L = fork length in cm; Ricker 1975).

### 4.4.1 Salmonids

A total of 28 cutthroat trout were sampled from lake L1 and tributary L1-T5 (Figure 2, Table 8, Appendix A). These fish ranged in size from 50 to 286 mm and in age from 0+ (no winter annulus; Mackay and Ash 1990) to age 5+ (five winter annuli). Age 0+ and 1+ trout were captured in tributary L1-T5. All of the trout caught in the lake were age 2+ and older except for one age 1+ fish. The majority of trout captured in the lake (74%) were age 3+. The fork length of lake L1 cutthroat trout of all age classes averaged 216 mm (n=19, stdev=31 mm) and was of moderate size compared to other systems sampled in the area (Table 9). Within the 3+ age class, lake L1 cutthroat trout averaged 217.3 mm (n=14, stdev=19.1 mm) and slightly less than the average mean size of age 3+ cutthroat trout sampled from four lakes and one marsh in the area (mean length=221.5 mm, stdev=22.3 mm). Sixty percent of the lake L1 trout were maturing and would spawn next spring, while the rest were at least one year from spawning. Females comprised 68% of the catch.

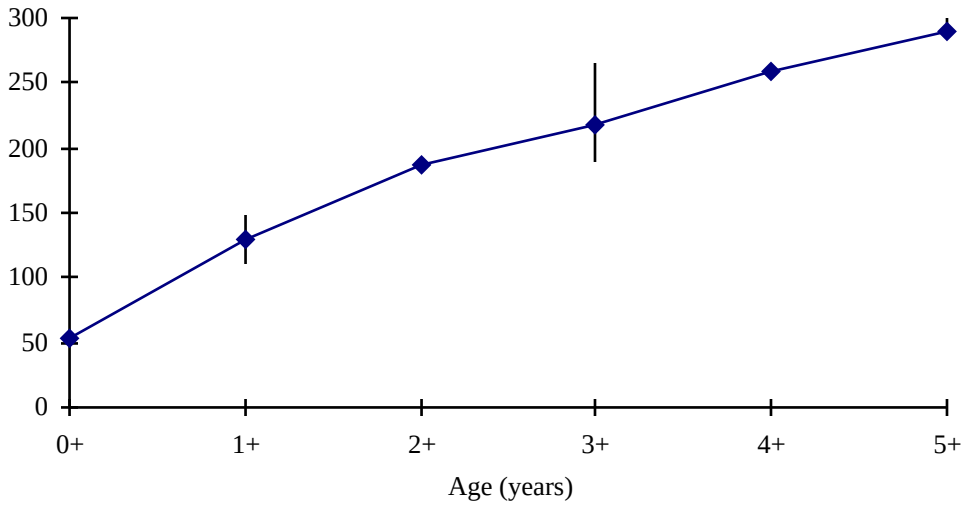
Figure 2. Length-frequency distribution of cutthroat trout captured from unnamed lake L1 and tributary L1-T5, October 6, 1996.



The cutthroat captured from lake L1 and its tributary had a mean condition factor of 0.99 (n=28, stdev=0.99; Table 8) which was similar to the mean K for cutthroat trout captured from the seven lakes and marshes in the area (K=1.01, n=112, stdev=0.08).

The growth of cutthroat trout is illustrated by Figure 3. The curve is unusual in that it shows almost linear growth. One would expect a jump in the growth rate between age 1+ and age 2+ when the fish move from a stream environment to a lake environment and then a slowing of growth in the older age classes. The upper part of the curve may not be an accurate reflection of actual growth as there is only one sample for each of the 4+ and 5+ age classes. An error in the aging of either of these two fish would change the curve.

Figure 3. Mean fork length with ranges of each age class of cutthroat trout captured from lake L1 and its tributary L1-T5.




Three kokanee were captured in the lake (Table 8, Appendix A). These fish were all age 2+ and ranged in size from 135 to 170 mm. The one male was mature and the two females were immature.

4.4.2 Non-salmonid species

Prickly sculpins captured from the lake ranged in size from 85 to 116 mm (n= 11, Table 8, Appendix A). Threespine stickleback ranged in size from 35 to 86 mm (n= 25).

Table 8. Length, weight and condition factor (K) statistics for fish caught in lake L1 and tributaries to the lake, October 1996.

| | | | Fork length (mm) | | | | Weight (g) | | | | Condition (K) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Age | Count | Average | Standard deviation | Minimum | Maximum | Average | Standard deviation | Minimum | Maximum | Average | Standard deviation | Minimum | Maximum |
| TSB | All | 25 | 66.4 | 10.0 | 35 | 86 | 2.72 | 1.16 | 0.30 | 5.50 | 0.86 | 0.10 | 0.68 | 1.05 |
| CAS | all | 11 | 101.5 | 10.1 | 85 | 116 | 10.91 | 3.45 | 5.70 | 16.30 | 1.01 | 0.11 | 0.80 | 1.19 |
| CT | all | 28 | 171.6 | 73.4 | 50 | 286 | 75.13 | 63.78 | 1.20 | 254.30 | 0.99 | 0.05 | 0.91 | 1.09 |
| CT | 0+ | 6 | 54.2 | 2.3 | 50 | 56 | 1.62 | 0.24 | 1.20 | 1.90 | 1.01 | 0.04 | 0.96 | 1.08 |
| CT | 1+ | 4 | 129.8 | 15.2 | 111 | 147 | 22.00 | 6.85 | 13.20 | 28.90 | 0.98 | 0.06 | 0.91 | 1.04 |
| CT | 2+ | 2 | 188.0 | 4.2 | 185 | 191 | 61.35 | 3.75 | 58.70 | 64.00 | 0.92 | 0.01 | 0.92 | 0.93 |
| CT | 3+ | 14 | 217.3 | 19.1 | 189 | 262 | 103.93 | 30.54 | 63.80 | 182.50 | 0.99 | 0.04 | 0.91 | 1.05 |
| CT | 4+ | 1 | 258.0 | - | 258 | 258 | 173.80 | - | 173.80 | 173.80 | 1.01 | - | 1.01 | 1.01 |
| CT | 5+ | 1 | 286.0 | - | 286 | 286 | 254.30 | - | 254.30 | 254.30 | 1.09 | - | 1.09 | 1.09 |
| KO | 2+ | 3 | 156.3 | 18.7 | 135 | 170 | 47.10 | 18.01 | 27.30 | 62.50 | 1.18 | 0.08 | 1.11 | 1.27 |

Species codes: TSB - threespine stickleback, CAS - prickly sculpin, CT - cutthroat trout, KO - kokanee

Table 9. Comparison of cutthroat trout sizes captured from various lakes in the lower Marble River area, October 6 - 17, 1996.

| System | n | Fork length (mm) | Standard deviation (mm) |
|---|---|---|---|
| Lake L1 | 19 | 216 | 31 |
| Lake L3 | 34 | 199 | 29 |
| Lake L4 | 19 | 273 | 55 |
| Lake L5 | 11 | 252 | 39 |
| Marsh M1 | 26 | 174 | 29 |
| Marsh M2 | 3 | 189 | 10 |

## 5.0 LIMNOLOGICAL SAMPLING

### 5.1 Methods

A limnological station was established at the deepest point (21.5 m) in the lake (Appendix E). Limnological data were collected at 14:30 on October 6, 1996. The following measurements were made:

- Water clarity was measured with a 20 cm diameter black and white Secchi disk. Each crew member independently made a measurement from the shaded side of the boat, and then the two measurements were averaged.

- Temperature and dissolved oxygen measurements were taken with a YSI model 57 meter. Measurements were taken at 1 m intervals from the surface to the bottom (±2.5%).

- A Hanna 4180 oxygen test kit was used to determine the oxygen level at the surface to ensure that the oxygen meter was calibrated properly.

- *in situ* pH was made with a bromthymol blue freshwater pH test kit (±0.5).

- *in situ* surface conductivity was measured with a Hanna CONMET 3291 ATC conductivity probe (±1.2% FS).

- *in situ* surface total alkalinity was measured with a Hanna 4811 alkalinity test kit.

- surface water temperature was measured with an alcohol pocket thermometer.

In addition, ground estimates were made on wind speed, percent cloud cover, wave height, and water colour (RIC 1995).

Water samples from the surface, the bottom of the thermocline (8 m) and near the bottom (19 m) were collected in plastic bottles. The sample taken at 19 m was processed by the lab twice. A Van Dorn bottle was used to take the subsurface samples. The sample used for nutrient analysis was preserved in the field with sulphuric acid. The water samples were placed on ice and shipped to Quanta Trace Laboratories within 48 h. The samples were analysed using procedures detailed in publications of the American Public Health Association, U.S. Environmental Protection Agency, B.C. Ministry of the Environment, and Environment Canada - Conservation and Protection. Total metals were determined in a sample aliquot which was acid digested in a closed Teflon vessel in a microwave oven (EPA Method 3015). The digest was analysed by UNICP-AES (EPA Method 200.15).

## 5.2 Results

### 5.2.1 Field conditions

| | |
|---|---|
| Date: | October 6, 1996 |
| Time: | 14:40 |
| Latitude/ longitude: | 50°33.02 N: 127°29.25 W |
| UTM: | 09.607168.5600868 |
| EMS: | |
| Water temperature (°C): | 12 |
| Air temperature (°C): | 15 |
| Cloud cover (%): | 100 |
| Wave height (cm): | 5 |
| *in situ* pH: | 7.2 |
| *in situ* conductance (µS): | 51 |
| *in situ* total alkalinity ($mg \cdot L^{-1}$): | 60 |
| Hanna surface $O_2$ ($mg \cdot L^{-1}$) surface: | 10.5 |
| Water colour: | greenish brown |

The water was rippled, the wind was from the south southwest at 10 $km \cdot h^{-1}$ and the sky was 100% overcast when the limnological data were collected from the deep station of the lake.

### 5.2.2 pH

The pH measurements of lake L1 ranged from 7.0 to 7.2 (Appendix D). The pH of lake L1 was close to being neutral and was in the middle of the range recommended for fish culture (6.5 - 8.5, SIGMA 1983; CCREM 1987; 6.5-9.0, Nagpal 1995).

### 5.2.3 Conductivity

Lab specific conductance measurements ranged from 47 to 50 $\mu S \cdot cm^{-1}$ and were slightly lower than average values for coastal B.C. (96.8 $\mu S \cdot cm^{-1}$; Ptolemy 1992). The conductivity measurements indicate that the ionic strength and total alkalinity of the water are low.

### 5.2.4 Total dissolved solids (TDS)

Levels of total dissolved solids ranged from 39 $mg \cdot L^{-1}$ at the surface to 60 $mg \cdot L^{-1}$ at 19 m.

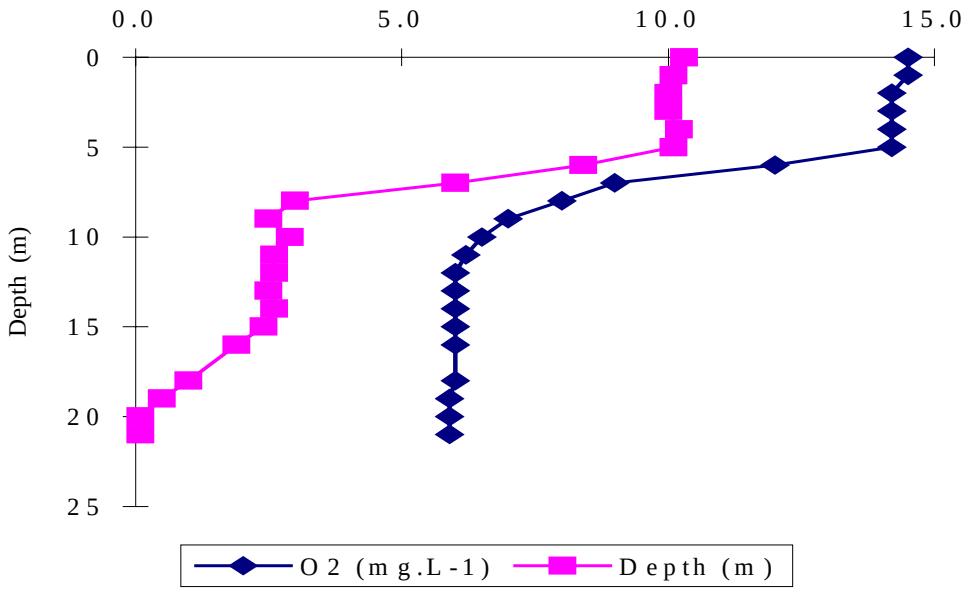
### 5.2.5 Turbidity

The Secchi disk depth of lake L1 was 5.4 m. The water transparency was similar to lakes L2 to L5 where Secchi disk depths range from 5.1 to 6.1 m. The water transparency appeared to be largely affected by plankton rather than dissolved organic material (tannin). There did not appear to be silt in the water.

### 5.2.6 Dissolved oxygen and temperature profile.

Oxygen and temperature data were collected from the deep station on lake Ll on October 6, 1996 (Appendix I, Figure 4). Water temperatures ranged from 14.5°C at the surface of the lake to 5.9 °C near the bottom at 19 m. The thermocline was situated between 6 and 8 m. Oxygen concentrations were near 100% saturation in the epilimnion at 10.3 to 10.0 $mg \cdot L^{-1}$. Below the thermocline, oxygen concentrations dropped substantially. Oxygen concentrations were only 0.1 $mg \cdot L^{-1}$ near the bottom of the lake.

Figure 4. Unnamed lake L1 oxygen - temperature profile, October 6, 1996.




The oxygen and temperature profiles are typical of a dimictic oligo-mesotrophic lake in late summer (Wetzel 1975). Oxygen levels are near saturation in the epilimnion and the water temperature is warm and uniform due to mixing caused by the wind. The oxygen concentration of the hypolimnion has become reduced over the summer by oxidative processes. Oxygen is lost by the respiration of animals, plants and bacteria and by chemical oxidation. Oxygen depletion is particularly rapid near the bottom were organic matter accumulates and bacterial metabolism is the greatest. Circulation and photosysnthesis offset some of the losses of oxygen in the epilimnion and metalimnion.

5.2.7 Other water chemistry results

Of the five lakes surveyed in the area, unnamed lake L1 had the highest phosphorus levels. Total phosphorus ranged from 0.010 $mg \cdot L^{-1}$ at the surface to 0.162 $mg \cdot L^{-1}$ at 19 m (Appendix D). A level of 0.010 $mg \cdot L^{-1}$ in the epilimnetic zone is indicative of an oligo-mesotrophic lake (Vollenweider 1968). Phosphorus levels were particularly high in the hypolimnion. The bogs around the lake, the fine organic substrate of the lake and the aquatic macrophytes may be responsible for the relatively high nutrient levels.

## 6.0 OTHER FLORA AND FAUNA

### 6.1 Aquatic plants

Aquatic plants observed in the lake included *Utricularia vulgaris*, *Potamogeton natans*, *Potamogeton robbinsi*, *Nuphar polyseppalum* and *Nymphaea odorata*. Samples have been sent to MELP in Nanaimo for positive identification.

### 6.2 Wildlife observations

Black bear, beaver (*Castor canadensis*), and blacktail deer (*Odocoileus hemionus*) sign were observed in the area. Other species of wildlife observed were ruffed grouse, marten (*Martes americana*) and Stellar's jay (*Cyanocitta stelleri*) .

## 7.0 SUMMARY OF PREVIOUS SURVEY INFORMATION

No information on previous surveys was found for lake L1. There is no information on file on lake L1 at the Nanaimo and Port Hardy MELP offices.

## 8.0 MANAGEMENT COMMENTS

Of the five lakes and two marshes examined in the area, lake L1 has seen the most human activity in the form of sport fishing and logging. Good road access and cutthroat trout presence have been drawing fishermen to the lake.

Food production is probably not a limiting factor for trout in the lake. Trout densities appeared to be relatively low compared to other lakes in the area and the lake appeared to be moderately productive with an abundance of aquatic macrophytes and moderate nutrient levels indicative of a oligo-mesotrophic lake.

Spawning and rearing habitat for cutthroat trout may be the greatest factor constraining the population. Juvenile trout were only found in tributary L1-T5. Tributary L1-T5 is a small creek with a small amount of spawning and rearing area. Unfortunately the creek was logged to the stream banks and as a result some spawning and rearing habitat may have been lost. This tributary is choked with sedge and grass due to the lack of crown cover and the creek contains an abundance of logging debris. These two factors have likely lead to some siltation and some loss of spawning habitat. As the crown cover develops conditions in this creek will probably improve for spawning.

Other than tributary L1-T5, no other areas were observed that provided spawning and rearing habitat for juvenile cutthroat trout. The outlet was surveyed for 500 m

and this section contained little spawning habitat as it flowed through marsh. Potential spawning and rearing habitat for lake Ll cutthroat trout could exist farther downstream, however and could be investigated futher. If indeed spawning habitat is limiting, some rehabilitation work on tributary L1-T5 could improve trout juvenile recruitment to the lake. From a preliminary look at the creek it appeared that logging debris could be impairing fish access and impeding flows. Little can be done with the sedges and grass in the channel but this situation should change naturally as the riparian zone grows up.

Logging of the remaining timber to the south of the lake will not impact fish populations in the lake as no tributary fish habitat was found in this area.

The fishing regulations are adequate for the lake. Angling could be depressing the trout population somewhat (few fish older than age 3+ were captured) but the gillnet catches indicates that the population is reasonably healthy. The lake probably does not receive heavy fishing pressure. Only one fishing party was observed at the lake over a two week period in October.

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# PHOTOGRAPHS

# APPENDIX A

# FISH COLLECTION DATA FORM

# Appendix A: Unnamed lake L1 fish collection data, October, 1996.

| Fish number | Capture technique | Location | Species | Fork length (mm) | Weight (g) | Scale sample # | Sex | Maturity | Activity | Age 1 | Age 2 | Age 3 | Final age | K | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EL | L1-T5 | CT | 135 | 25.6 | | | J | R | | | | 1+ | 1.04 | |
| 2 | EL | L1-T5 | CT | 55 | 1.7 | | | J | R | | | | 0+ | 1.02 | |
| 3 | EL | L1-T5 | CT | 56 | 1.7 | | | J | R | | | | 0+ | 0.97 | |
| 4 | EL | L1-T5 | CT | 111 | 13.2 | | | J | R | | | | 1+ | 0.97 | |
| 5 | EL | L1-T5 | CT | 126 | 20.3 | | | J | R | | | | 1+ | 1.01 | |
| 6 | EL | L1-T5 | CT | 56 | 1.9 | | | J | R | | | | 0+ | 1.08 | |
| 7 | EL | L1-T5 | CT | 53 | 1.5 | | | J | R | | | | 0+ | 1.01 | |
| 8 | EL | L1-T5 | CT | 50 | 1.2 | | | J | R | | | | 0+ | 0.96 | |
| 9 | EL | L1-T5 | CT | 55 | 1.7 | | | J | R | | | | 0+ | 1.02 | |
| 1 | SGN | Lake | CT | 223 | 107.2 | 1 | F | MT | R | 4+ | 2 | 3+ | 3+ | 0.97 | |
| 2 | FGN | Lake | CT | 230 | 122.6 | 2 | F | IM | R | 4+ | 3 | 4+ | 3+ | 1.01 | |
| 3 | FGN | Lake | CT | 258 | 173.8 | 3 | F | MT | R | 4+ | 3 | 5+ | 4+ | 1.01 | |
| 4 | FGN | Lake | CT | 225 | 112.4 | 4 | F | MT | R | | 3 | 2+ | 3+ | 0.99 | |
| 5 | FGN | Lake | CT | 191 | 64.0 | 5 | F | MT | R | 2+ | 3 | 2+ | 2+ | 0.92 | |
| 6 | FGN | Lake | CT | 207 | 89.5 | 6 | F | MT | R | 3+ | 3 | 2+ | 3+ | 1.01 | |
| 7 | FGN | Lake | CT | 225 | 119.9 | 7 | M | IM | R | 3+ | 3 | 3+ | 3+ | 1.05 | |
| 8 | FGN | Lake | CT | 189 | 63.8 | 8 | F | MT | R | 3+ | 2 | 3+ | 3+ | 0.95 | |
| 9 | FGN | Lake | CT | 147 | 28.9 | 9 | M | IM | R | 1+ | 1 | 2+ | 1+ | 0.91 | |
| 10 | SGN | Lake | KO | 135 | 27.3 | 1 | F | IM | R | regen | regen | | | 1.11 | |
| 11 | FGN | Lake | KO | 164 | 51.5 | 2 | F | IM | R | 2+ | 2 | | 2+ | 1.17 | |
| 12 | FGN | Lake | KO | 170 | 62.5 | 3 | M | M | R | 2+ | 2 | | 2+ | 1.27 | |
| 13 | FGN | Lake | CT | 191 | 68.5 | 10 | M | IM | R | 3+ | 3 | 2+ | 3+ | 0.98 | |
| 14 | FGN | Lake | CT | 198 | 78.2 | 11 | F | IM | R | 3+ | 2 | 3+ | 3+ | 1.01 | |
| 15 | FGN | Lake | CT | 211 | 85.8 | 12 | F | IM | R | 3+ | 3 | 3+ | 3+ | 0.91 | |
| 16 | FGN | Lake | CT | 215 | 94.0 | 13 | F | IM | R | | 3 | 3+ | 3+ | 0.95 | |
| 17 | FGN | Lake | CT | 262 | 182.5 | 14 | M | MT | R | 3+ | 3 | 3+ | 3+ | 1.01 | |
| 18 | FGN | Lake | CT | 185 | 58.7 | 15 | F | IM | R | 2+ | 2 | 2+ | 2+ | 0.93 | |
| 19 | FGN | Lake | CT | 213 | 91.6 | 16 | F | MT | R | 3+ | 3 | 3+ | 3+ | 0.95 | |
| 20 | FGN | Lake | CT | 237 | 134.8 | 17 | M | MT | R | 4+ | 3 | 3+ | 3+ | 1.01 | |
| 21 | FGN | Lake | CT | 216 | 104.2 | 18 | F | MT | R | 3+ | 3 | 4+ | 3+ | 1.03 | |
| 22 | FGN | Lake | CT | 286 | 254.3 | 19 | M | MT | R | 5+ | 3 | 5+ | 5+ | 1.09 | |
| 23 | MT | Lake | CAS | 100 | 10.5 | | | | | | | | | 1.05 | |
| 24 | MT | Lake | CAS | 85 | 5.7 | | | | | | | | | 0.93 | |
| 25 | MT | Lake | CAS | 104 | 11.0 | | | | | | | | | 0.98 | |
| 26 | MT | Lake | CAS | 113 | 16.3 | | | | | | | | | 1.13 | |
| 27 | MT | Lake | CAS | 110 | 15.9 | | | | | | | | | 1.19 | |
| 28 | MT | Lake | CAS | 116 | 12.5 | | | | | | | | | 0.80 | |
| 29 | MT | Lake | CAS | 104 | 11.8 | | | | | | | | | 1.05 | |
| 30 | MT | Lake | CAS | 99 | 10.6 | | | | | | | | | 1.09 | |
| 31 | MT | Lake | CAS | 89 | 7.0 | | | | | | | | | 0.99 | |
| 32 | MT | Lake | CAS | 106 | 12.0 | | | | | | | | | 1.01 | |
| 33 | MT | Lake | CAS | 90 | 6.7 | | | | | | | | | 0.92 | |
| 34 | MT | Lake | TSB | 75 | 3.6 | | | | | | | | | 0.85 | |
| 35 | MT | Lake | TSB | 58 | 1.5 | | | | | | | | | 0.77 | |
| 36 | MT | Lake | TSB | 61 | 2.0 | | | | | | | | | 0.88 | |
| 37 | MT | Lake | TSB | 75 | 4.2 | | | | | | | | | 1.00 | |
| 38 | MT | Lake | TSB | 66 | 2.1 | | | | | | | | | 0.73 | |
| 39 | MT | Lake | TSB | 65 | 2.3 | | | | | | | | | 0.84 | |
| 40 | MT | Lake | TSB | 66 | 2.7 | | | | | | | | | 0.94 | |
| 41 | MT | Lake | TSB | 68 | 2.5 | | | | | | | | | 0.80 | |
| 42 | MT | Lake | TSB | 68 | 2.5 | | | | | | | | | 0.80 | |

Codes:
Species: CAS - Prickly sculpin; CT-Cutthroat; KO-Kokanee; TSB-Threespine stickleback
Capture methods: ES-Electroshocking;; FGN-Floating gillnet; SGN-Sinking gillnet; MT-Minnow trap
Activity: R-Rearing
Maturity: J-Juvenile; IM-Immature; MT-Maturing; M-Mature

# Appendix A: Unnamed lake L1 fish collection data, October, 1996.

| Fish number | Capture technique | Location | Species | Fork length (mm) | Weight (g) | Scale sample # | Sex | Maturity | Activity | Age 1 | Age 2 | Age 3 | Final age | K | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | MT | Lake | TSB | 35 | 0.3 | | | | | | | | | | |
| 44 | MT | Lake | TSB | 58 | 1.4 | | | | | | | | | | |
| 45 | MT | Lake | TSB | 68 | 2.8 | | | | | | | | | | |
| 46 | MT | Lake | TSB | 60 | 1.9 | | | | | | | | | | |
| 47 | MT | Lake | TSB | 69 | 2.7 | | | | | | | | | | |
| 48 | MT | Lake | TSB | 86 | 5.5 | | | | | | | | | | |
| 49 | MT | Lake | TSB | 72 | 3.8 | | | | | | | | | | |
| 50 | MT | Lake | TSB | 71 | 3.3 | | | | | | | | | | |
| 51 | MT | Lake | TSB | 51 | 0.9 | | | | | | | | | | |
| 52 | MT | Lake | TSB | 72 | 3.0 | | | | | | | | | | |
| 53 | MT | Lake | TSB | 56 | 1.5 | | | | | | | | | | |
| 54 | MT | Lake | TSB | 74 | 3.8 | | | | | | | | | | |
| 55 | MT | Lake | TSB | 71 | 3.0 | | | | | | | | | | |
| 56 | MT | Lake | TSB | 79 | 4.4 | | | | | | | | | | |
| 57 | MT | Lake | TSB | 68 | 3.0 | | | | | | | | | | |
| 58 | MT | Lake | TSB | 68 | 3.3 | | | | | | | | | | |

Codes:
Species: CAS - Prickly sculpin; CT-Cutthroat; KO-Kokanee; TSB-Threespine stickleback
Capture methods: ES-Electroshocking;; FGN-Floating gillnet; SGN-Sinking gillnet; MT-Minnow trap
Activity: R-Rearing
Maturity: J-Juvenile; IM-Immature; MT-Maturing; M-Mature

# APPENDIX B

# ORIGINAL STREAM SURVEY FORMS

Unnamed creek - V500 crossing L1-T5 to L1 (~500m from lake)

Unnamed creek (L1-T1) - 150m above lake L1.

Unnamed outlet to lake - 300m below lake

# APPENDIX C

# PHOTODOCUMENTATION FORM

# Appendix C. Unnamed lake L1 photodocumentation

| Survey start date | Stream name (gaz.) | Stream name (loc.) | Watershed code | Agency | Crew (Init 1) | Crew (Init 2) | Reach/ site card (Y/N) | Fish cards (Y/N) | Roll/ Batch no. | Counter no. | Negative no. | Date of photo | Reach no. | Site no. | Map no. NTS/TRIM | UTM mtd G/M | Zone | E(field) | N(field) | Stream photo dir. | Picture type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 14 | 13 | 96/10/06 | | | 92L.053 | G | 9 | 607256 | 5601006 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 15 | 14 | 96/10/06 | | | 92L.053 | G | 9 | 607256 | 5601006 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 16 | 15 | 96/10/06 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 17 | 16 | 96/10/06 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 18 | 17 | 96/10/06 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 19 | 18 | 96/10/06 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 20 | 19 | 96/10/06 | | | 92L.053 | G | 9 | 606882 | 5600469 | | O |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 21 | 20 | 96/10/07 | | | 92L.053 | G | 9 | 607363 | 5600682 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 22 | 21 | 96/10/07 | | | 92L.053 | G | 9 | 607375 | 5600829 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 1 | 23 | 22 | 96/10/07 | | | 92L.053 | G | 9 | 607375 | 5600829 | | L |
| 96/10/06 | Unnamed Creek | Creek L1-T1 | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 1 | 24 | 23 | 96/10/07 | 1 | 1 | 92L.053 | G | 9 | 606851 | 5601186 | Up | CH |
| 96/10/06 | Unnamed Creek | Creek L1-T1 | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 1 | 25 | 24 | 96/10/07 | 1 | 1 | 92L.053 | G | 9 | 606851 | 5601186 | | XS |
| 96/10/06 | Unnamed Creek | Creek L1-T2 | 930-865200-10000-299( | ARL | RJF | JRF | N | N | 1 | 26 | 25 | 96/10/07 | | | 92L.053 | M | 9 | 607100 | 5600500 | Up | CH |
| 96/10/06 | Unnamed Creek | Creek L1-T1 | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 2 | 1 | 1 | 96/10/07 | 1 | 1 | 92L.053 | G | 9 | 606973 | 5601093 | Up | CH |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 2 | 2 | 2 | 96/10/07 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | Unnamed Lake | Lake L1 | 930-8652-100-299 | ARL | RJF | JRF | N | N | 2 | 3 | 3 | 96/10/07 | | | 92L.053 | G | 9 | 607168 | 5600868 | | L |
| 96/10/06 | | | | ARL | RJF | JRF | N | N | 2 | 4 | 4 | 96/10/07 | | | 92L.053 | G | 9 | 606849 | 5600597 | Up | CH |
| 96/10/06 | Unnamed Creek | Lake L1 outlet | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 2 | 5 | 5 | 96/10/07 | 1 | 3 | 92L.053 | G | 9 | 607472 | 5600664 | Down | CH |
| 96/10/06 | Unnamed Creek | Lake L1 outlet | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 2 | 6 | 6 | 96/10/07 | 1 | 3 | 92L.053 | G | 9 | 607736 | 5600520 | Down | CH |
| 96/10/06 | Unnamed Creek | Lake L1 outlet | 930-8652-100-299 | ARL | RJF | JRF | Y | Y | 2 | 7 | 7 | 96/10/07 | 1 | 3 | 92L.053 | G | 9 | 607736 | 5600520 | Up | CH |

Appendix C: Photograph documentation, equipment details, August-October 1996

Survey start date: 17-Aug-96
Survey end date: 14-Oct-96

Camera #1
Make & Model: Pentax PC-700
Format: 135 mm film

Camera #2
Make & Model: Pentax Spotmatic
Format: 135 mm film
Lens: 1:1.4/50

| Roll # | Camera | Output medium | Film type | ISO |
|---|---|---|---|---|
| T1 | 1 | neg | colour | 400 |
| T2 | 1 | neg | colour | 400 |
| T3 | 1 | neg | colour | 400 |
| T4 | 1 | neg | colour | 400 |
| T5 | 1 | neg | colour | 400 |
| T6 | 1 | neg | colour | 400 |
| T7 | 1 | neg | colour | 400 |
| T8 | 1 | neg | colour | 400 |
| R1 | 2 | neg | colour | 400 |
| R2 | 2 | neg | colour | 400 |
| R3 | 2 | neg | colour | 400 |
| R4 | 2 | neg | colour | 400 |
| R5 | 2 | neg | colour | 400 |
| 1 | 1 | neg | colour | 400 |
| 2 | 1 | neg | colour | 400 |
| 3 | 1 | neg | colour | 400 |
| 4 | 1 | neg | colour | 400 |
| 5 | 1 | neg | colour | 400 |
| 6 | 1 | neg | colour | 400 |

# APPENDIX D

# WATER CHEMISTRY ANALYSIS LABORATORY REPORT

# APPENDIX E

# LAKE OUTLINE MAP

# APPENDIX F

# BATHYMETRY

# APPENDIX G

# AIR PHOTO

# APPENDIX H

# WATERSHED CODE SUMMARY

# APPENDIX I

## LAKE L1 OXYGEN AND TEMPERATURE DATA, OCTOBER 06, 1996

Appendice I. Dissolved oxygen and temperature data collected from lake L1, October 6, 1996.

| Depth (m) | Temperature (°C) | $O_2$ ($mg \cdot L^{-1}$) |
|---|---|---|
| 0 | 14.5 | 10.3 |
| 1 | 14.5 | 10.1 |
| 2 | 14.2 | 10.0 |
| 3 | 14.2 | 10.0 |
| 4 | 14.2 | 10.2 |
| 5 | 14.2 | 10.1 |
| 6 | 12.0 | 8.4 |
| 7 | 9.0 | 6.0 |
| 8 | 8.0 | 3.0 |
| 9 | 7.0 | 2.5 |
| 10 | 6.5 | 2.9 |
| 11 | 6.2 | 2.6 |
| 12 | 6.0 | 2.6 |
| 13 | 6.0 | 2.5 |
| 14 | 6.0 | 2.6 |
| 15 | 6.0 | 2.4 |
| 16 | 6.0 | 1.9 |
| 18 | 6.0 | 1.0 |
| 19 | 5.9 | 0.5 |
| 20 | 5.9 | 0.1 |
| 21 | 5.9 | 0.1 |