A reconnaissance survey of

UNNAMED LAKE (L3)

Marble River Watershed

(Watershed code 930-8652-100)
(Sequence no. 02)

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 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 L3 is located 18.5 km south of Port Hardy. Roads, accessible by a two wheel drive vehicle with good ground clearance, come to within 600 m of the lake. The lake was surveyed on October 10 and 11, 1996.

Unnamed lake L3 is a small 46,600 m^2 lake with a drainage area of 2.8 km^2. The lake has a maximum depth of 10.9 m and a mean depth of 4.0 m. It is drained by an creek (watershed code 930-8652-100) that flows southeast for 3.0 km to the lower Marble River. This creek drains four of the lakes and the two marshes that were surveyed during the study. There are three tributaries flowing into the lake. One of the tributaries drains marsh M2 and lake L4.

The lake lies within Tree Farm License #6 managed by Western Forest Products Ltd. The area in the immediate vicinity of the lake is unlogged and is forested mainly by 90 year old western hemlock. Active logging is currently taking place 600 m to the north of the lake.

Fish in the lake were sampled by gillnet and Geetraps. Cutthroat trout and prickly sculpins were captured. Cutthroat trout densities were high and sizes were small compared to cutthroat trout in the other lakes that were surveyed in the area. Cutthroat trout juveniles were captured in the main tributary to the lake. The lake is inaccessible to anadromous fish.

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 ultra-oligotrophic. The pH is close to neutral.

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

Currently the area around lake L3 has had little human impact. There was little indication that the lake has been used for recreation. As logging gets closer to the lake the improved access will likely result in an increase in fishing activity. At the present time the fish in

the lake are slow growing and small but numerous. Increased fishing pressure could reduce the population resulting in increased growth rates and an increase in fish size.

The outlet to the marsh M2 and the outlet to lake L4 are probably the most important spawning and rearing areas for lake L3 cutthroat trout. Other creeks that may provide spawning habitat are the lake L2 outlet and tributary M2-T1. Logging in the vicinity of these creeks should closely follow fish - forestry guidelines to minimize changes to spawning and rearing habitat in these areas.

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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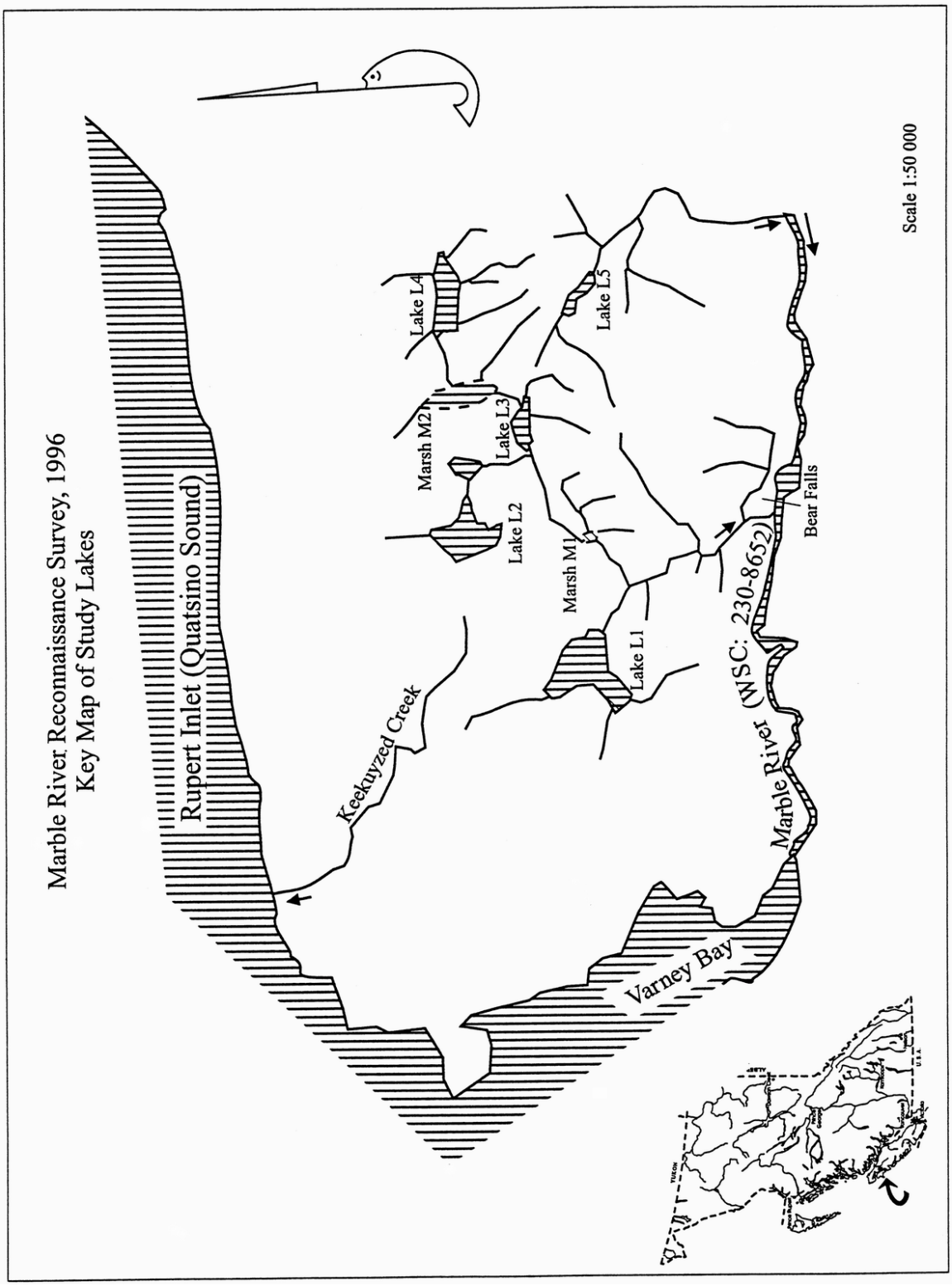
1.0 INTRODUCTION

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 (Fielden 1997a-f). The Marble River (watershed code 930-8652) is located on northern Vancouver Island south of Port Hardy. The lakes and ponds are all located within four kilometres of one another (Figure 1). The lakes were labelled lake L1, L2, L3, etc. in order from west to east and the ponds were labelled as M1 and M2. All the waterbodies except L5 flow into a tributary of the Marble River (watershed code 930-8652-100) which flows into the Marble River from the north 3.2 km upstream from the mouth. Lake L5 flows into a separate tributary (watershed code 930-8652-156) that flows into the Marble River 6.2 km from the mouth and 1.5 km downstream of Alice Lake. The surveys were conducted between October 6, 1996 and October 17, 1996. Unnamed Lake L3 was surveyed on October 10 and 11, 1996, by Rob Fielden and Rick Fielden of Aquatic Resources Ltd. The primary objective of the study was to collect information for fisheries and resource management. Procedures used followed those outlined 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 that were 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
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2.0 GEOGRAPHIC AND MORPHOLOGIC INFORMATION

2.1 Location

Location:	18.5 km south of Port Hardy, B.C
Watershed name:	Marble River
Watershed code:	930-8652-100 (02)
Gazetted lake name:	none
Lake elevation:	64 m +/- (TRIM map no. 92 L.053)
Latitude/ longitude:	50°33.25 N: 127°27.50 W
UTM at outlet:	09.608457.5601146
NTS map number:	92 L/11
BCGS map number:	92 L.053
TRIM map number:	92 L.053
Biogeoclimatic zone:	Submontaine variant of the very wet maritime subzone in the Coastal Western Hemlock biogeoclimatic zone (CWHvm1).
MOE region, district:	Region 1, Vancouver Island, Port Hardy District
Management units:	1-13
Fisheries planning unit:	West Coast Planning Unit
Native land claim areas:	Quatsino Band
MOF region, district:	Vancouver, Port McNeill Forest District
Aerial photo survey no's:	30BC80066 no. 127 (year - 1980)

2.2 Data on file

The following sources were reviewed for information on lake L3:

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 L3 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 L3.

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

7) Western Forest Products (Port McNeill) was contacted in August 1996 for stream classification information. WFP has no new stream classification information for lake L3.

2.3 Lake drainage

Unnamed lake L3 is a small 46,600 m^2 lake situated 18.5 km north of Port Hardy, B.C (Figure 1). The lake lies north of the Marble River and south of Rupert Inlet at an elevation of 64 m. The outlet to the lake is a second order stream (watershed code 930-8652-100) that flows southwest for 3.2 km to the Marble River. The confluence is 3.2 km upstream from the Marble River mouth and approximately 200 m downstream of Bear Falls. Bear Falls is one of three sets of falls located on the lower Marble River. The Marble River flows into Varney Bay in Rupert Inlet on the west coast of Vancouver Island. There are only three small tributaries to the lake.

The main tributary to lake L3 (watershed code 930-8652-100) drains marsh M2 and Lake L4 (Fielden 1997c and Fielden 1997f). Another creek (watershed code 930-8652-100-587) drains lake L2 (Fielden 1997b) and a marsh and flows into the lake L3 outlet, 100 m downstream of the lake.

No areas of mass wasting were observed in the lake L3 watershed.

2.3.1 Stream habitat summaries

The 1:20,000 TRIM (92L.053) map shows three small tributaries to lake L3 (Appendix E). The lower reaches of a fourth creek, which drains lake L2, flow into the outlet 50 m downstream of the lake. This creek may provide spawning and rearing habitat for lake L3 salmonids.

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.

An uncorrected Garmin 45 GPS was used to determine the positions of various features and samples sites. The GPS accuracy varied between 15 and 100 m and depended on the number of satellites that could be located. Differential GPS was not used. 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 bromthymol 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 930-8652-100)

The outlet to lake L3 is a second order creek that flows for about 800 m before draining into marsh M1. For 600 m below the lake the creek meanders through marsh habitat that is up to 50 m wide (Photographs 12 and 13). The creek is deep and slow flowing in this area with a channel width of about 5 m at Site 3, 200 m downstream of the lake (Appendix E). The gradient is close to 0%. Aquatic vegetation is growing in the channel and hardhack is growing thickly along the banks. This reach of the outlet was not sampled for fish, however it probably contains prickly sculpins and adult cutthroat trout. This reach has no salmonid spawning habitat due to the fine substrate and has a low suitability for juvenile salmonids due to its slow flowing marshy nature.

The last 200 m before marsh M1 the gradient of the creek increases to 5%. The substrate is cobble and gravel and the channel width is 8.4 m (Table 1). The discharge was approximately 0.01 $m^3 \cdot sec^{-1}$ on October 13, 1996.

The outlet below marsh M1 is steeper (5%) and fast flowing for about 400 m. The channel width in this area is 6.4 m and the substrate is primarily cobble and boulder. There are cascades below marsh M1 that could impede or prevent the upstream passage of some species of fish. Stickleback were captured downstream of the cascades in lake L1 but none were captured in any of the lakes, streams or marshes above the cascades. Approximately 400 m below marsh M1 the creek joins with the outlet from lake L1 and flows for another 1.4 km before joining the Marble River.

2.3.1.3 Lake L2 outlet creek (watershed code 930-8652-100-587)

The L2 outlet creek flows into the lake L3 outlet about 50 m below lake L3. This creek is 2.6 m wide and has a 7% gradient in the lower 150 m (Site 4; Table 1, Appendix E). A falls 150 m upstream is a barrier to all species of fish. The dense canopy created by the 90 year old western hemlock forest provides 100% crown cover and as a consequence there is very little underbrush (Photograph 11). This creek has a small amount of salmonid spawning and rearing habitat that could be utilized by lake L3 salmonids. One age 1+ cutthroat and two prickly sculpins were captured in 669 sec of electroshocking (Table 3 and 4). Fish densities appeared to be low.

2.3.1.4 Tributary M2 outlet creek (watershed code 930-8652-100)

The M2 outlet creek flows into the east end of the north side of the lake. This tributary drains marsh M2, 200 m upstream from lake L3. It has a channel width of 8.5 m, a gradient of 0.5% and a gravel cobble substrate at Site 5 (Appendix E). The creek is heavily overhung by salmonberry bushes and salal and flows through a 90 year old hemlock forest (Photographs 7 and 8). The creek had a discharge of 5 $L \cdot sec^{-1}$ on October 11, 1996. The creek appears to have good cutthroat trout spawning and rearing habitat although fish densities did not appear to be high. Six cutthroat trout juveniles were captured at the site in 439 sec of electroshocking (Tables 3 and 4).

2.3.1.5 Tributary L3-T1 (watershed code 930-8652-100-663)

Tributary L3-T1 (watershed code 930-8652-100-663) flows into the east end of the lake. This small creek has a channel width of 1 m, has a fine, gravel, cobble substrate and only had a flow of 1 $L \cdot sec^{-1}$ on October 11, 1996 (Photograph 9). The channel is not well defined in some areas due to the lack of flow. The creek is likely dry in the summer and is probably not utilised by fish. No fish were found in several small pools that were electroshocked.

2.3.1.6 Tributary L3-T2 (watershed code 930-8652-100-653)

Tributary L3-T2 has a slope of 38%, 20 m upstream from the lake. The channel width is 2.5 m and the substrate is boulder and cobble. The creek had no flow on October 11, 1996 and it has no fish habitat (Photograph 10).

Table 1. Summary of habitat characteristics of creeks in the vicinity of lake L3.

	L3 Outlet	M3 Outlet	L2 Outlet
Site number	3	5	4
Length (km)	0.8	0.2	0.3
Chan. width (m)	5	8.5	2.6
Wet. width (m)	5	3.2	0.8
Riffle depth (cm)	-	5	3
Pool depth (cm)	-	20	11
% pool	100	60	50
% riffle	0	20	50
% glide	0	20	0
% cascades	0	0	0
% rapids	0	0	0
Gradient (%)	0	0.5	7
Debris area (%)	0	15	0-5
% stable	-	100	100
% fines	100	10	0
% small gravel	0	30	5
% large gravel	0	20	20
% small cobble	0	20	30
% large cobble	0	10	35
% boulder	0	10	10
% bedrock	0	0	0
D_{90} (cm)	102	30	30
Total cover (%)	100	30	20
% deep pool	0	0	0
% LOD	0	20	10
% boulder	0	10	80
% instream veg.	50	10	0
% overstream veg.	50	50	10
% cutbank	0	10	0

2.4 Access

The closest roads to lake L3 are V200 and V500 which are branches of the Varney mainline, that runs along the south shore of Rupert Inlet. Branch V200 currently comes to within 600 m of the east end of the lake. The road is gravel and is easily passable by two wheel drive vehicle. The end of branch V200 is a 40 minute (38 km) drive from Port Hardy. The accessible portion of branch V500 is 1.2 km

from the west end of the lake. Branch V500 is also accessible by two wheel drive vehicle and it is 41 km from Port Hardy.

The lake is 15 km southwest of the Port Hardy airport. A helicopter can land on the marsh around the lake during dry periods. The lake is too small for a float plane to land.

2.5 Physical data

Lake drainage area:	2.8 km^2	Volume:	188,100 m^3
Water surface area:	46,600 m^2	Flushing rate:	7 days
Area above 6 m contour:	32,400 m^2	Perimeter of islands:	n/a
Shoreline perimeter:	1.14 km	Number of islands:	0
Maximum depth:	10.9 m	Mean depth:	4.0 m
Filterable residue (T.D.S.):	17 - 31 $mg \cdot L^{-1}$	Secchi disc:	5.1 m
Sounding device:	Furuno FE 4300		
Elevation source:	TRIM map no. 92L.053		

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 the 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 were calculated by a computer program called Lakestat.

2.6 Benchmark

For a benchmark, a 25 cm long galvanised spike was driven into a 0.6 m diameter hemlock tree at 1.88 m above the water level on October 11, 1996. The bench mark is located at the west end of the lake at UTM co-ordinates 09.608947.5601378. 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.

2.7 High water mark

The high water mark was 0.23 m higher than the lake level and 1.65 m below the benchmark on October 11, 1996. The high water mark was determined from signs of erosion along 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

Lake L3 has an irregular, elongated shape oriented in an east - west direction. The lake has no islands. Marsh vegetation, consisting of hardhack, Labrador tea and sedge, grows all around the shores of the lake in a band that varies in width from 5 to 50 m. The areas of marsh are particularly extensive where the M2 outlet and tributary L3-T1 enter the lake. This vegetation grows to the waters edge so that there are no exposed beaches. Along the edge of the marsh habitat, where the ground starts to slope upward, is a thick 5 m wide band of salal and small red cedar trees at the edge of the coniferous forest.

The lake bottom is composed of fine organic sediment. Several species of aquatic macrophytes grow around the shore of the lake. Floating-leaved pondweed (*Potamogeton natans*) grows at depths less than 1.5 m. Pond lilies are scattered along the lake shore. Cedar windfalls extend out into the lake along the south shore and in areas were the marsh is narrower.

All along the shore is an abundance of cover for fish in the form of large woody debris and emergent, floating leaved and submergent vegetation. The cover is probably not important for prickly sculpins and cutthroat trout, however the vegetation is significant for fish in that it adds to lake productivity.

2.8.2 Surrounding country

The country surrounding lake L3 has a relatively low relief and lies in the Coastal Western hemlock biogeoclimatic zone. One hill to the south rises to 183 m at a slope of 25%. The rest of the area has a lower gradient. The area all around the lake is unlogged and forested by 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 snags and windfalls that are the remains of old growth cedar trees killed in the fire. There are also 400 year old cedar and Douglas fir that survived the fire and the storm mixed in with the hemlock. 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 and amabilis fir. There are few understory plants, except along the larger creeks and around the lakes and marshes, because of the dense canopy created by the 90 year old western hemlock trees.

An area 600 m to the north of the lake was logged in 1996. An area 1 km west of the lake was logged in the late 1980's.

3.0 DEVELOPMENTS

There is no development around lake L3 except for logging activities 600 m to the north. No surveying, road building or logging is taking place along the lake at the present time but it is likely logging will take place at some time in the future.

3.1 Land status

Unnamed lake L3 lies within Tree Farm License #6 managed by Western Forest Products. The lake is within the Kwakiutl Tribal Group - Quatsino Band consultation area. The area is crown land. Logging activity has come to within 600 m of the lake. Logging has improved the access but it has not changed the aesthetics of the lake as it is not visible from the lake.

3.2 Development and land use

3.2.1 Resorts and campsites

There are no resorts or camping facilities on the lake. There was no evidence that people have been camping at the lake in the past.

3.2.2 Timber harvest

Unnamed lake L3 lies within Tree Farm License #6 managed by Western Forest Products. The area 600 m to the north of the lake is being logged. The area surrounding the lake has not yet been logged. No logging is planned for the area around lake L3 in the 1996 -2000 five year logging plan (Phillip Wainwright, WFP, pers. comm.).

3.2.3 Trap lines

Unnamed lake L3 lies within trap line licence TR0113T807 (Map no.: 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, MELP, pers. comm.).

3.2.4 Waste permits

There are no waste permits for the area around lake L3.

3.2.5 Water permits

There are no water permits for lake L3.

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 lake L3 was laid down during the upper Triassic period and is of a formation within a group of stratified rocks called the Vancouver group. The surrounding area 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 lake L3 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 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 has a good population of cutthroat trout (*Oncorhynchus clarkii*), although the fish are small. There is little evidence that the lake is frequented by anglers, probably due to the poor access. The only evidence of any use of the lake was the remains of an old wooden boat along the shore. The boat has been unusable for several years. The lake would not be appealing for campers and swimmers due to the lack of any beaches and the marsh habitat around the perimeter of the lake. The closest roads are 600 m to the north making it difficult to get a boat into the lake.

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

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 (Appendix E). 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 the two sites.

Sinking gillnet:

Site 7		Site UTM:	09.609305.5601364
Date set:	Oct. 10, 1996	Time set:	14:49
Date lifted:	Oct. 10, 1996	Time lifted:	15:40
Total soak time:	0.8 h	Distance from shore:	20 m
Shallow end depth:	4 m	Shallow end substrate:	organic ooze
Deep end depth:	11 m	Deep end substrate:	organic ooze
Deep end mesh size:	89 mm	Shallow end mesh size:	25 mm

Floating gillnet:

Site 8		Site UTM:	09.608947.5601378
Date set:	Oct. 10, 1996	Time set:	14:41
Date lifted:	Oct. 10, 1996	Time lifted:	15:30
Total soak time:	0.8 h	Distance from shore:	10 m
Shallow end depth:	3 m	Shallow end substrate:	organic ooze
Deep end depth:	6 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 (Table 2, Appendix E). The traps were baited with salmon roe and left to fish over night.

Site 1		Site UTM:	09.609071.5601417
Date set:	Oct. 10, 1996	Time set:	14:00
Date lifted:	Oct. 11, 1996	Time lifted:	11:48
Total soak time:	22 h	Number of traps:	5
Site 2		Site UTM:	09.609330.5601343
Date set:	Oct. 10, 1996	Time set:	14:00
Date lifted:	Oct. 11, 1996	Time lifted:	11:48

Total soak time: 22 h Number of traps: 5

Table 2. Habitat characteristics of the areas where the Gee traps were set in lake L3.

Trap #	Depth (m)	Substrate	Cover type	Distance to shore (m)	Distance to cover (m)
1	0.5	fine	LOD	8	1.0
2	0.5	fine	IV	8	0.0
3	0.6	fine	LOD, IV	5	0.5
4	0.6	fine	IV	4	1.0
5	0.3	fine	LOD	3	0.5
6	0.3	fine	LOD	3	0.5
7	0.4	fine	LOD	4	0.3
8	0.5	fine	IV	6	0.2
9	0.4	fine	LOD	2	0.1
10	0.6	fine	LOD, IV	3	0.1

IV - instream vegetation 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 the lake tributaries (Table 3).

Table 3. Electrofishing data for the tributaries and outlet of lake L3, October 11, 1996.

Location	UTM	Shocking time (sec)	Temp. (°C)	Cond. ($\mu S \cdot cm^{-1}$)	Length of site shocked (m)	Shocker settings
M2 outlet Site 5	09.609400.5601475	439	12.5	45?	N/R	L5, 600V
L3-T1 Site 6	09.609450.5601350	158	N/R	N/R	N/R	L5, 600V
L2 outlet Site 4	09.608900.5601375	679	11.0	39	N/R	L5, 600V

N/R - not recorded

4.2 Catch summary/species composition

Cutthroat trout (*Oncorhynchus clarki*) and prickly sculpin (*Cottus asper*) were the only species of fish that were captured in the lake and its tributaries (Table 4). The outlet just downstream of marsh M1 is quite steep and may have prevented stickleback from colonising the system upstream of this spot. No anadromous fish were captured in any of the areas sampled in this system (lakes L1-L4 and

marshes M1 and M2). The creek below lake L1 and marsh M1 may contain a barrier to anadromous fish.

Table 4. Lake L3 and streams in the vicinity of lake L3 catch summary, October 11, 1996.

Location	Site	Capture technique	Cutthroat trout	Prickly sculpin
Lake L3	8	F-GN	33	0
Lake L3	7	S-GN	1	0
Lake L3	1	MT	0	0
Lake L3	2	MT	0	3
M2 outlet	5	EL	6	0
L3-T1	6	EL	0	0
L2 outlet	4	EL	1	2

4.2.1 Relative abundance

The gillnets averaged 21.3 cutthroat·h^{-1}·net^{-1} during day light hours (Table 5). Most of the fish were captured in the floating net which captured 41 cutthroat·h^{-1}·net^{-1}. The minnow traps caught 0.3 prickly sculpins per trap per overnight set.

Table 5. Catch per unit effort (CPUE) for all cutthroat and aged cutthroat caught in gillnets set in lake L3 on October 10, 1996.

Gear type	Time (h)	Age	n	Average FL (mm)	Range (mm)	CPUE (fish·h^{-1}·net^{-1})
GN	0.8	2+	6	179.5	159-191	3.8
GN	0.8	3+	25	199.5	177-249	15.6
GN	0.8	4+	1	335.0	335-335	0.6
GN	0.8	all	34	199.2	159-335	21.3

GN - gillnet, sinking and floating

Compared to other systems sampled in the area, the trout catch per unit effort was high (Table 6). Unnamed lake L3and marsh M1 both had catch rates of 21.3 - 22.0 trout per hour per gillnet compared to 1.9, 1.8, and 0.9 trout per hour per gillnet in lakes L1, L4 and L5, respectively.

Table 6. 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	0.0	1.9	0.0	0.3
Lake L2	0.0	0.0	0.0	0.0
Lake L3	0.0	21.3	0.0	0.0
Lake L4	0.0	1.7	0.0	0.0
Lake L5	0.2	0.9	0.7	0.0
Marsh M1	0.0	22.0	0.0	0.0
Marsh M2	0.0	0.6	0.0	0.0

4.3 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 labelled 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 Limited. 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).

4.3.1 Salmonids

A total of 42 cutthroat trout were sampled from lake L3 and its tributaries (Appendix A). These fish ranged in size from 53 to 335 mm and in age from 0+ (no winter annulus; Mackay and Ash 1990) to age 4+ (four winter annuli). Age 0+ trout were captured in the marsh M2 and lake L2 outlet creeks. All of the trout caught in the lake were age 2+ and older. The majority of trout captured in

Table 7. Length, weight and condition factor (K) statistics for fish caught in lake L3 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
CAS	All	3	87.3	36.5	47	118	8.63	7.22	0.90	15.20	0.96	0.11	0.87	1.07
CT	All	43	171.0	61.2	53	335	64.75	57.21	1.60	361.60	0.97	0.08	0.83	1.19
CT	0+	9	64.2	9.0	53	75	2.78	1.20	1.60	5.00	1.00	0.12	0.84	1.19
CT	2+	6	179.5	11.4	159	191	57.22	11.13	41.10	76.10	0.98	0.09	0.83	1.09
CT	3+	25	199.5	14.1	177	249	77.36	20.11	55.20	160.30	0.96	0.05	0.83	1.04
CT	4+	1	335.0	-	335	335	361.60	-	361.60	361.60	0.96	-	0.96	0.96

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

the lake (78%) were age 3+ and ranged in size between 177 and 249 mm (Table 7). The cutthroat trout from the lake had an average fork length of 199 mm (n = 34, stdev = 29 mm) and were the smallest fish of the lakes sampled in the area (Table 8). Within the 3+ age class lake L3 cutthroat trout averaged 199.5 mm (n = 25, stdev = 14.1 mm) and were the smallest of age 3+ cutthroat trout sampled from the four lakes and one marsh in the area (mean length = 221.5 mm, stdev = 22.3 mm). The age 2+ and 3+ cutthroat in the lake were slow growing, probably as a result of the high fish densities in the lake (Figure 3). The one age 4+ trout was much larger than expected given the size of the younger fish. This fish had wider spaced annuli due to faster growth, possibly as a result of rearing in another area. The high fish densities may indicate an abundance of spawning and rearing habitat and little fishing pressure.

The cutthroat captured from lake L3 and its tributary had a mean condition factor of 0.97 (n = 43, stdev = 0.08; Table 8) which was 0.04 less than 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 high densities and slower growth would account for the lower condition factors of cutthroat trout in this lake.

Sixty-two percent of the trout were maturing and would spawn next spring, while the rest were at least one year from spawning. Females comprised 56% of the catch.

Table 8. Comparison of cutthroat trout sizes captured from various lakes in the lower Marble River area, October 6 - 17, 1996.

System	n	Mean 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

4.3.2 Non-salmonid species

Prickly sculpins captured from the lake ranged in size from 47 to 118 mm (n = 3, Table 7). No stickleback were captured in the lake. A set of cascades in the outlet just below marsh M1 may block stickleback from colonizing the lake.

Figure 2. Length - frequency distribution of cutthroat trout captured from lake L3 and its tributaries, October 11, 1996.

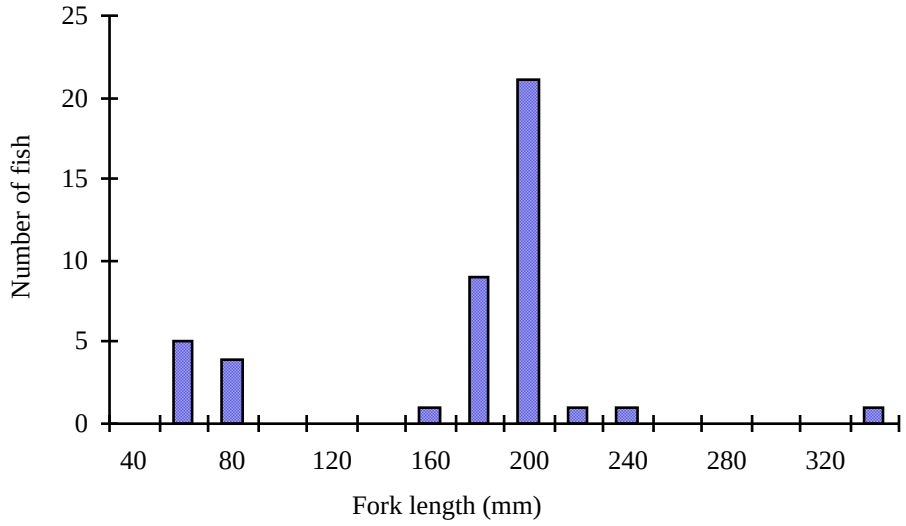
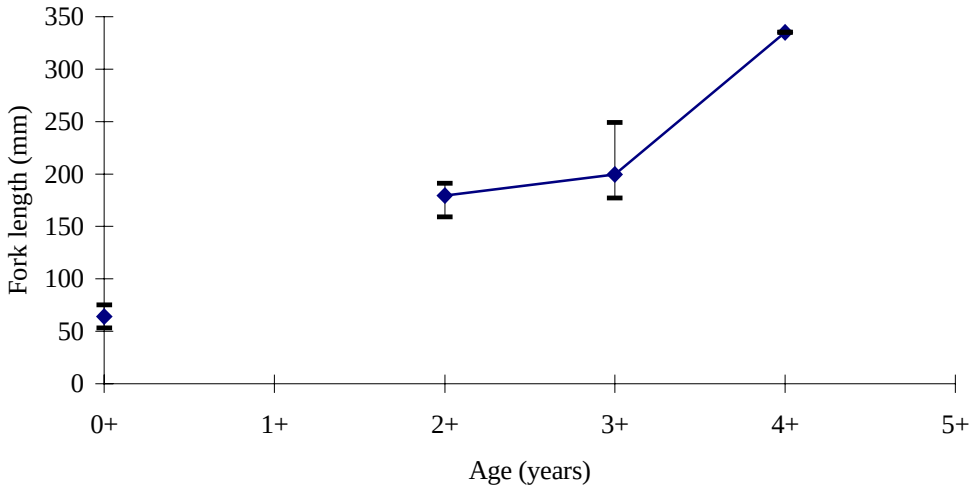


Figure 3. Graph of mean fork length with ranges of each age class of cutthroat trout captured from lake L3 and its tributaries.



5.0 LIMNOLOGICAL SAMPLING

5.1 Methods

A limnological station was established at the deepest point (10.9 m) in the lake (Figure 1). Limnological data was collected at 12:21 on October 11, 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 and at 10 m 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 a pocket thermometer.

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

Water samples were collected in plastic bottles at the surface, at the bottom of the thermocline (6 m), and near the bottom (10 m). A Van Dorn bottle was used to obtain 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 11, 1996
Time:	12:05
Latitude/ longitude:	50°33.25 N: 127°27.48 W
UTM:	09.609303.5601315
EMS site no.	
Barometric pressure mm Hg	752
Water temperature (°C):	14.0
Air temperature (°C):	
Cloud cover (%):	20
Wind speed (km/h)	0
Wave height (cm):	calm
in situ pH:	6.6
in situ conductance (µS):	41
in situ total alkalinity ($mg \cdot L^{-1}$):	20
Hanna surface O_2 ($mg \cdot L^{-1}$) surface:	10.75
10 m:	0.1
Secchi depth (m)	5.1
Water colour:	light brown

The water was calm, there was no wind and the sky was 20% overcast when the limnological data were collected from the deep station of the lake.

5.2.2 pH

Laboratory pH measurements of lake L3 ranged from 7.0 at the surface to 6.5 at 18 m (Appendix D). The pH was close to neutral at the surface and became slightly more acidic with depth. The pH was in the middle of the range recommended for fish culture (6.5 - 8.5 - SIGMA 1983; Canadian water quality guidelines; 6.5-9.0, Nagpal 1995).

5.2.3 Conductivity

Laboratory specific conductance measurements ranged from 23 to 33 $\mu S \cdot cm^{-1}$ and were 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 17 $mg \cdot L^{-1}$ at the surface to 31 $mg \cdot L^{-1}$ at 10 m.

5.2.5 Turbidity

The Secchi disk depth of lake L3 was 5.1 m. The water transparency was the lowest of the five lakes surveyed in the area in which Secchi disk depths ranged from 5.1 to 6.1 m. The water transparency was probably affected by plankton and dissolved organic material (tannin) in the water. There did not appear to be silt in the water.

5.2.6 Dissolved oxygen and temperature profile.

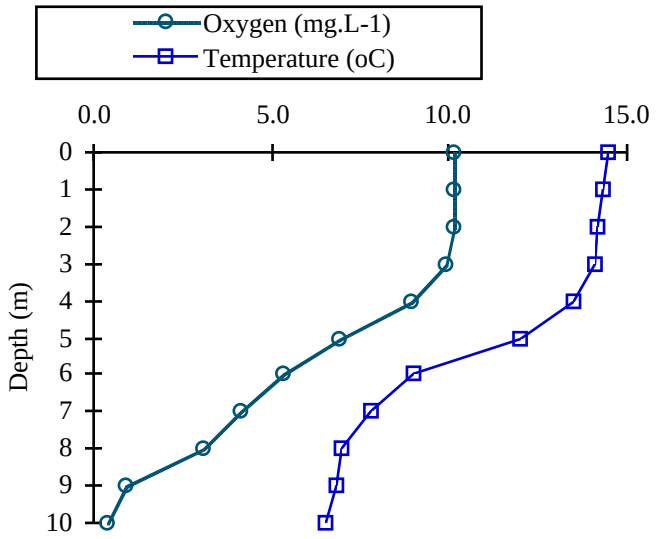
Oxygen and temperature data were collected from the deep station on lake L3 on October 11, 1996 (Table 9, Figure 3). Water temperatures ranged from 14.5°C at the surface of the lake to 6.5°C near the bottom at 10 m. The thermocline was situated between 4.5 and 6.5 m. Oxygen concentrations were near 100% (10.1 $mg \cdot L^{-1}$) saturation at the surface. Below the thermocline oxygen concentrations dropped substantially. Oxygen concentrations were 0.4 $mg \cdot L^{-1}$ near the bottom of the lake.

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 photosynthesis offset some of the losses of oxygen in the epilimnion and metalimnion.

5.2.7 Other water chemistry results

The total phosphorus measurement at the surface was 3 $g \cdot L^{-1}$. This level indicates that the lake is ultra-oligotrophic (Vollenweider 1968).

Figure 4. Lake L3 oxygen - temperature profile, October 11, 1996.



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 were collected and sent to MELP in Nanaimo for positive identification.

6.2 Wildlife observations

There were signs of (or observations of) the following species of wildlife in the vicinity of lake L3; black bear, blacktail deer (*Odocoileus hemionus*), red squirrel (*Tamiasciurus hudsonicus*), Stellar's jay (*Cyanocitta stelleri),* widgeon (*Anas americana*), junco (*Junco hyemalis*), crow (*Corvus brachyrhynchos*) and beaver (*Castor canadensis*).

7.0 SUMMARY OF PREVIOUS SURVEY INFORMATION

No information on previous surveys was found for lake L3. There is no information on file on lake L3 at the Nanaimo and Port Hardy MELP offices.

8.0 MANAGEMENT COMMENTS

Currently the area around lake L3 has had little human impact. There was little indication that the lake has been used for recreation. Logging is currently being conducted approximately 600 m to the north of the lake. As logging gets closer to the lake the improved access will likely result in an increase in fishing activity. At the present time the fish in the lake are slow growing and small but numerous. Food production is limiting fish growth due to the high densities of fish. The high trout densities in the lake indicates that spawning and juvenile rearing habitat is adequate in the creeks in the area.

The outlet to the marsh M2 and the outlet to lake L4 are probably the most important spawning and rearing areas for lake L3 cutthroat trout. Other creeks that may provide spawning habitat are the lake L2 outlet and tributaries to marsh M2 (Fielden 1997f). Logging in the vicinity of these creeks should closely follow the provincial fish - forestry guidelines to minimize changes to spawning and rearing habitat in these areas.

There are no enhancement projects that would benefit fish production in the lake. Most of the area around the lake has not been impacted by human activity and the lake L3 trout population is large.

The fishing regulations are adequate for the lake. The trout population would benefit from an increase in fishing pressure so additional restrictions are not needed for the lake. A reduction in fish densities would lead to increased growth rates and an increase in the average size of fish in the lake. There is probably very little if any fishing pressure on the lake at the present time.

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PHOTOGRAPHS

APPENDIX A

FISH COLLECTION DATA FORM

Appendix A: Unnamed lake L3 fish collection data, October, 1996.

Fish number	Capture technique	Location	Site no.	Species	Fork length (mm)	Weight (g)	Scale sample #	Sex	Maturity	Activity	Age 1	Age 2	Age 3	Final age	K	Comments
1	GN	lake	7/8	CT	335	361.6	1	F	MT	R	5+	4	4+	4+	0.96	
2	GN	lake	7/8	CT	191	68.0	2	F	IM	R	3+	2	3+	3+	0.98	
3	GN	lake	7/8	CT	194	73.2	3	M	MT	R	3+	2	3+	3+	1.00	
4	GN	lake	7/8	CT	192	66.9	4	F	IM	R	3+	2	3+	3+	0.95	
5	GN	lake	7/8	CT	186	63.1	5	M	MT	R	3+	2	3+	3+	0.98	
6	GN	lake	7/8	CT	205	86.2	6	F	IM	R	3+	2		3+	1.00	
7	GN	lake	7/8	CT	201	73.8	7	F	MT	R	3+	2	3+	3+	0.91	
8	GN	lake	7/8	CT	189	56.3	8	M	IM	R	2+	2	2+	2+	0.83	
9	GN	lake	7/8	CT	194	72.4	9	M	MT	R	3+	2	3+	3+	0.99	
10	GN	lake	7/8	CT	208	89.2	10	M	MT	R	3+	2	1+	3+	0.99	
11	GN	lake	7/8	CT	207	81.0	11	M	MT	R	3+	2	3+	3+	0.91	
12	GN	lake	7/8	CT	220	100.0	12	F	MT	R	3+	3	4+	3+	0.94	
13	GN	lake	7/8	CT	177	55.2	13	M	IM	R	3+	2	3+	3+	1.00	
14	GN	lake	7/8	CT	180	55.9	14	F	IM	R	3+	2	2+	2+	0.96	
15	GN	lake	7/8	CT	177	56.5	15	M	IM	R	3+	2	2+	2+	1.02	
16	GN	lake	7/8	CT	208	82.1	16	F	MT	R	3+	2	4+	3+	0.91	
17	GN	lake	7/8	CT	185	65.0	17	M	IM	R	3+	2	4+	3+	1.03	
18	GN	lake	7/8	CT	198	73.3	18	M	IM	R	3+	2	4+	3+	0.94	
19	GN	lake	7/8	CT	203	76.2	19	F	MT	R	3+	2	3+	3+	0.91	
20	GN	lake	7/8	CT	199	69.9	20	F	MT	R	3+	2	2+	3+	0.89	
21	GN	lake	7/8	CT	202	84.7	21	M	MT	R	3+	2	3+	3+	1.03	
22	GN	lake	7/8	CT	202	73.7	22	M	MT	R	3+	2	4+	3+	0.89	
23	GN	lake	7/8	CT	175	54.3	23	F	IM	R	3+	regen	regen		1.01	
24	GN	lake	7/8	CT	198	73.6	24	F	MT	R	3+	2	3+	3+	0.95	
25	GN	lake	7/8	CT	203	83.9	25	F	MT	R	3+	2	3+	3+	1.00	
26	GN	lake	7/8	CT	181	57.4	26	F	IM	R	3+	2	2+	2+	0.97	
27	GN	lake	7/8	CT	191	76.1	27	F	MT	R	regen	1	2+	2+	1.09	
28	GN	lake	7/8	CT	177	56.0	28	M	IM	R	3+	3	3+	3+	1.01	skin parasite
29	GN	lake	7/8	CT	249	160.3	29	F	MT	R	4+	2	3+	3+	1.04	
30	GN	lake	7/8	CT	193	65.8	30	M	MT	R	3+	regen	3+	3+	0.92	
31	GN	lake	7/8	CT	199	66.0	31	F	MT	R	regen.	2	regen	regen	0.84	
32	GN	lake	7/8	CT	198	64.4	32	F	MT	R	3+	2	3+	3+	0.83	
33	GN	lake	7/8	CT	198	76.0	33	F	IM	R	3+	1	3+	3+	0.98	
34	GN	lake	7/8	CT	159	41.1	34	M	MT	R	3+		2+	2+	1.02	
35	MT	lake	1	CAS	47	0.9				R					0.87	
36	MT	lake	1	CAS	118	15.2				R					0.93	
37	MT	lake	2	CAS	97	9.8				R					1.07	
38	EL	M2 outlet	5	CT	58	1.7	1			R	0+		0+	0+	0.87	
39	EL	M2 outlet	5	CT	71	3.0	2			R	0+		0+	0+	0.84	
40	EL	M2 outlet	5	CT	57	1.8				R				0+	0.97	
41	EL	M2 outlet	5	CT	66	2.7				R				0+	0.94	
42	EL	M2 outlet	5	CT	53	1.6				R				0+	1.07	
43	EL	M2 outlet	5	CT	53	1.7				R				0+	1.14	
44	EL	L2 outlet	4	CT	75	5.0	1			R	0+		0+	0+	1.19	
45	EL	L2 outlet	4	CAS	73	3.9				R				0+	1.00	
46	EL	L2 outlet	4	CAS	72	3.6				R				0+	0.96	

Codes:

Species: CT - cutthroat trout; CAS - prickly sculpin; CO - coho; DV - Dolly Varden; KO - kokanee; TSB - threespine stickleback

Capture method: ES -electroshocking; FGN - floating gillnet; SGN - sinking gillnet; MT - minnow trap

Activity - R - rearing

Maturity - J - juvenile; IM - immature; MT - maturing; M - mature; A - adult

APPENDIX B

ORIGINAL STREAM SURVEY FORMS

Outlet to lake L3 - 200 m below lake.

Outlet to unnamed lake L2 -100 m upstream from L3 outlet.

Unnamed marsh M2 outlet.

APPENDIX C

PHOTODOCUMENTATION FORM

Appendix C. Unnamed lake L3 photodocumentation

Survey start date	Stream name (gaz.)	Stream name (loc.)	Watershed code	Agency	Crew (Init 1)	Crew (Init 2)	Crew (Init 3)	Reach/ site card (Y/N)	Fish cards	Roll/ Batch no.	Counter no.	Negative no.	Date of photo	Reach no.	Site no.	Map no. NTS/TRIM	UTM nutd G/M	Zone	E(field)	N(field)	E(correct)	N(correct)	Stream photo dir.	Picture type	Photo direction	Focal length (mm)	Focal range	Scale item	Comments
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		2	22	22	9/8/96			92L.053	G	9	0609600	5601700				L	SW				L3
10/6/96	Unnamed Lake	Lake L3 and Lake L3 outlet	930-8652-100	ARL	RJF	JRF		Y	N	2	23	23	9/8/96			92L.053	G	9	0608400	5601000				L	ENE				L3 and outlet
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	18	17A	9/11/96			92L.053	G	9	0610289	5600750				L	NE				North shore
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	19	18A	9/11/96			92L.053	G	9	0610289	5600750				L	NE				North shore
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	21	20A	9/11/96			92L.053	G	9	0610289	5600750				L	E				south shore east end
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	22	21A	9/11/96			92L.053	G	9	0610289	5600851				O					Bench mark
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	23	22A	9/11/96			92L.053	G	9	0609400	5601350				L	W				west end of lake
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	23	23A	9/11/96			92L.053	G	9	0608947	5601378				L	NW				north side of lake near inlet
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		3	24	24A	9/11/96			92L.053	G	9	0608947	5601378				L	W				west end of lake
10/6/96	Unnamed Creek	M2 outlet	930-852-100	ARL	RJF	JRF		Y	Y	4	1	1	9/11/96	8	5	92L.053	M	9	0609425	5601500			Up	Ch					M2 outlet 200 m upstream
10/6/96	Unnamed Creek	M2 outlet	930-852-100	ARL	RJF	JRF		Y	Y	4	2	2	9/11/96	8	5	92L.053	M	9	0609425	5601500			Down	Ch					M2 outlet 200 m upstream
10/6/96	Unnamed Creek	Creek L3-T2	930-8652-100-653	ARL	RJF	JRF		N	N	3	25	25A	9/11/96	1	1	92L.053	M	9	0609231	5601275			Up	Ch	S				Tributary L3-T2 50 m upstream
10/6/96	Unnamed Creek	Creek L3-T1	930-8652-100-663	ARL	RJF	JRF		N	Y	4	3	3	9/11/96	1	6	92L.053	M	9	0609425	5601350			Up	Ch					L3-T1 100 m upstream
10/6/96	Unnamed Creek	Creek L3-T1	930-8652-100-663	ARL	RJF	JRF		N	Y	4	4	4	9/11/96	1	6	92L.053	M	9	0609425	5601350			Down	Ch					L3-T1 100 m upstream
10/6/96	Unnamed Lake	Lake L3	930-8652-100	ARL	RJF	JRF		N		4	5	5	9/11/96			92L.053	G	9	0610290	5600850				L	E				View of the lake from the outlet

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 L3 OXYGEN AND TEMPERATURE DATA, OCTOBER 11, 1996

Dissolved oxygen and temperature data collected from lake L3, October 11, 1996.

Depth (m)	Temperature (°C)	O_2 ($mg \cdot L^{-1}$)
0	10.1	14.5
1	10.1	14.3
2	10.1	14.2
3	9.9	14.1
4	8.9	13.5
5	6.9	12.0
6	2.3	9.0
7	4.1	7.8
8	3.1	7.0
9	0.9	6.8
10	0.4	6.5