

**FISH STOCK ASSESSMENT
OF
LITTLE SALMON AND QUIET LAKES
1994**

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Yukon Government
Department of Environment
Fish and Wildlife Branch
Fisheries Section
Box 2703
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Y1A 2C6

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1.0 INTRODUCTION

In 1989 the Yukon Territorial Government assumed the management and administrative responsibility of the freshwater fisheries' resource from the Federal Government. As part of the transfer agreement, assessment programs were initiated to establish the status of the fisheries resource within the Territory. Lakes with significant fisheries involving several user groups and potential allocation conflicts, and where limited stock information was available, became assessment priorities. Consequently, Little Salmon Lake and Quiet Lake were assessed in 1994 because of the limited available stock information.

1.1 Little Salmon Lake

There is very little historic data on fishing activity from Little Salmon Lake. Seigal and McEwen (1984) report RNWMP correspondence to the Fishery Inspector from 1902 that relates First Nations from the vicinity of Little Salmon Lake complaining about impinging commercial fishing operations. First Nations were afraid that continued fishing would prevent them from catching enough fish to keep from starving. As a result commercial fishermen were asked to relocate.

From 1961 to 1969 Little Salmon Lake had a combined commercial quota of 2,727 kilograms (6,000 pounds) of all fish. The commercial fishery on the lake was closed in 1969 to protect recreation activities and sport fishing interests.

Domestic license records have been kept for Little Salmon Lake since 1991. From 1991 to 1997 (no licenses were issued in 1992) the average annual production was 26.7 kilograms of lake trout and 147.8 kilograms of whitefish. There are currently less than five domestic licenses issued for Little Salmon Lake.

There is a small but active sport fishery on Little Salmon Lake due to the close proximity to Faro, although historically fishing pressure was much greater when mining operations

in Faro were at their peak. Primary species targeted are lake trout, northern pike and Arctic grayling.

The Faro Lions Club has held a number of fishing derbies on Little Salmon Lake. There have been four derbies held between 1992 and 1998, with an average of 28 lake trout caught at each. This number is slightly misleading as the number of fish caught was higher during earlier derbies but became much lower during more recent ones. This is a result of the fluctuating population of the town of Faro due to mine closures. The catch from this derby is monitored and is not considered to be an issue for the lake.

1.2 Quiet Lake

From 1961 to 1989 Quiet Lake had a combined commercial quota of 2,722 kilograms (6,000 pounds) of which 1,361 kilograms (3,000 pounds) was lake trout. Records are inconsistent over most of this period, but for the five years that data does exist there were a total of 1,282 kilograms of lake trout and 1,135 kilograms of lake whitefish taken. The commercial fishery on Quiet Lake was closed in 1989.

A small number of domestic licenses were issued for Quiet Lake until 1986. No new licenses have been issued since. Sporadic data for seven of these years exists with a total reported amount harvested of 234 kilograms of lake trout and 327 kilograms of lake whitefish.

There is an active sport fishery on Quiet Lake. Primary species targeted are lake trout and Arctic grayling.

2.0 OBJECTIVES

The primary objective of this survey was to determine the status of important commercial, recreational and food fish species within Little Salmon and Quiet Lakes. Specific objectives of this study were:

1. To determine the abundance of lake trout and lake whitefish relative to other lakes in the Yukon;
2. To determine the biological population parameters for lake trout and lake whitefish;
3. To determine lake trout production and harvest capacity; and
4. Based on the findings of objectives 1 through 3, make recommendations on harvest management for these three lakes.

3.0 STUDY AREAS

3.1 Little Salmon Lake

Little Salmon Lake is located at 62° 11' N and 134° 40' W approximately 75 kilometres east of Carmacks. It is 33 kilometres long with a surface area of 6,210 hectares and is oriented in an east-west direction at an elevation of 615 meters. It receives water from the Magundy River and Drury Creek in the east and north and flows out to the west into the Little Salmon River, which then flows into the Yukon River.

Access to the lake is from the Robert Campbell Highway, which opened in 1968, and runs parallel to the lake for its entire length. There are two government campgrounds on the lake, one at the west end of the lake at kilometre 517 and another at the east end at kilometre 483. Both of these campgrounds provide boat launches. There are a few cottages scattered along the lake and a government highway maintenance camp at the east end. A commercial highway lodge also operated near the east end of the lake until its closure in 1996.

3.2 Quiet Lake

Quiet Lake is located at 61° 05' N and 133° 05' W approximately 60 kilometres north of Johnson's Crossing. It is 12 kilometres long with a surface area of 3,780 hectares. With an elevation of 787 metres the lake is oriented in a north-south direction. It is fed by Crater and Granite creeks and is the headwaters of the Big Salmon River, which flows out of the north end of the lake and eventually into the Yukon River. The lake is accessed by the South Canol Road, open to vehicles in the summer only. The road runs along the east side of the lake for about two thirds of its length. There is a government campground at kilometre 77 and a day use area at kilometre 99, both of which have boat launches. There is also a government highways maintenance camp at kilometre 99 and a small number of cabins scattered along the southern portion of the lake.

4.0 METHODS AND MATERIALS

4.1 Lake Morphometry

Both lakes were depth sounded by the Government of Canada, Department of Fisheries and Oceans, Whitehorse, Yukon. Little Salmon Lake was completed in 1981 and Quiet Lake in 1982. Exact methodology used is described in Horler (1982).

4.2 Physical and Chemical Limnology

Water quality data for both lakes was obtained from field studies in 1997. Two profiles were completed on each lake on July 24, 1997. Profiles were done using a Hydrolab DataSonde 3 Water Quality Multiprobe Logger. Variables measured included pH, total dissolved solids (TDS), temperature and conductivity. Total alkalinity was taken from studies done by Shortreed and Stockner in 1983. Water chemistry sample locations for Little Salmon and Quiet Lakes are shown in Appendix I.

4.3 Morphoedaphic Index and Yield

Computed mean depths and observed TDS values for each lake were used to determine morphoedaphic indices (MEI). MEI's were then used to calculate the maximum sustainable yield (MSY) for all species using the following equation:

$$\log_{10}\text{MSY}=0.05(\text{temp})+0.28(\log_{10}\text{MEI})+0.236 \text{ (Schlesinger and Regier, 1982).}$$

The temperature variables used in the above equation are from annual air temperature data collected from atmospheric weather stations (Environment Canada, 1993). The calculated MSY for all species was then partitioned using lake trout biomass data obtained from experimental gillnet catch data to determine the lake trout MSY.

4.4 Index Gillnetting

Index gillnetting on both lakes was performed during the month of July 1994. The experimental fishing effort was based upon an objective of obtaining a minimum of 250 lake whitefish. Gillnet gangs were set off points of land perpendicular to shore. Each standard gang consisted of seven sinking multifilament gillnets with mesh sizes arranged in the following order: 3.8 cm, 11.4 cm, 6.4 cm, 8.9 cm, 12.7 cm, 10.2 cm and 7.6 cm. Each gillnet was 22.9 metres long (total length) and 2.4 metres deep. Gangs were set overnight for approximately 24 hours. An effort was made to set nets in a variety of shoreline habitats in each lake. Set locations for each lake are shown in Appendix I.

Lake trout, lake whitefish, round whitefish, broad whitefish, arctic grayling and northern pike were measured for fork length, while for burbot, total length was used. Fish were sampled for weight, sex, sexual maturity, age and stomach contents. Arctic grayling, lake whitefish, broad whitefish and round whitefish stomach contents were examined using a dissecting microscope in the lab. Stomach contents from northern pike, burbot and lake trout were identified visually in the field. Longnose sucker and least cisco were measured and weighed only.

For age determination, otoliths were used, except for northern pike where the cleithrum was used. Otoliths were embedded in Arladite epoxy, which is clear, hard and has a low

refractive index. The otolith was then sectioned transversely, using an isomet low-speed saw. A microscope was used to read the annuli. Cleithrums were cleaned and read visually by holding them up to a bright light.

Lake whitefish from both lakes were sampled for the parasite *Triaenophorus crassus*. Fish were sampled by filleting and shaving the fillets into thin slices at right angles to the backbone. The numbers of cysts were totalled for all samples, and the rate of infestation (cysts/45kgs) was determined by using the following formula:

$$\{\text{cyst count/sample weight (kgs)}\} * 100 = \text{rate of infestation}$$

4.5 Other Calculations

Total mortality rates (Z) were calculated according to Robson and Chapman (1961). Only the descending limb of the catch curve and age classes with more than five fish was used in the analysis.

The mean weighted age at sexual maturity was calculated using the corrected version of Abrasov's (1967) original equation (Lysack, 1980). Only fish less than or equal to 20 years of age were used in the analysis.

The relationship between weight (w) and length (l) defines the body condition of a fish population and can be expressed as $W=CL^3$. The coefficient C is multiplied by 10^5 to produce the condition factor. This formula implies that where $CF=1$ growth is isometric. Average condition factors were calculated for lake trout and lake whitefish for both lakes surveyed. Lake trout were grouped into 5 centimetre length classes, while lake whitefish, which are smaller, were grouped in 1 centimetre length classes.

Length-weight scatter plots were curve fitted by least square's regression of logarithmical transformed data. Von Bertalanfy growth curves were derived from age/length scatter plots using an empirical method as described by Payne (1990).

5.0 RESULTS

5.1 Lake Morphometry

The surface areas, volumes and depth variables for each lake are presented in Table 1. Little Salmon Lake has nearly twice the surface area of Quiet Lake and although Quiet has a deeper maximum depth, 170 and 155 metres respectively, the mean depth of Little Salmon is almost triple that of Quiet, 92.6 and 32.9 metres respectively. This difference is reflected in contrasting volumes as Little Salmon Lake has nearly four and a half times the volume of Quiet Lake. Quiet Lake has more gradually sloping shores and a large portion of both ends is much shallower than the deep section in the middle of the lake. Little Salmon Lake has steeply sloped shorelines and is consistently deep in the west end, shallowing only slightly more gradually to the east. Bathymetric maps for each lake are shown in Figures 1 and 2.

5.2 Physical and Chemical Limnology

Water chemistry parameters for Little Salmon and Quiet Lakes are presented in Table 2. Both lakes are low in terms of total dissolved solids (TDS) compared to other Yukon lakes, but Quiet Lake is again quite a bit lower than Little Salmon Lake, at 35 and 96mg/l respectively. Quiet Lake is also consistently lower than Little Salmon Lake in both conductivity and alkalinity. Quiet Lake is very close to pH neutral (7.4) and Little Salmon Lake is only slightly alkaline (8.1).

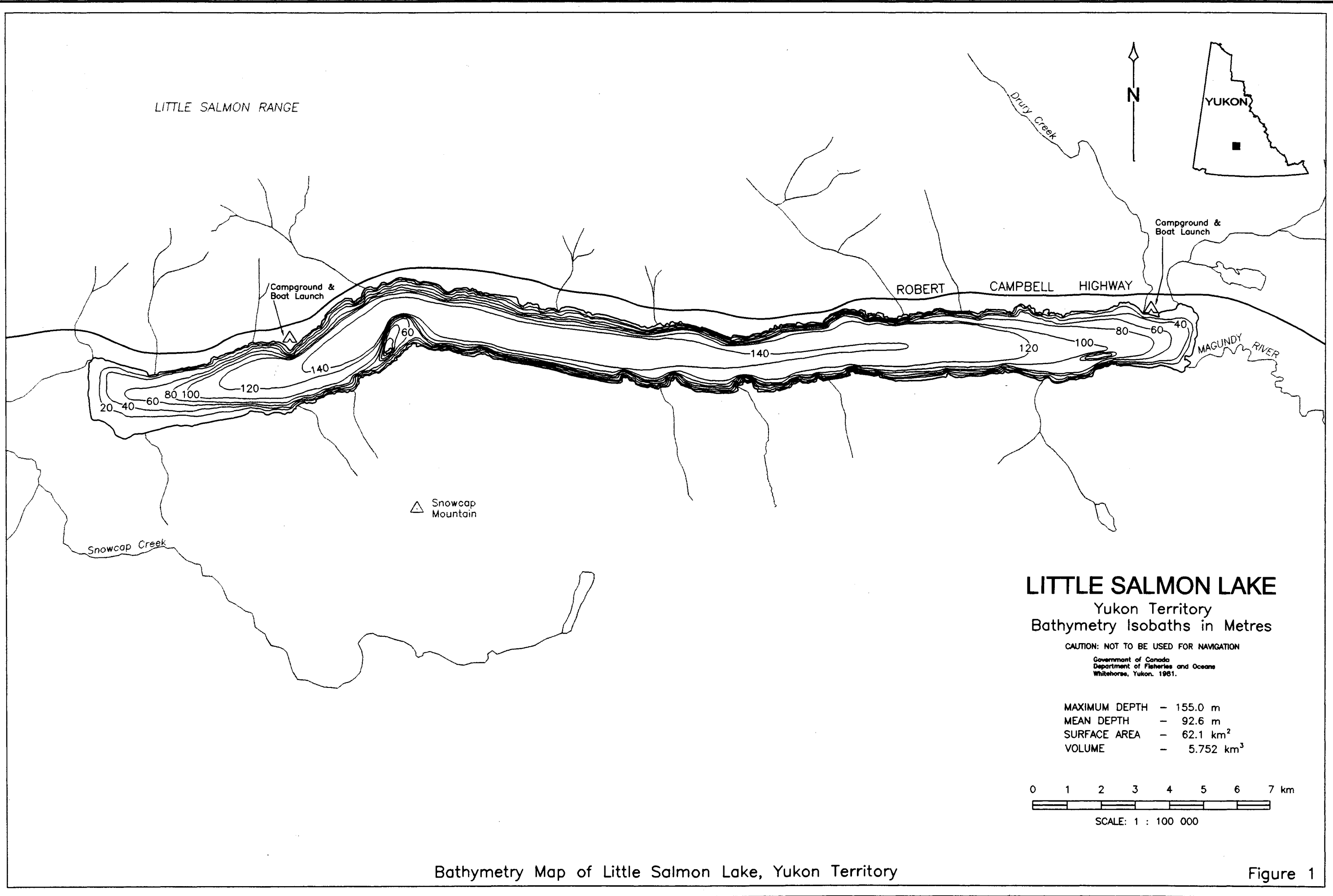
Table 1. Morphometric Data for Little Salmon and Quiet Lakes.

Variable	Lake	
	Little Salmon	Quiet
Surface Area (ha)	6,210	3,780
Volume (km ³)	5.75	1.24
Maximum depth (m)	155	170
Mean depth (m)	92.6	32.9

Table 2. Water chemistry data from profiles on Little Salmon and Quiet Lakes.

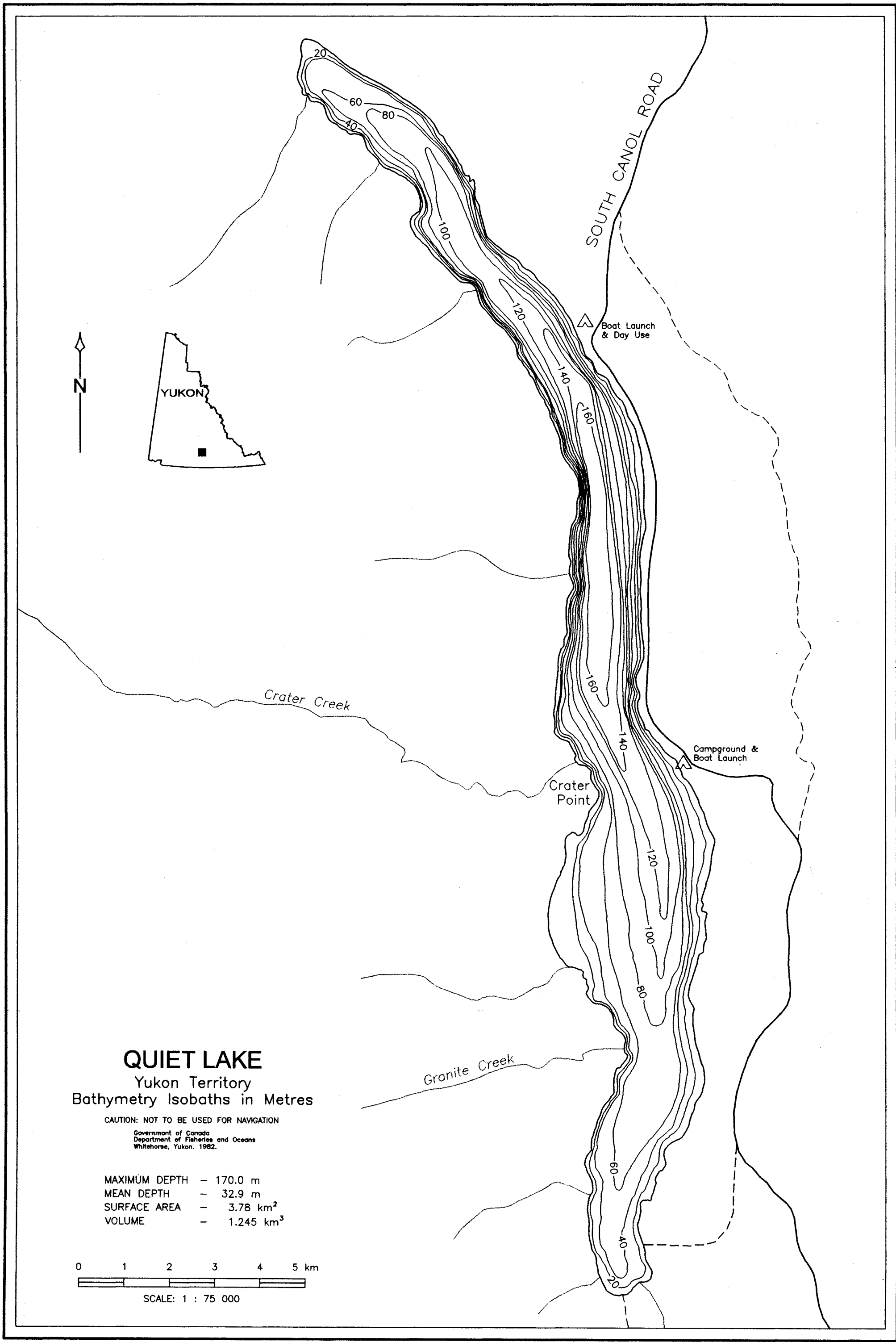
Variable	Lake	
	Little Salmon	Quiet
Total alkalinity (mg/l) ¹	101.4	38.3
TDS (mg/l)	96	35
Conductivity (μS/cm)	150	55
pH	8.1	7.4
Number of Stations	2	2
Sampling Date	July 24, 1997	July 24, 1997

¹ Shortreed and Stockner, 1983.



Bathymetry Map of Little Salmon Lake, Yukon Territory

Figure 1



QUIET LAKE
 Yukon Territory
 Bathymetry Isobaths in Metres

CAUTION: NOT TO BE USED FOR NAVIGATION
 Government of Canada
 Department of Fisheries and Oceans
 Whitehorse, Yukon, 1982.

- MAXIMUM DEPTH - 170.0 m
- MEAN DEPTH - 32.9 m
- SURFACE AREA - 3.78 km²
- VOLUME - 1.245 km³

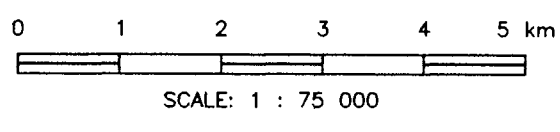


Figure 2

Bathymetry Map of Quiet Lake, Yukon Territory

5.3 Morphoedaphic Index and Yield

The calculated morphoedaphic indices (MEI), mean annual air temperatures and maximum sustained yield (MSY) for all species as well as partitioned calculations for lake trout are presented in Table 3. The MEI for Little Salmon and Quiet Lakes are virtually identical at 1.04 and 1.06 respectively. The MSY (kilograms per hectare) for all species is very similar as well with Little Salmon being only slightly higher than Quiet. The partitioned lake trout MSY results in a higher value for Quiet Lake, 0.69 kgs/ha, compared to 0.48 kgs/ha for Little Salmon Lake.

Table 3. Calculated morphoedaphic indices (MEI), mean annual temperatures and maximum sustainable yields (MSY) for lake trout within Little Salmon and Quiet Lakes.

Variable	Lake	
	Little Salmon	Quiet
MEI	1.04	1.06
Temperature ¹ (°C)	-2.8	-3.8
Surface area (ha)	6,210	3,780
MSY ² all species (kgs)	7,825	4,271
MSY all species (kgs/ha)	1.26	1.13
Lake trout biomass (%)	38.21	60.66
MSY lake trout (kgs)	2,990	2,591
MSY lake trout (kgs/ha)	0.48	0.69

¹ mean annual air temperature (Environment Canada, 1993)

² calculated from (Schlesinger & Reiger, 1982):

$$\log_{10} \text{MSY} = 0.050 \text{ Temperature} + 0.280 \log_{10} \text{MEI} + 0.236$$

5.4 Species Composition and Catch per Unit Effort

The species composition was quite different between these two lakes. As is apparent in Table 4, lake trout were by far the most dominant species caught in Quiet Lake representing 60.1% of the total biomass. In Little Salmon Lake the species with the highest catch biomass was lake whitefish at 49.0%. Lake trout were second highest at 38.2%. By comparison lake whitefish represented 26.8% of the biomass catch on Quiet Lake. Other predator species were represented poorly in the catch on both lakes. Burbot and northern pike each represent only slightly over 2% of the catch biomass in Little Salmon Lake. In Quiet Lake there were no northern pike caught, although they are known to be present in low numbers, and burbot represented only 4% of the total catch biomass. No longnose suckers or broad whitefish were found in Quiet Lake, while broad whitefish and longnose suckers were caught in Little Salmon Lake but only represented a combined total catch biomass of 5%. Round whitefish catches were identical in both lakes representing 4% in each. Arctic grayling were under 1% in both lakes. There is also a difference between the two lakes in regards to cisco biomass. In Quiet Lake they represent over 4% while in Little Salmon only 0.6% of the total catch biomass. This is due to the least cisco in Quiet Lake being of the giant spotted variation, which averaged approximately three times the size of those in Little Salmon Lake.

The catch per unit effort (CPUE) of lake trout, which is an index or relative measure of abundance, was highest on Quiet Lake at 10.29fish/100m/24hours (Table 5). This is approximately one and half times that of Little Salmon Lake. CPUE for lake whitefish was higher than for lake trout on Little Salmon Lake. The CPUE for all species combined was highest on Quiet Lake at 23.34fish/100m/24hours, which is more than double that of 12.25fish/100m/24hours for Little Salmon Lake.

Table 4. Species composition, as percentage of the total catch biomass, from summer index netting on Little Salmon and Quiet Lakes, 1994.

Scientific Name	Species	Lake	
		Little Salmon	Quiet
<i>Salvelinus namaycush</i>	lake trout	38.21	60.66
<i>Coregonus clupeaformis</i>	lake whitefish	49.01	26.77
<i>Coregonus nasus</i>	broad whitefish	4.23	-
<i>Coregonus sardinella</i>	least cisco	0.64	4.05
<i>Prosopium cylindraceum</i>	round whitefish	4.16	3.64
<i>Catostomus catostomus</i>	longnose sucker	0.78	-
<i>Lota lota</i>	burbot	1.52	3.89
<i>Esox lucius</i>	northern pike	1.08	-
<i>Thymallus arcticus</i>	arctic grayling	0.37	0.99

Table 5. Relative catch per unit effort data from summer index netting on Little Salmon and Quiet Lakes, 1994.

Unit	Species	Lake	
		Little Salmon	Quiet
#/100m/24hr	lake trout	4.10 ± 0.95	10.29 ± 4.27
	lake whitefish	5.32 ± 3.12	6.23 ± 3.96
	round whitefish	1.03 ± .76	3.43 ± 3.65
	broad whitefish	0.39 ± 0.39	no catch
	least cisco	0.46 ± 0.38	1.70 ± 2.39
	burbot	0.34 ± 0.27	1.06 ± 0.47
	longnose sucker	0.28 ± 0.25	no catch
	northern pike	0.15 ± 0.15	no catch
	arctic grayling	0.10 ± 0.14	0.63 ± 0.54
	species combined	12.25 ± 4.05	23.34 ± 10.78
kg/100m/24hr	lake trout	5.69 ± 1.32	18.57 ± 7.71
	lake whitefish	6.78 ± 3.97	8.04 ± 5.11
	round whitefish	0.61 ± 0.45	1.02 ± 1.08
	broad whitefish	0.59 ± 0.59	no catch
	least cisco	0.10 ± 0.09	1.57 ± 2.21
	burbot	0.24 ± 0.19	1.09 ± 0.48
	longnose sucker	0.12 ± 0.11	no catch
	northern pike	0.15 ± 0.15	no catch
	arctic grayling	0.05 ± 0.07	0.30 ± 0.26
	species combined	14.53 ± 4.80	30.37 ± 14.02

5.5 Age and Growth

5.5.1 Lake trout

Age specific mean fork lengths and weights for lake trout are presented in Tables 6 and 7. Age frequency distributions for both lakes are presented in Figure 3. Age-length scatter plots can be found in Figure 4.

Sixty-seven of the 78 lake trout that were caught on Little Salmon Lake were aged and they ranged from 2 years to 38 years of age. The mean age was 15 years and the modal age was 15 years. Ninety-seven of the 115 lake trout that were caught on Quiet Lake were aged and they ranged from 3 years to 41 years of age. The mean age was 14 years and the modal age was 12 years.

Length frequency distributions are shown in Figure 5. Fork lengths of lake trout captured on Little Salmon Lake ranged from 173mm to 975mm. The mean length was 469mm while the modal length was 490mm. Lake trout captured on Quiet Lake ranged from a fork length of 200mm to 924mm. The mean length was 498mm and the modal length was 450mm.

Length-weight scatter plots and linear equations for both lakes are presented in Figure 6 and Table 8. For most lengths lake trout from Quiet Lake are heavier than those from Little Salmon Lake.

Table 6. Age specific mean fork lengths and weights of lake trout from Little Salmon Lake, 1994.

Age	Male			Female			Combined ¹		
	N	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)
2							1	205.00	75.00
3							2	181.00	87.50
4	1	232.00	200.00				1	232.00	200.00
5				1	235.00	100.00	1	235.00	100.00
6	2	296.50	200.00	1	305.00	250.00	3	299.33	216.67
7				2	367.00	550.00	2	367.00	550.00
8	2	431.50	775.00	3	357.67	433.33	6	385.17	583.33
9	1	435.00	900.00				1	435.00	900.00
10	3	408.00	633.33	1	491.00	800.00	5	417.00	640.00
11				1	423.00	550.00	1	423.00	550.00
12	2	450.00	925.00	3	429.33	933.33	5	437.60	930.00
13	2	488.50	1500.00				2	488.50	1500.00
14	3	483.67	733.33	1	448.00	800.00	4	474.75	750.00
15	2	562.00	2050.00	5	474.60	1140.00	7	499.57	1400.00
16	4	496.50	1225.00				4	496.50	1225.00
18	2	545.00	1625.00	1	522.00	1400.00	3	537.33	1550.00
19				3	524.33	1633.33	3	524.33	1633.33
21	2	425.00	900.00	1	637.00	2900.00	3	495.67	1566.67
22				1	460.00	1050.00	1	460.00	1050.00
23	1	492.00	1000.00	1	545.00	1650.00	2	518.50	1325.00
24	1	544.00	1100.00	1	740.00	4450.00	2	642.00	2775.00
25	1	531.00	1250.00	1	534.00	1700.00	2	532.00	1475.00
26				1	664.00	3900.00	1	664.00	3900.00
27	1	572.00	1800.00				1	572.00	1800.00
28				1	720.00	4700.00	1	720.00	4700.00
30	1	975.00	13500.00				1	975.00	13500.00
35				1	565.00	1850.00	1	565.00	1850.00
38				1	465.00	1200.00	1	465.00	1200.00

¹ includes fish of unknown sex

Table 7. Age specific mean fork lengths and weights of lake trout from Quiet Lake, 1994.

Age	Male			Female			Combined ¹		
	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)
3							1	200.00	100.00
4							2	244.00	150.00
5				2	355.50	525.00	2	355.50	525.00
6	1	365.00	500.00				1	365.00	500.00
7	2	381.50	612.50	3	357.33	466.67	5	367.00	525.00
8	2	369.50	462.50	6	409.50	720.83	8	399.50	656.25
9	1	410.00	750.00	5	418.40	820.00	7	426.14	835.71
10	1	348.00	500.00	1	483.00	1050.00	3	420.33	766.67
11	4	473.75	1137.50	4	454.00	1037.50	8	463.88	1087.50
12	3	471.67	1533.33	7	476.14	1128.57	10	474.80	1250.00
13				8	501.88	1381.25	8	501.88	1381.25
14	2	497.50	1300.00	4	539.75	1750.00	6	525.67	1600.00
15	2	566.00	2600.00	1	455.00	1125.00	3	529.00	2108.33
16	2	446.50	1000.00	1	495.00	1300.00	3	462.70	1100.00
17				2	582.00	2425.00	2	582.00	2425.00
18	1	570.00	1500.00	1	587.00	2500.00	2	578.50	2000.00
19	2	623.50	3250.00	3	577.67	2100.00	5	596.00	2560.00
20				2	551.00	2075.00	2	551.00	2075.00
21				3	520.67	2000.00	3	520.67	2000.00
22	1	749.00	6700.00	5	573.00	2440.00	6	602.33	3150.00
23	2	675.00	6300.00	1	675.00	4075.00	3	675.00	5558.33
24	1	665.00	4150.00				1	665.00	4150.00
26	2	693.00	4550.00				2	693.00	4550.00
28				1	560.00	2000.00	1	560.00	2000.00
29	1	850.00	10300.00				1	850.00	10300.00
32				1	665.00	4100.00	1	665.00	4100.00
41	1	499.00	1500.00				1	499.00	1500.00

¹ includes fish of unknown sex

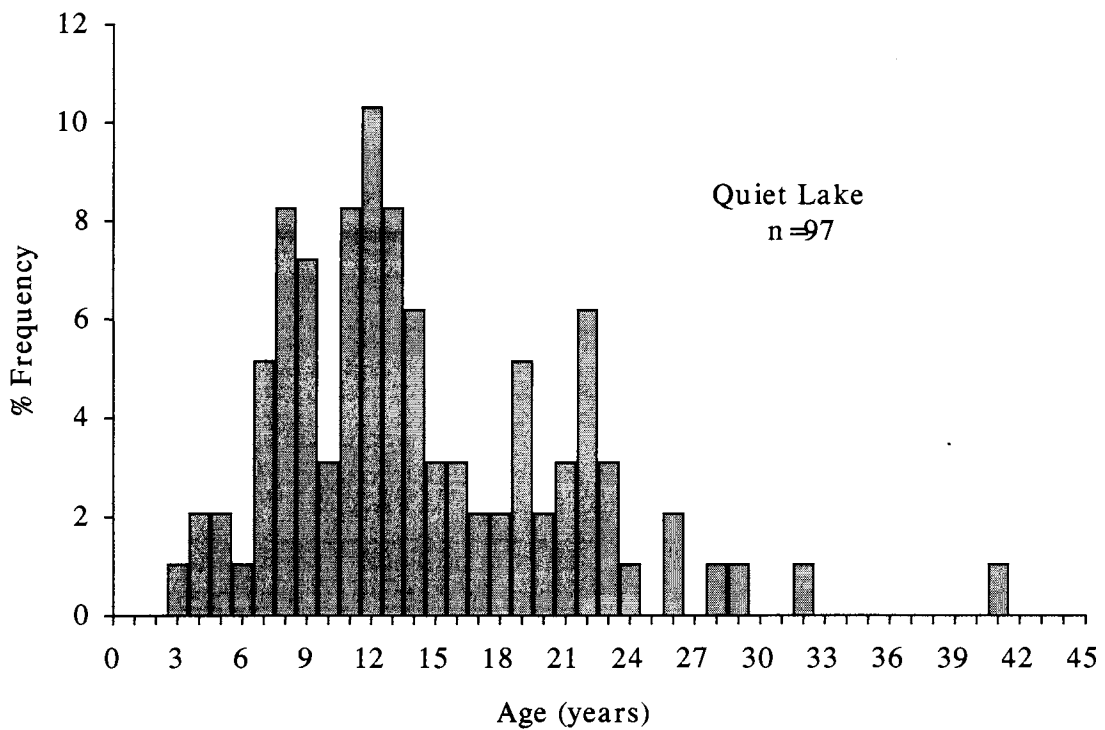
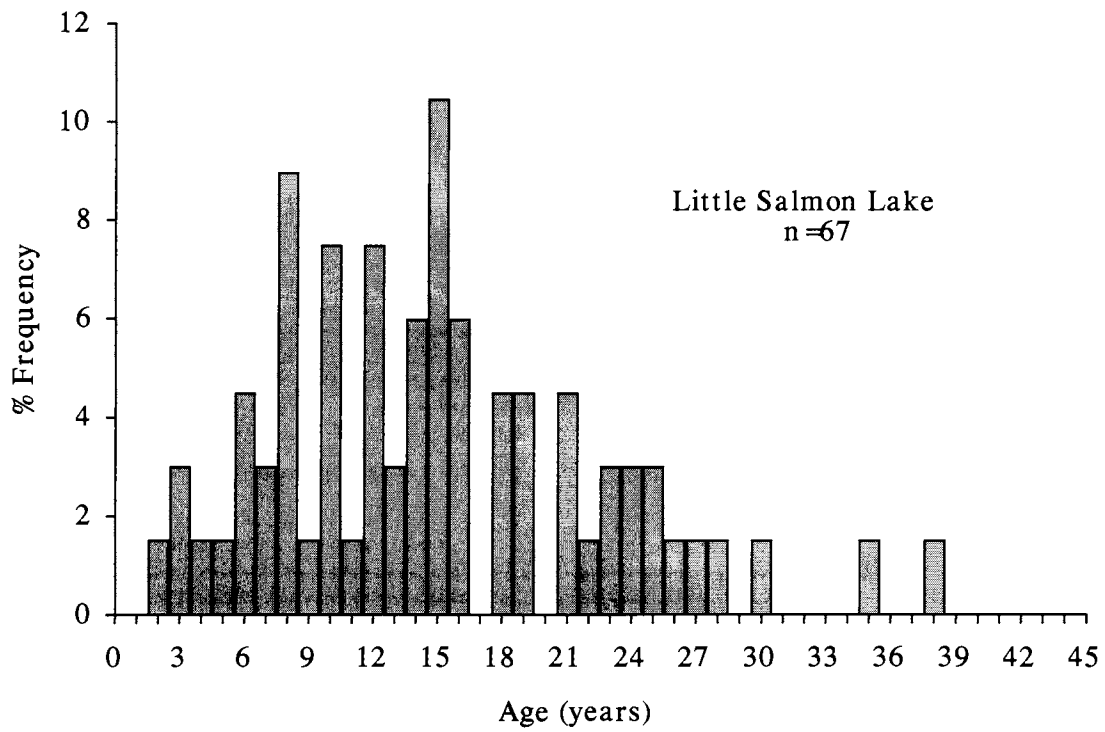


Figure 3. Age frequencies of lake trout caught in index nets on Little Salmon and Quiet Lakes, 1994.

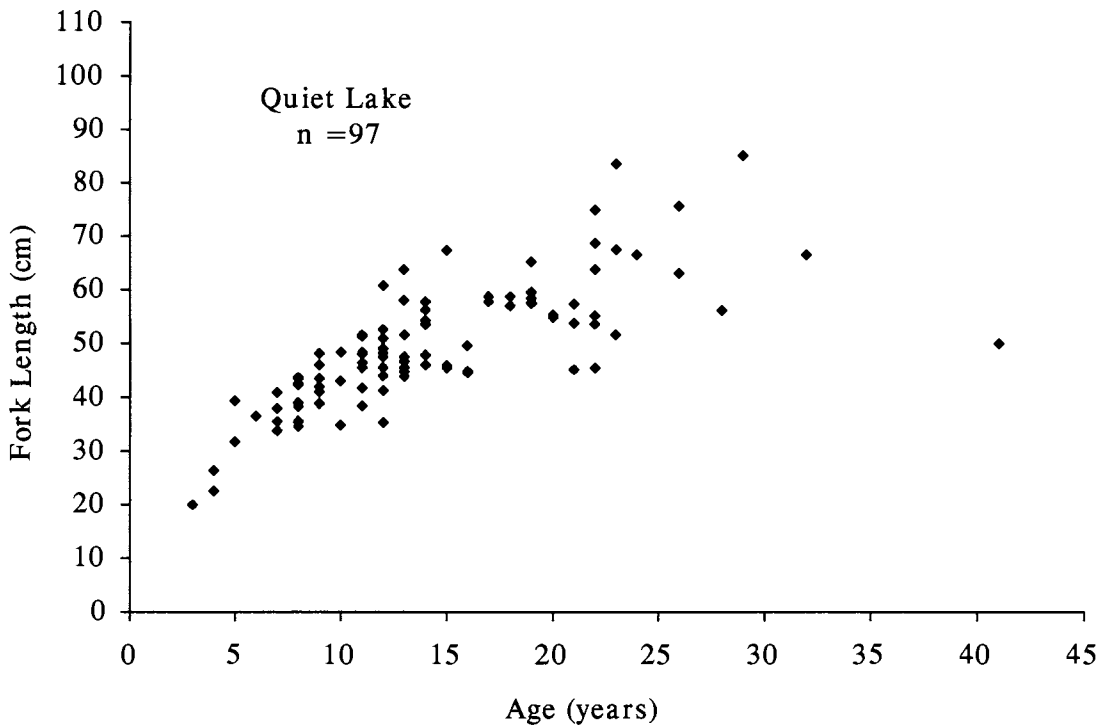
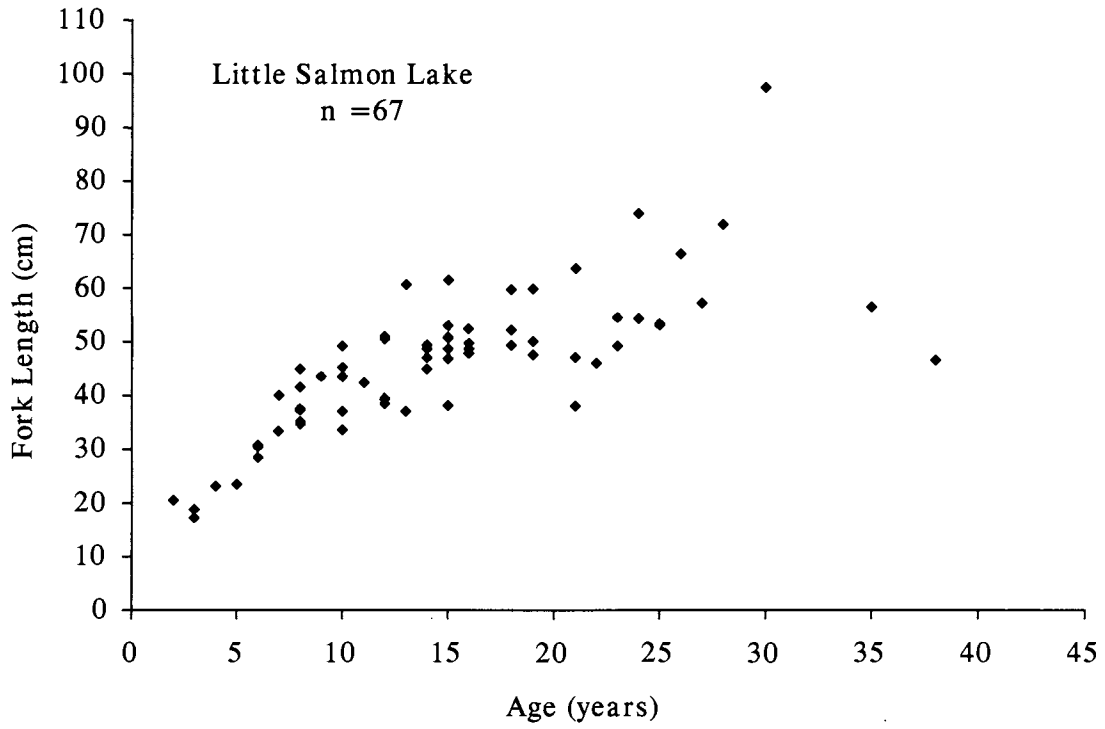


Figure 4. Age-length scatter plots of lake trout from Little Salmon and Quiet Lakes, 1994.

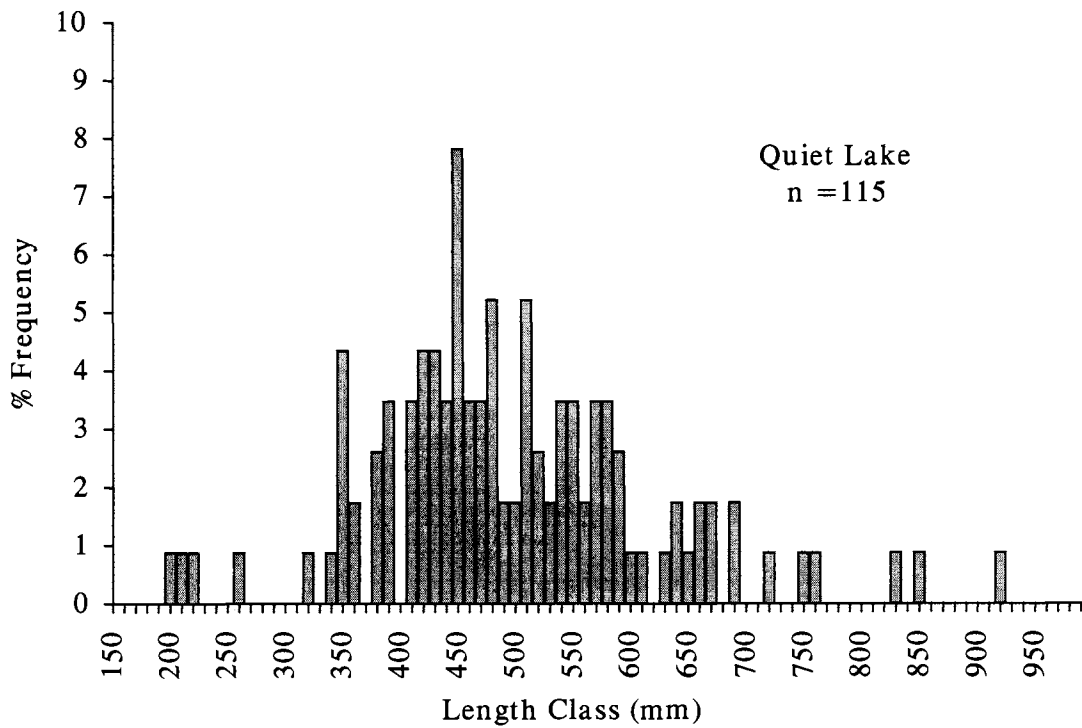
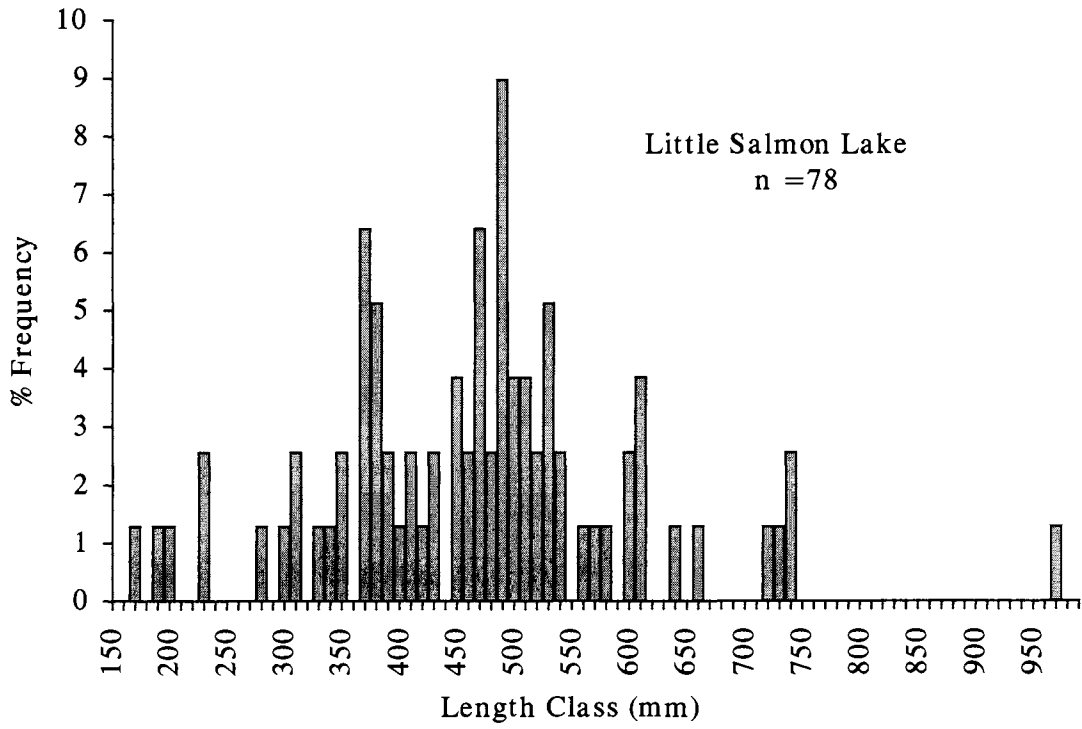


Figure 5. Length frequencies of lake trout caught in index nets on Little Salmon and Quiet Lakes, 1994.

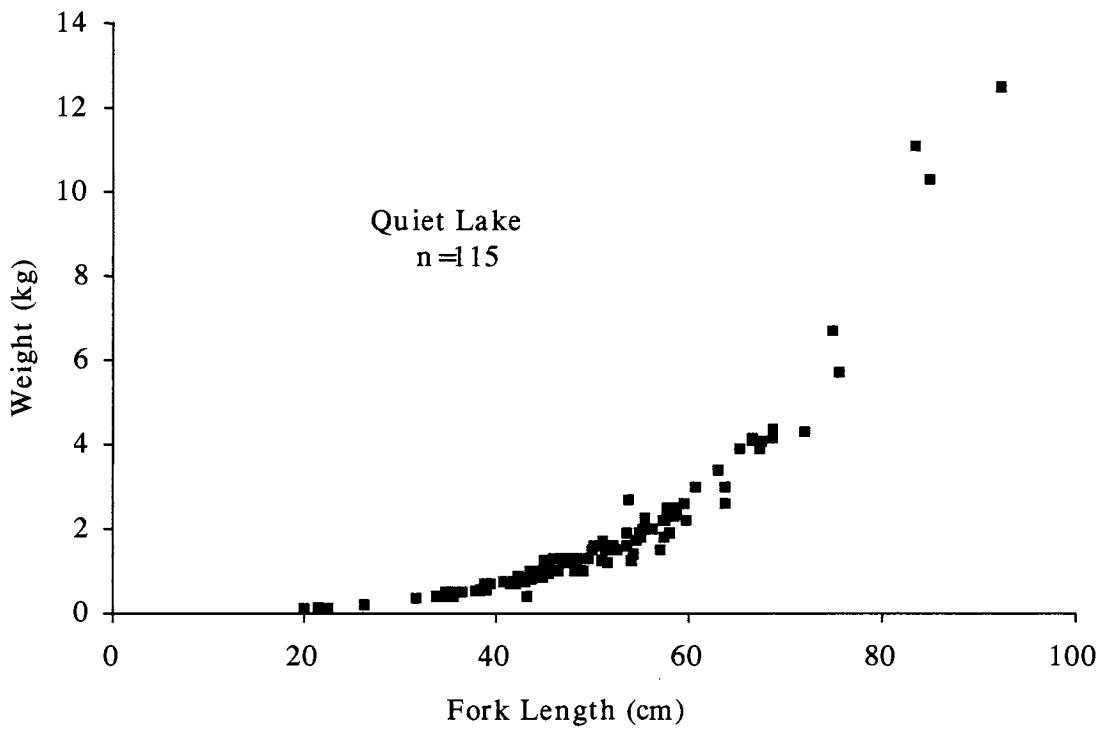
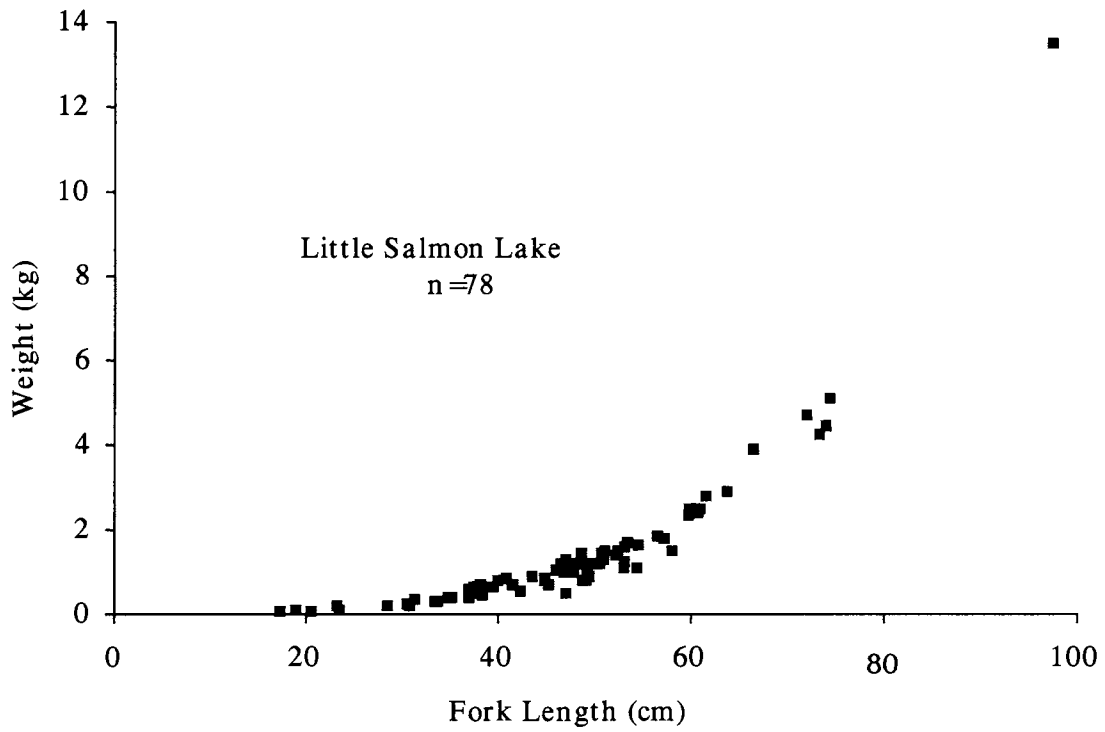


Figure 6. Length-weight scatter plots of lake trout from Little Salmon and Quiet Lakes, 1994.

Table 8. Sex specific length-weight relationships of lake trout from Little Salmon and Quiet Lakes, 1994.

Lake	Sex	Length-Weight Equation	n	r ²
Little Salmon	M	Log ₁₀ weight = -5.35 + Log ₁₀ length (3.12)	38	0.9220
	F	Log ₁₀ weight = -5.65 + Log ₁₀ length (3.25)	35	0.9679
	Combined	Log ₁₀ weight = -5.08 + Log ₁₀ length (3.03)	78	0.9501
Quiet	M	Log ₁₀ weight = -6.21 + Log ₁₀ length (3.47)	38	0.9795
	F	Log ₁₀ weight = -5.57 + Log ₁₀ length (3.23)	70	0.9530
	Combined	Log ₁₀ weight = -5.67 + Log ₁₀ length (3.27)	115	0.9651

The average condition factor for lake trout is also higher for Quiet Lake than for Little Salmon Lake, 1.14 and 1.01 respectively (Figure 7). Both lakes have an average condition factor of over 1.0, which is indicative of lake trout that are heavy for their length.

Age-length scatter plots and Von Bertalanfy growth variables are presented in Figure 4 and Table 9. Lake trout growth rates are higher for Quiet Lake, they grow to a longer length for their age on Quiet Lake and the largest calculated asymptotic size was also calculated for Quiet Lake.

Of observed lake trout stomachs containing food, those from both lakes had a mixture of invertebrates and fish. Stomachs from Quiet Lake had a higher occurrence of fish and the invertebrate portion was dominated by Trichoptera and Diptera, while on Little Salmon Lake the occurrence of fish was lower and the invertebrates were dominated by Coleoptera, Hymenoptera and Diptera (Table 10).

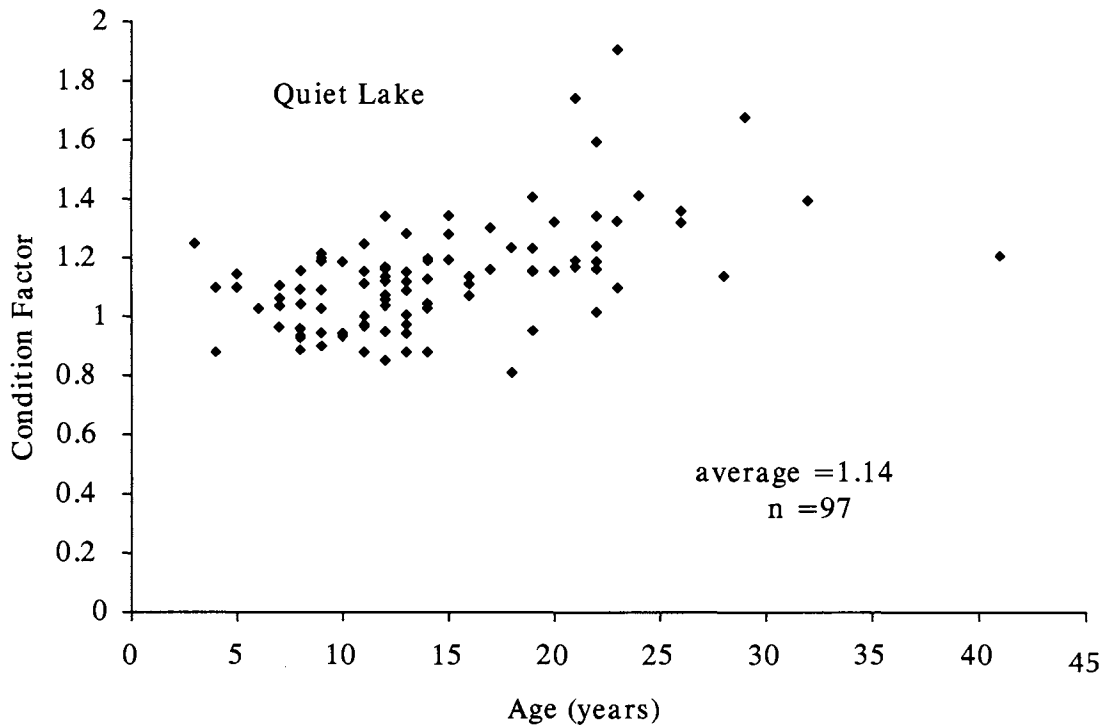
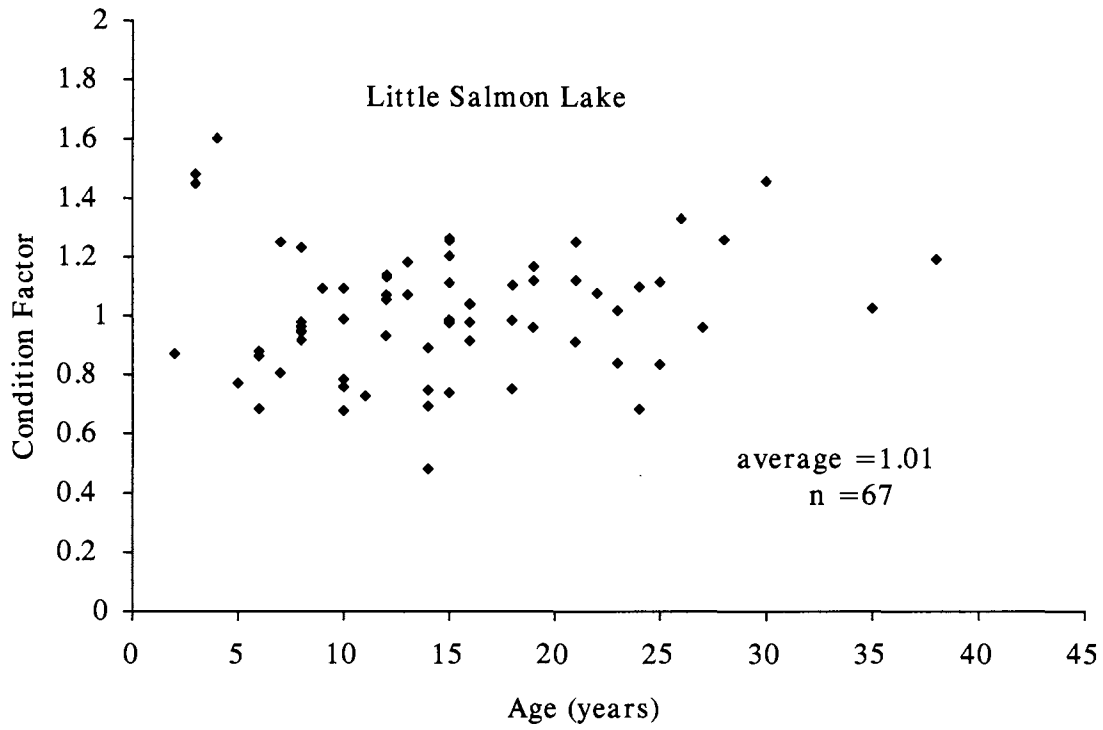


Figure 7. Condition factors at age of lake trout from Little Salmon and Quiet Lakes, 1994.

Table 9. Von Bertalanfy growth variables for lake trout and lake whitefish captured from summer index netting on Little Salmon and Quiet Lakes, 1994.

Species	Lake	L_{∞} '(mm)	K'	Age Range	n
Lake Trout	Little Salmon	798	0.067	8,10,12,16,16	27
	Quiet	806	0.072	7-9,11-14,19,22	63
Lake Whitefish	Little Salmon	520	0.142	3,9,11,19,22,23	48
	Quiet	530	0.143	9,10,12-14,24	36

Table 10. Frequencies of occurrence of food items within stomachs of fish species captured from summer index netting programs within Little Salmon and Quiet Lakes, 1994.

Lake	Species	Food Items																					
		Unidentified Mammal	Unidentified Fish	Coregonids	Unidentified	Round Whitefish	Least Cisco	Lake Whitefish	Burbot	Shiny Sculpin	Invertebrates	Unidentified	Bivalves (clams)	Gastropods (Snails)	Caddisflies (Trichoptera)	Stoneflies (Plecoptera)	Orthoptera (Grasshoppers)	Hymenoptera (ants/wasps)	Coleoptera (Beetles)	Diptera (Flies)	Crustaceans	Arachnida (Spider/Mites)	Oligochaeta (worms)
Little Salmon	Lake Trout		9	2	1	3	12	2	2	2	1	2	3	2			9	2	32	11		1	
	Lake Whitefish		2					1	4	6	38	119	3	4	1	1	1	4	32	1	3	4	
	Round Whitefish										1	2	6						2		1		
	Broad Whitefish										6	3		1					5				
	Least Cisco										1								1	3			
	Burbot		1		1					1													
	Arctic Grayling												1		1		1	2	1				
Quiet	Lake Trout	1	28	7	8	5	6	4				2	44				3	1	2	15	1		
	Lake Whitefish									1	12	55	12				2		18	4	1		
	Round Whitefish										2	7	13	1				1	4	5			
	Least Cisco																				7		
	Burbot		7																				
	Arctic Grayling											1	4				3	1	7	6		2	

5.5.2 Lake Whitefish

Age specific mean fork lengths and weights for lake whitefish are presented in Tables 11 and 12. Age frequency distributions for both lakes are presented in Figure 8. Age-length scatter plots are presented in Figure 9.

Ninety-eight of the 109 lake whitefish caught on Little Salmon Lake were aged and they ranged from 2 years to 39 years of age, with a mean age of 17.2 years and a modal age of 23 years. Sixty-six of the 71 lake whitefish caught on Quiet Lake were aged and they ranged from 6 years to 40 years of age, with a mean age of 14.9 years and a modal age of 9 and 14 years.

Table 11. Age specific mean fork lengths and weights of lake whitefish from Little Salmon Lake, 1994.

Age	Male			Female			Combined ¹		
	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)
2							2	155.00	50.00
3				1	247.00	100.00	7	204.43	85.71
4				1	261.00	300.00	1	261.00	300.00
7	1	463.00	1350.00				1	463.00	1350.00
8	3	422.00	866.67				3	422.00	866.67
9	3	446.33	1116.67	4	459.75	1250.00	7	454.00	1192.86
10	2	456.50	1250.00				3	455.67	1133.33
11	2	469.00	1325.00	3	456.00	1250.00	5	461.20	1280.00
12	2	451.50	1275.00	2	497.50	1500.00	4	474.50	1387.50
13	2	484.00	1550.00	1	492.00	1500.00	3	486.67	1533.33
14				2	491.00	1550.00	3	485.00	1366.67
15				2	501.00	1250.00	2	501.00	1250.00
16				1	500.00	1700.00	1	500.00	1700.00
17	2	458.00	1150.00	1	489.00	1700.00	3	468.33	1333.33
18	1	500.00	1400.00	2	490.50	1500.00	3	493.67	1466.67
19	4	479.50	1437.50	3	482.00	1566.67	7	480.57	1492.86
20	2	456.00	1575.00				2	456.00	1575.00
21	2	499.50	1250.00	2	478.50	1500.00	4	489.00	1375.00
22	5	488.40	1390.00	5	491.80	1420.00	10	490.10	1405.00
23	2	490.00	1425.00	10	495.70	1515.00	12	494.75	1500.00
24	1	490.00	1650.00	2	479.50	1475.00	3	483.00	1533.33
26				2	503.50	1175.00	2	503.50	1175.00
27				1	510.00	2100.00	1	510.00	2100.00
28				1	473.00	1350.00	1	473.00	1350.00
30				1	494.00	2000.00	1	494.00	2000.00
31	1	515.00	1950.00				1	515.00	1950.00
32				1	500.00	1400.00	1	500.00	1400.00
33	1	501.00	1700.00	2	476.50	1350.00	3	484.67	1466.67
37	1	486.00	1200.00				1	486.00	1200.00
39				1	504.00	1200.00	1	504.00	1200.00

¹ includes fish of unknown sex

Table 12. Age specific mean fork lengths and weights of lake whitefish from Quiet Lake, 1994.

Age	Male		Female		Combined ¹				
	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)	n	Mean Length (mm)	Mean Weight (gm)
6	1	394.00	700.00	1	328.00	500.00	2	361.00	600.00
7	1	405.00	1000.00	3	406.67	908.33	4	406.25	931.25
8	1	375.00	700.00				1	375.00	700.00
9	2	404.50	900.00	6	424.00	991.67	8	419.13	968.75
10	2	436.00	1187.50	2	397.00	900.00	5	415.20	995.00
11				2	451.50	1225.00	2	451.50	1225.00
12	4	452.00	1225.00	1	405.00	1000.00	5	442.60	1180.00
13	3	457.00	1083.33	2	443.50	1112.50	5	451.60	1095.00
14	4	463.25	1412.50	4	481.25	1500.00	8	472.25	1456.25
15				2	476.50	1350.00	2	476.50	1350.00
16	1	500.00	1500.00	3	484.00	1700.00	4	488.00	1650.00
17	2	470.00	1450.00	1	468.00	1300.00	3	469.33	1400.00
18	3	477.33	1316.67				3	477.33	1316.67
20				1	517.00	1600.00	1	517.00	1600.00
21	1	525.00	2025.00				1	525.00	2025.00
22				2	513.50	1700.00	2	513.50	1700.00
23	1	446.00	1500.00				1	446.00	1500.00
24	2	518.50	1725.00	3	496.67	1758.33	5	505.40	1745.00
25	1	494.00	1400.00				1	494.00	1400.00
28	1	472.00	1500.00				1	472.00	1500.00
31	1	514.00	1600.00				1	514.00	1600.00
40				1	523.00	1700.00	1	523.00	1700.00

¹ includes fish of unknown sex

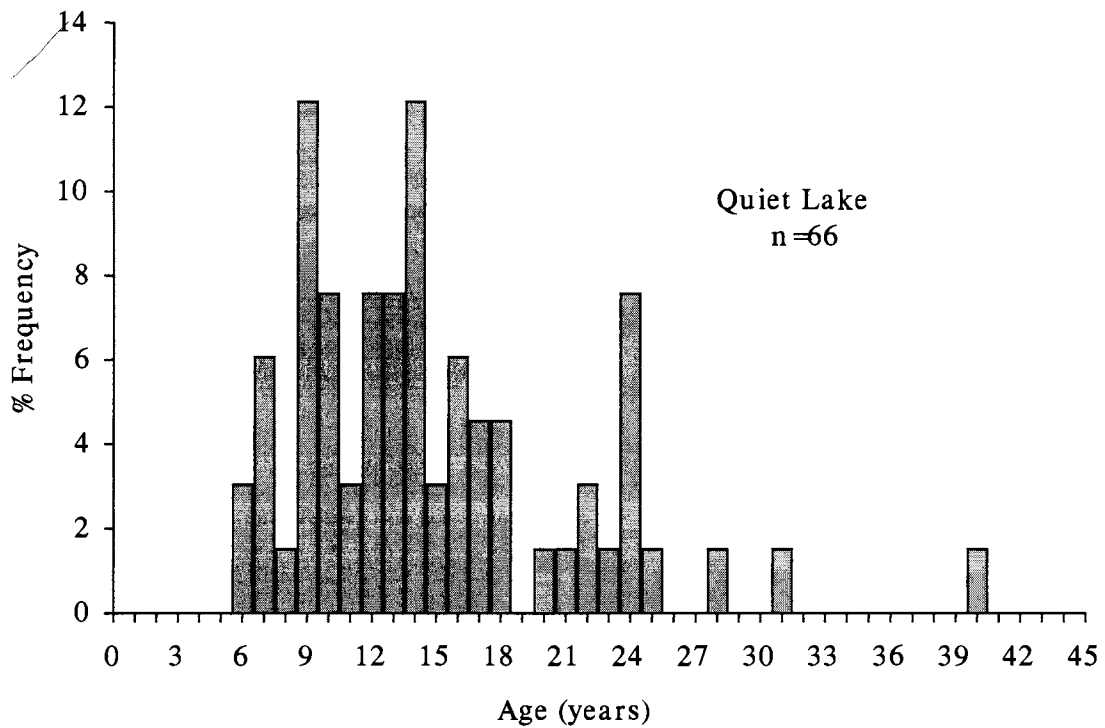
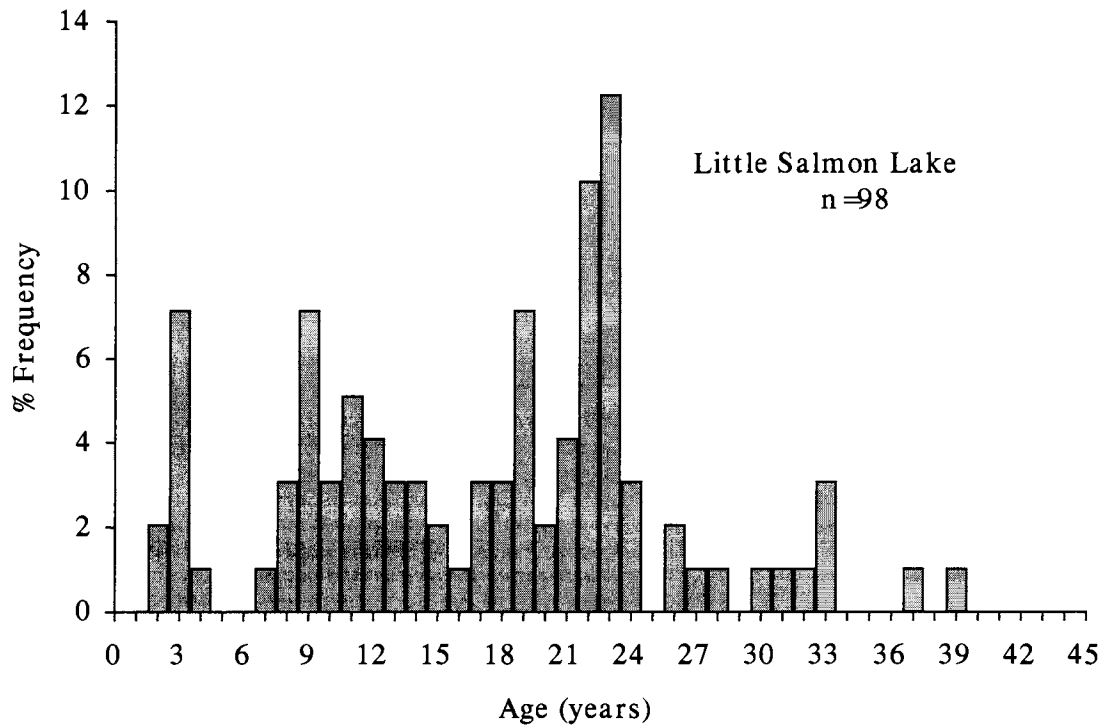
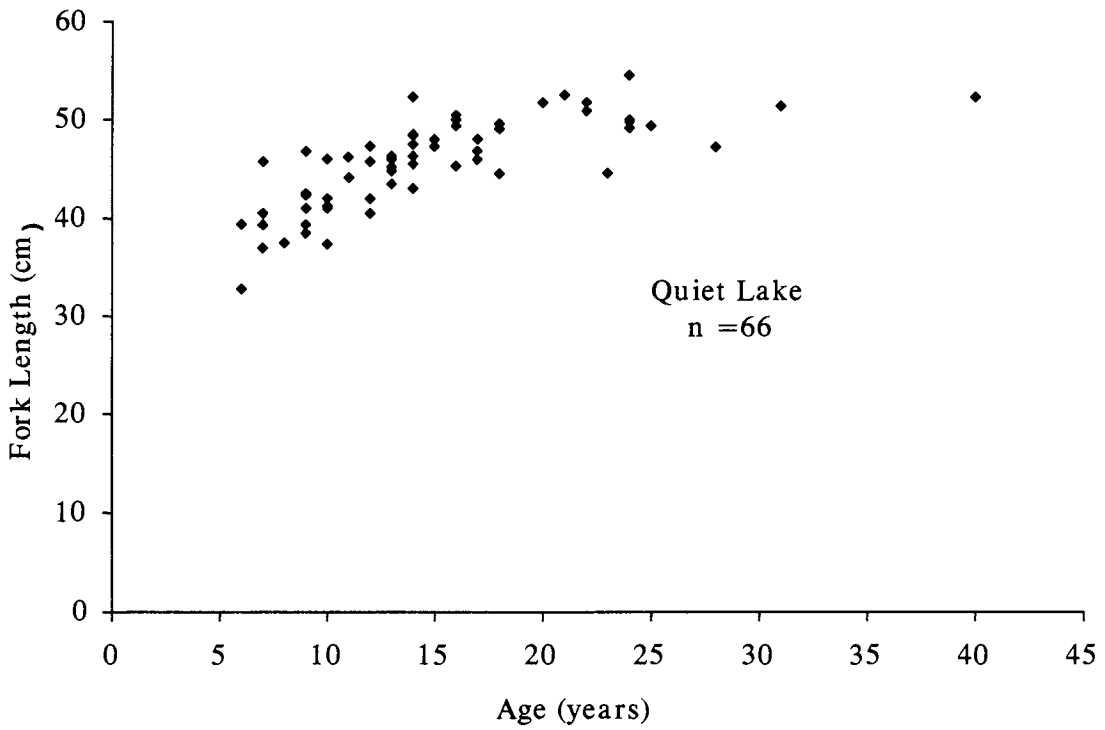
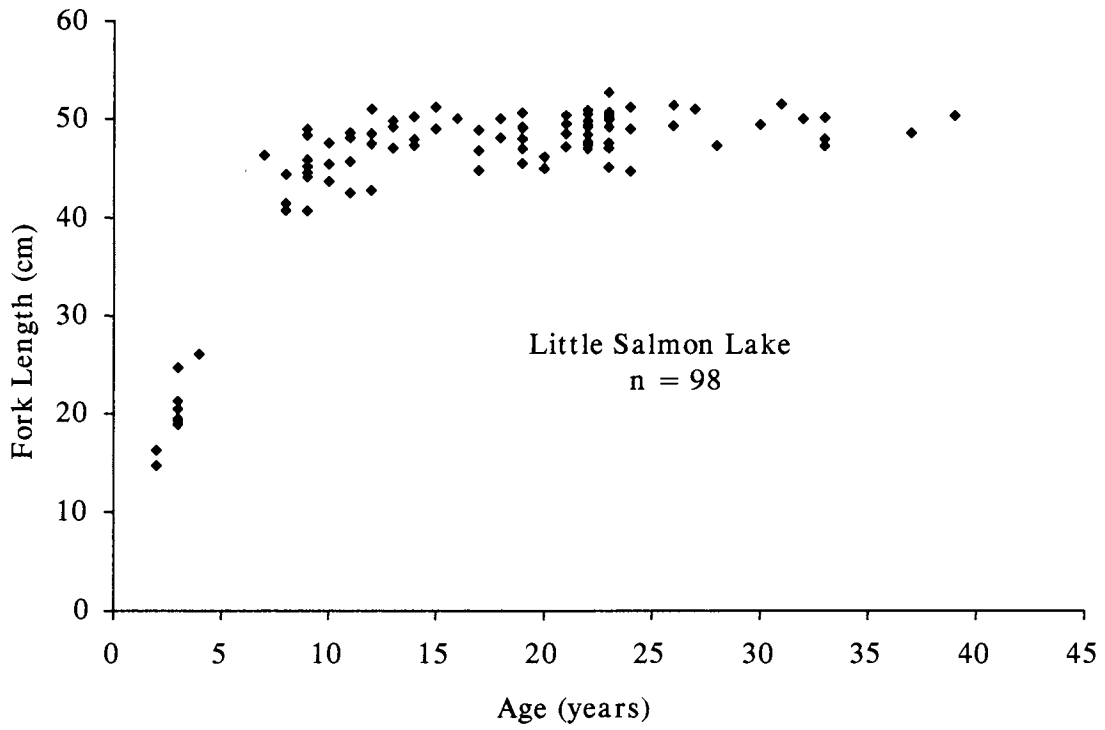


Figure 8. Age frequencies of lake whitefish caught in index nets on Little Salmon and Quiet Lakes, 1994.



Length frequency distributions for lake whitefish are shown in Figure 10. Fork lengths of fish captured in Little Salmon Lake ranged from 150 to 530mm. The mean length was 455mm while the mode was 500mm. Lake whitefish captured on Quiet Lake ranged from a fork length of 330 to 540mm. Mean length was 457mm while the mode was 460mm.

Length-weight scatter plots and linear equations for both lakes are presented in Figure 11 and Table 13. Length-weight relationships from the two lakes are quite comparable with lake whitefish from Little Salmon Lake being slightly heavier for most lengths.

The average condition factor for lake whitefish is slightly higher for Quiet Lake than for Little Salmon Lake, 1.32 to 1.24 (Figure 12). Both lakes have condition factors of well over 1.0, which is indicative of fish that are heavy for their length.

Age-length scatter plots and Von Bertalanfy growth variables are presented in Figure 9 and Table 9. Lake whitefish growth rates are almost identical for both lakes, they grow only slightly longer for their age on Little Salmon Lake, and the largest calculated asymptotic size is slightly larger for Quiet Lake.

Of observed lake whitefish stomachs containing food, fish from both lakes consumed predominantly invertebrates. Snails, clams and flies were the most common with caddis flies being found in both lakes. No fish were found in the diet of lake whitefish from Quiet Lake while there was a small frequency found in the diet of those from Little Salmon Lake (Table 10).

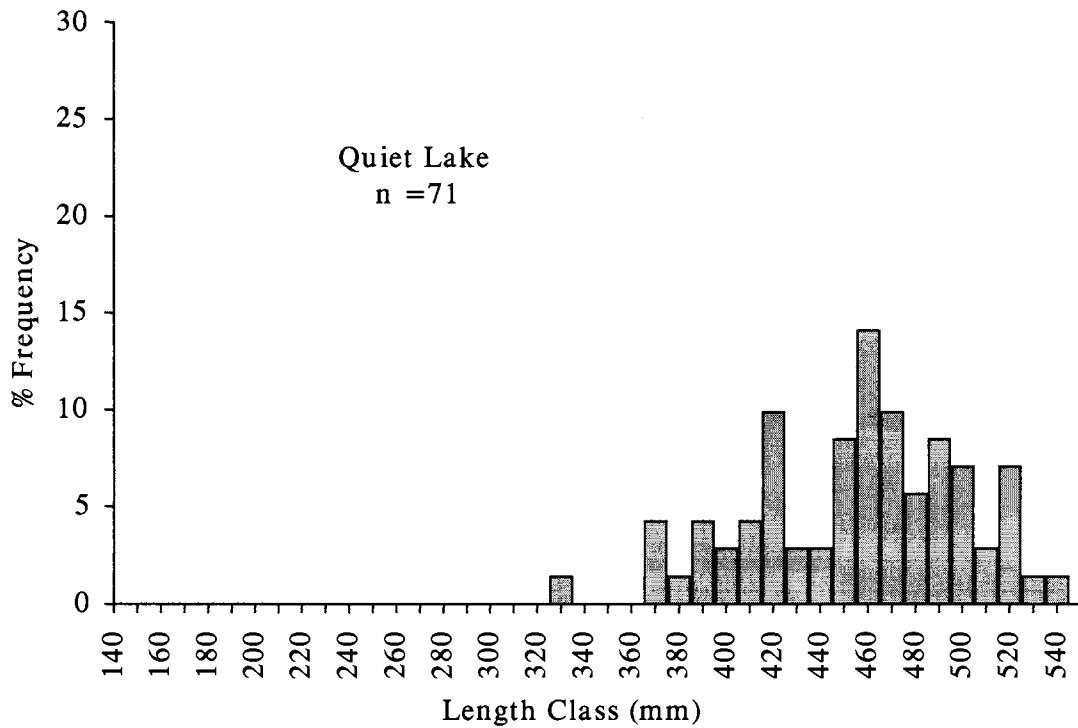
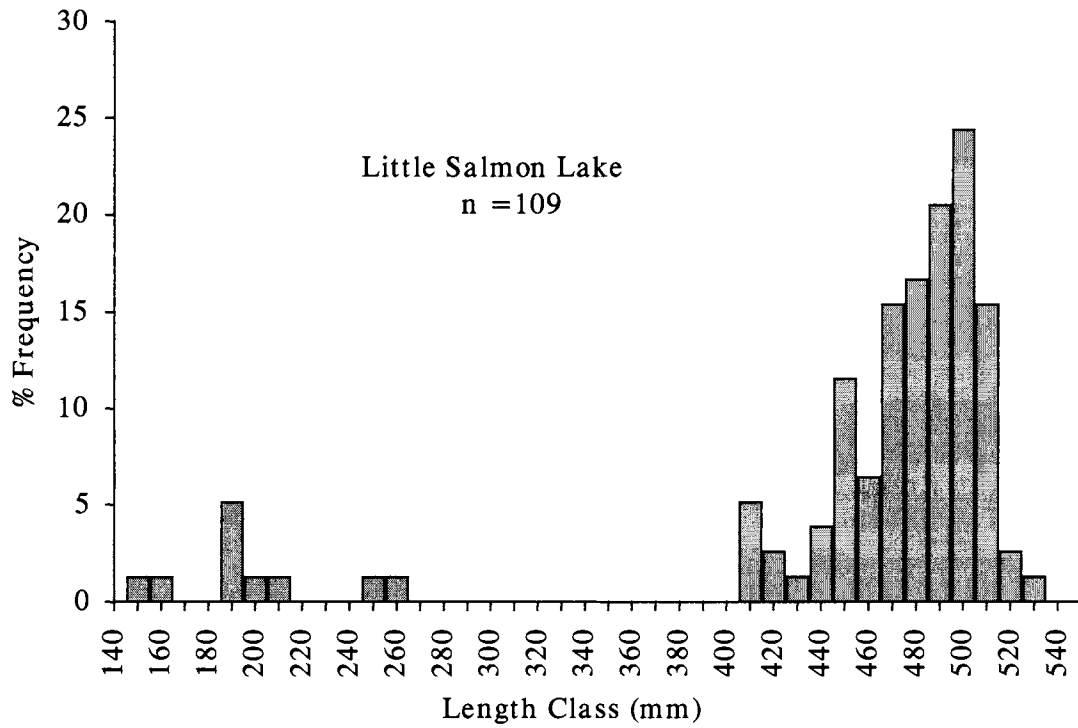


Figure 10. Length frequencies of lake whitefish caught in index nets on Little Salmon and Quiet Lakes, 1994.

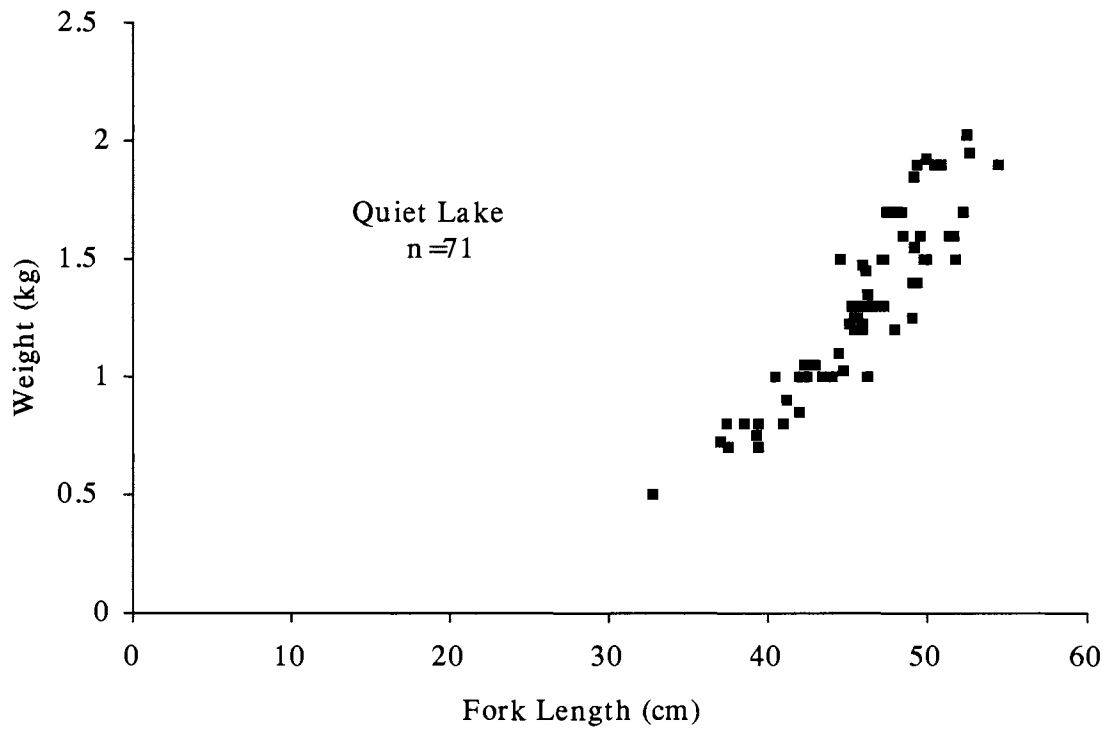
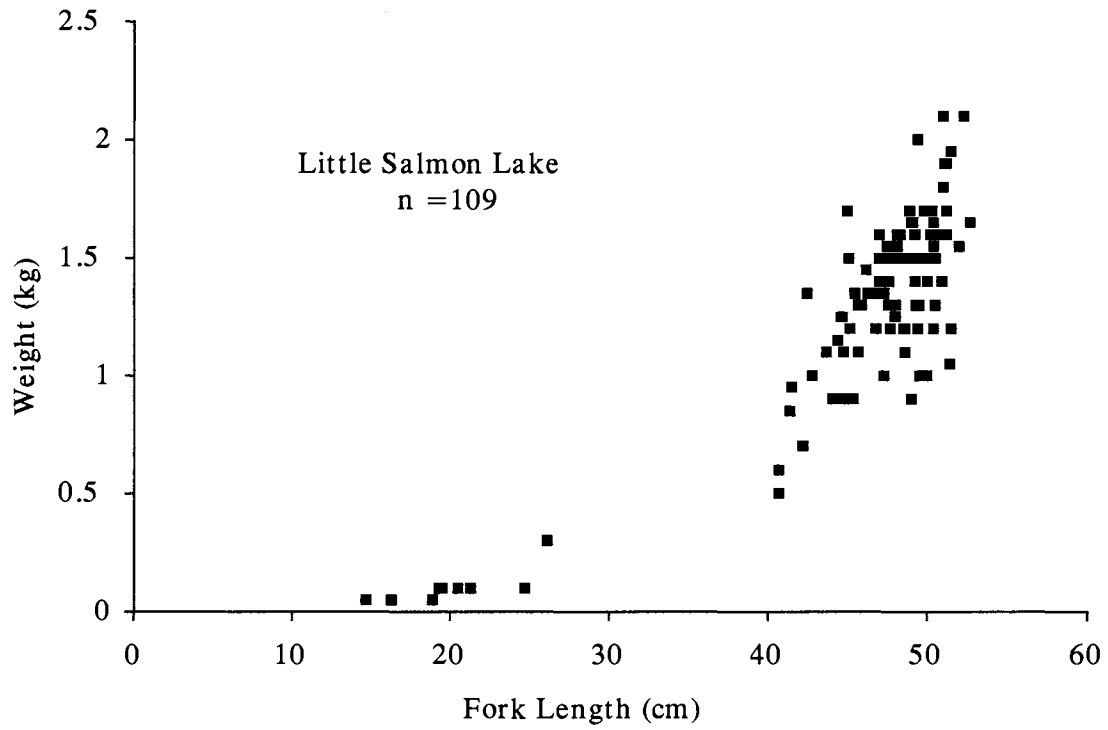


Figure 11. Length-weight scatter plots of lake whitefish from Little Salmon and Quiet Lakes, 1994.

Table 13. Sex specific length-weight relationships of lake whitefish from Little Salmon and Quiet Lakes, 1994.

Lake	Sex	Length-Weight Equation	n	r ²
Little Salmon	M	Log ₁₀ weight = -4.84 + Log ₁₀ length (2.97)	38	0.5046
	F	Log ₁₀ weight = -5.36 + Log ₁₀ length(3.17)	61	0.8040
	Combined	Log ₁₀ weight = -5.18 + Log ₁₀ length (3.10)	109	0.9465
Quiet	M	Log ₁₀ weight = -4.43 + Log ₁₀ length (2.83)	33	0.8274
	F	Log ₁₀ weight = -4.42 + Log ₁₀ length (2.83)	37	0.9060
	Combined	Log ₁₀ weight = -4.47 + Log ₁₀ length (2.85)	71	0.8756

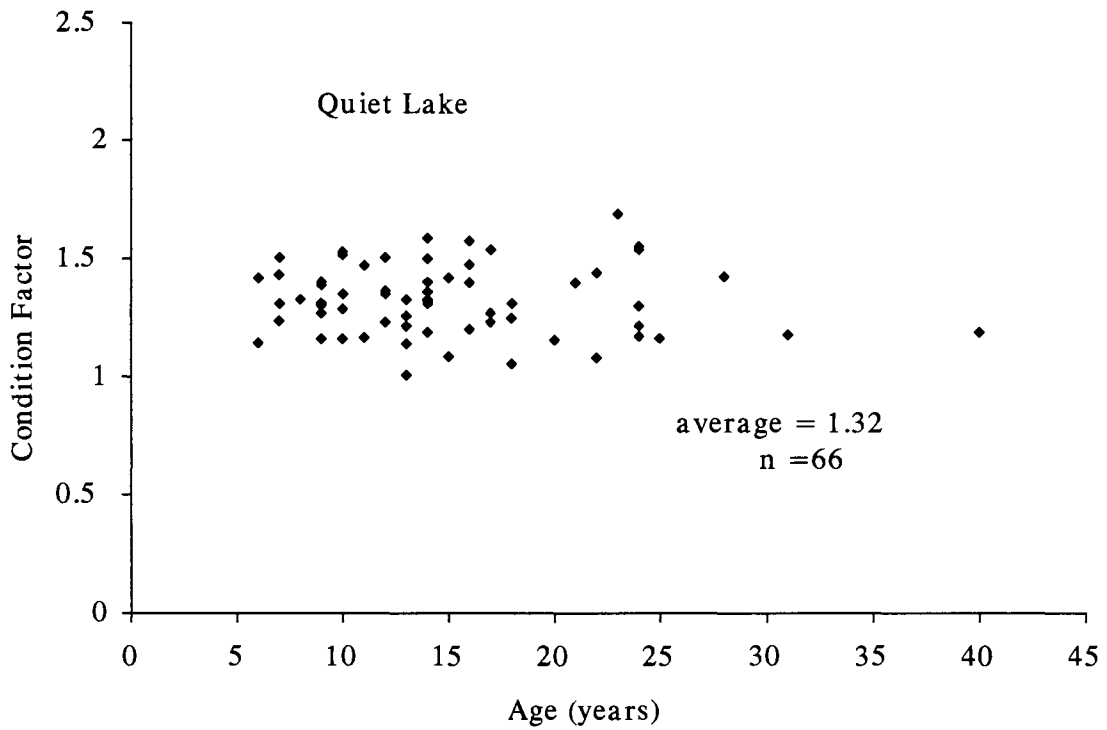
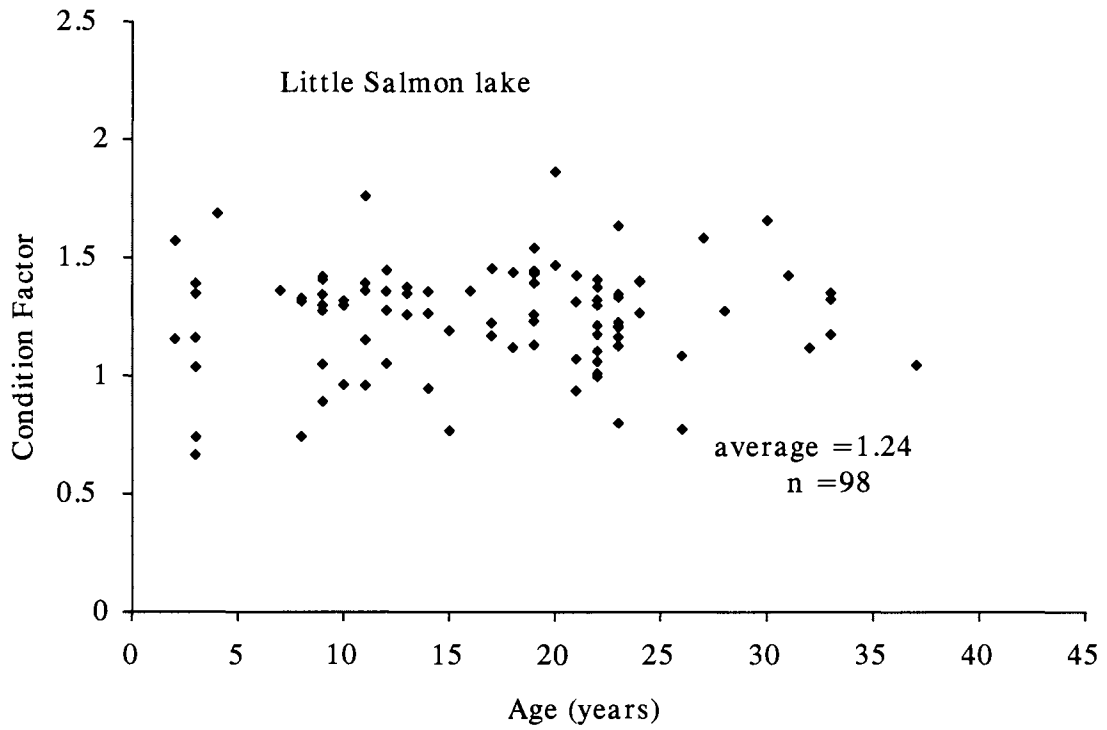


Figure 12. Condition factors at age of lake whitefish from Little Salmon and Quiet Lakes, 1994.

5.6 Mortality

Mortality and survival rates for lake trout and lake whitefish are presented in Table 14. Sample sizes for both species were too small for analysis on Little Salmon Lake. Annual survival rates calculated as outlined by Robson-Chapman (1961) and instantaneous mortality rates are shown for both species on Quiet Lake.

Table 14. Robson-Chapman mortality and survival rates for lake trout and lake whitefish from summer index netting on Little Salmon and Quiet Lakes, 1994.

Lake	Species	Instantaneous Mortality(Z)	Annual Mortality (A)	Annual Survival (S±1.96 S.E.)	Age Range (years)
Lake Trout	Little Salmon	*	*	*	*
	Quiet	0.012	0.014	0.986 ± .022	13,14, 19,22
Lake Whitefish	Little Salmon	*	*	*	*
	Quiet	0.001	0.001	0.999 ± .019	10,12-14, 24

* Insufficient sample size for calculation

5.7 Maturity

Mean ages of maturity (MAM) were calculated for lake trout and lake whitefish on both lakes and are presented in Table 15. There are insufficient sample sizes for male and female lake trout from Quiet Lake and all lake whitefish from Quiet Lake as well as female lake whitefish from Little Salmon Lake. Lake trout (sexes combined) matured at 9.7 years of age on Quiet Lake and 4 years later at 13.6 years of age on Little Salmon Lake. Males and females matured at the same age on Quiet Lake. Lake whitefish (sexes combined) matured at 9.7 years of age in Little Salmon Lake. Maturity at age tables for both species on each lake is presented in Appendix II.

Table 15. Mean ages of maturity for lake trout and lake whitefish from summer index netting on Little Salmon and Quiet Lakes, 1994.

Lake	Species	Mean Age of Maturity (years)		
		Male	Female	Combined
lake trout	Little Salmon	*	*	13.62
	Quiet	11.25	11.09	9.69
lake whitefish	Little Salmon	13.25	*	9.70
	Quiet	*	*	*

* Insufficient sample size for calculation

5.8 Mesh Size Effects

The effects of gillnet mesh size on lake trout and lake whitefish catches in both lakes are presented in Appendix III. Mean lengths, weights and percentages of mature fish generally increased with mesh size. The frequency of lake trout catches was slightly different between the two lakes. On Little Salmon Lake catches were fairly evenly distributed among the middle mesh sizes and peaked in the 6.4 and 8.9 cm mesh sizes. On Quiet Lake they grew steadily through the smaller mesh sizes and peaked in the 11.4cm mesh size. Lake whitefish catches were fairly evenly distributed between the two lakes with catches peaking in the 10.2 cm mesh size (Figure 13).

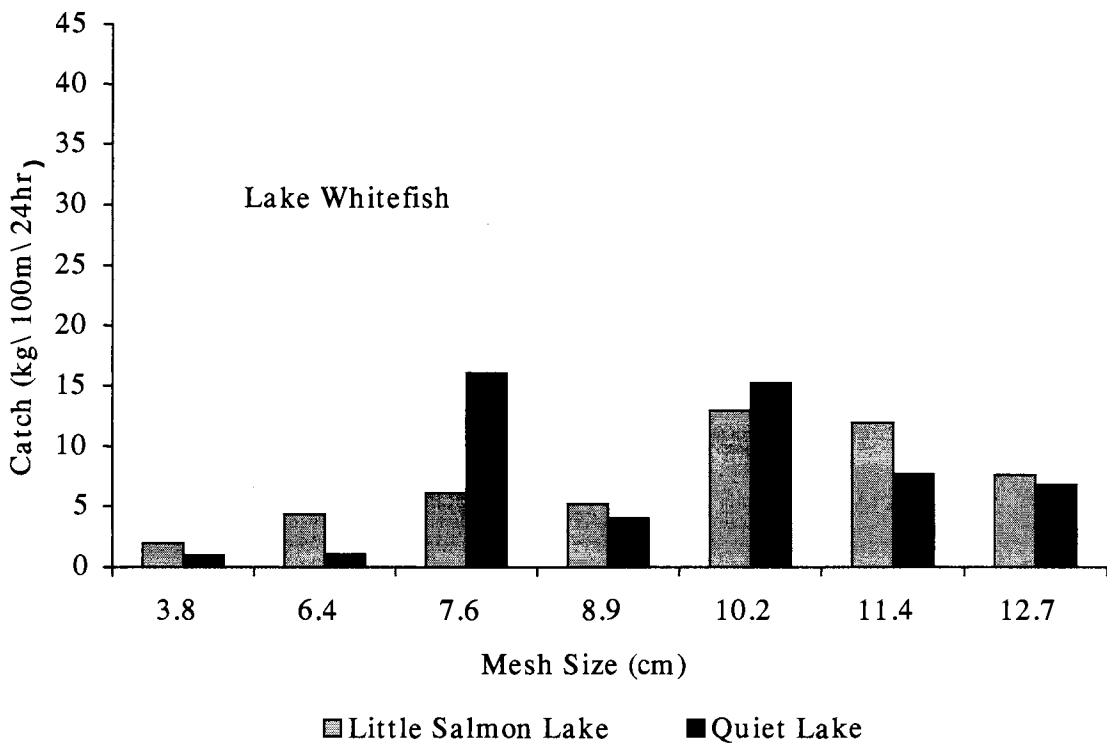
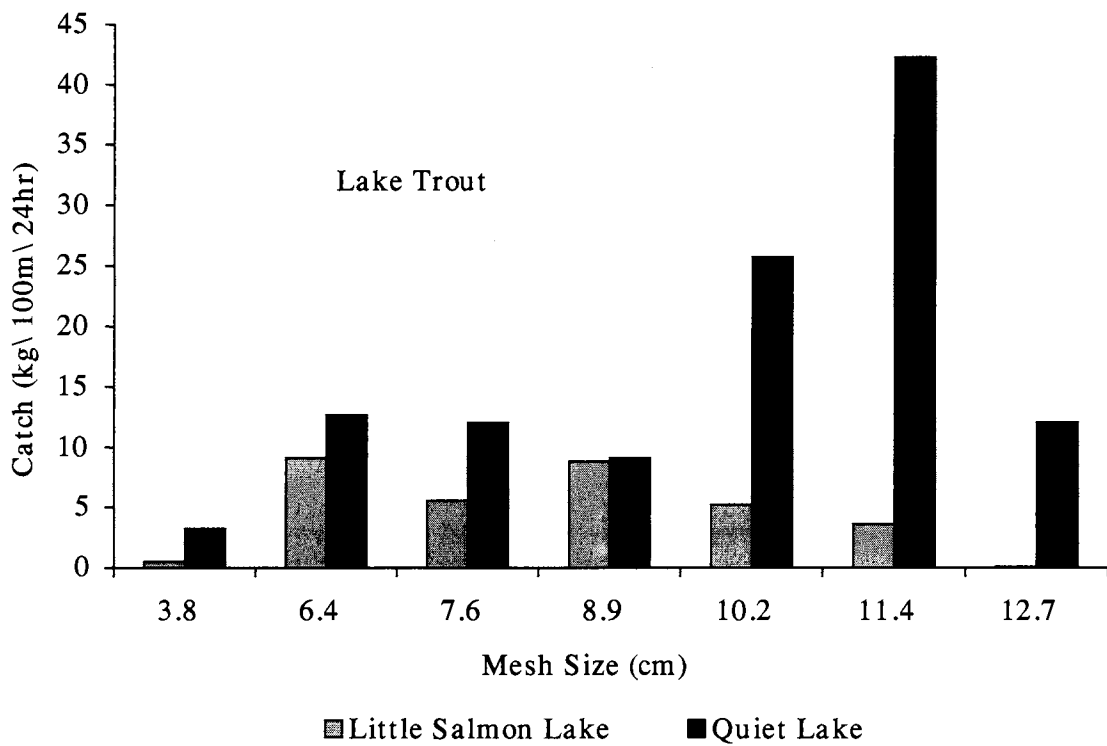


Figure 13. Mesh size effects on catches of lake trout and lake whitefish from index netting in Little Salmon and Quiet Lakes, 1994.

5.9 Lake Whitefish Cyst Infestation

Infestation rates of *Triaenophorus crassus* in lake whitefish are presented in Table 16. Little Salmon Lake had the higher infestation rate at 87 cysts per 45 kilograms with the infestation rate for Quiet Lake at 61 cysts per 45 kilograms.

Table 16. Lake whitefish infestation rates of *Triaenophorus crassus* from Little Salmon and Quiet Lakes, 1994.

Variable	Lake	
	Little Salmon	Quiet
Sample weight (kgs)	39.1	62.6
Cyst count	75	84
Mean cysts per fish	2.8	1.9
Infestation rate (cysts/45 kgs)	87.0	60.9
Sample size	27	45

6.0 DISCUSSION

6.1 Lake Productivity

Calculated MEI values for Little Salmon and Quiet Lakes are relatively low compared to results for similar sized lakes in the Yukon (Horler, 1982 & YTG Files). In spite of Little Salmon Lake's moderate size, the low MEI is more comparative with the larger lakes in the Yukon due to its very high mean depth and moderately low TDS. Quiet Lake's low MEI is a result of the very low TDS coupled with a moderate mean depth.

TDS results from this study are much lower than those that have been recorded for these lakes in the past by Shortreed and Stockner (1983) and Lindsey et. al. (1981). This is because of a significant difference in methodology. We are now using a Hydrolab DataSonde 3 Water Quality Multiprobe Logger, which calculates TDS, based on the conductivity of the water. The Hydrolab also enables us to do a water column profile, which gives us average TDS for the entire water column. This results in lower values than were obtained through the traditional method of TDS calculation which involved running a water sample collected near the surface through a filter and analyzing the residue. The result obtained with the new methodology is considered to be more representative of the actual conditions in the lake.

The difference in TDS values between these two lakes can be partially explained by the thickness of the ash layer deposited throughout this area by the White River eruption approximately 1,400 years ago (Lindsey, et. al. 1981). In their study they found that lakes through the central Yukon in the Upper Yukon River drainage had consistently higher TDS values than others in the surrounding area. These higher values correspond quite nicely with isopleths of ash thickness. Little Salmon Lake is in the 5 to 6 inch band while Quiet Lake is out of the influence of this event altogether. This is only a partial explanation as local TDS values are also influenced by other factors such as climatic variation and geology.

Both of these northern latitude lakes are in areas of low mean annual air temperature, have short open water seasons resulting in very cold water temperatures, have steep shorelines and differing geological regimes, which associated with low nutrient levels contribute to low and varying TDS values and low productivity. Both of these lakes are typically oligotrophic.

6.2 Lake Trout

The percentage of the catch as lake trout biomass was very different between these two lakes. Quiet Lake had a lake trout catch biomass of 60%, while on Little Salmon Lake the catch was 38% of the total catch by weight. These numbers are both higher, Quiet Lake significantly, than the average of around 30% reported for previously surveyed lakes in the Yukon (deGraff, 1992 and 1993, Thompson, 1996, YTG files and Horler, et.al. 1983). Of the thirteen lakes surveyed to date with this same methodology by YTG, Quiet Lake has the highest recorded and almost double the average of 31.9%. Little Salmon Lake is the fourth highest.

Catch per unit effort (CPUE) data for lake trout was also quite different between the two lakes. Quiet Lake had the second highest result for lakes surveyed to date by YTG at 10.3fish/100m/24hrs. The highest is Tagish Lake at 11.3fish/100m/24hrs. Little Salmon Lake had 4.1fish/100m/24hrs, which is below the average of 6.0fish/100m/24hrs for all the previously surveyed lakes.

The mean ages of sexual maturity that were calculated in this study may be overestimated due to the difficulties in determining maturity and differentiating immature gonadal tissues with those of mature non-spawning (resting) fish. Determining maturity of fish while in the field is difficult and can vary depending on the experience of the observer. A mature fish has been defined as a fish that will spawn or has spawned in the year of capture, or a fish that has spawned at some time, not necessarily in the year of capture (Healey, 1970). In some instances, mature, older aged (non-spawning) fish were misidentified as immature.

It is well established that mature lake trout do not spawn every year (McPhail and Lindsay, 1970).

From the limited data that we do have, mean age of lake trout maturity is earlier on Quiet Lake at 10 years compared to 14 years on Little Salmon Lake. Age at first maturity is also earlier on Quiet Lake at 6 years compared to 10 years on Little Salmon Lake. The bulk of maturation was complete on Quiet Lake by the age of 13 and by the age of 14 on Little Salmon Lake. There is no difference between sex data for Quiet Lake but on Little Salmon Lake the males and females both have a mean age of maturity of 11 years. This is slightly atypical as males generally mature earlier than females (YTG files). The results from Quiet Lake are some of the earliest mean ages of maturity for all of the lakes surveyed to date (deGraff, 1992 and 1993, Thompson, 1996 and YTG Files). The only population that has earlier maturation dates are those in Kusawa Lake which do so at 7 years of age. Little Salmon Lake has the oldest mean age of maturity of those lakes surveyed to date. The next oldest is Kluane Lake at 13 years of age.

Lake trout on Quiet Lake also grow faster than do those from Little Salmon Lake, a 0.72 growth rate compared to 0.67 growth rate. Lake trout from Quiet Lake also grow to a heavier weight for their length than do those from Little Salmon Lake as well as having a larger calculated asymptotic size, 806mm compared to 798mm. Both of these parameters are within the range found for other Yukon lakes (deGraff, 1992 and 1993, Thompson, 1996 and YTG Files). The calculated asymptotic size for Quiet Lake was the highest recorded to date, just slightly higher than that for Kluane Lake.

The condition factor is a measure of the relationship between the length and weight of fish. A condition factor of 1.0 indicates isometric growth, so the higher above 1 the value is, the heavier the fish are for their length. Higher values are indicative of fish that are getting better feed as a result of a more plentiful forage base. Quiet Lake lake trout have an average condition factor of 1.14 as compared to Little Salmon Lake where the average condition factor is 1.01. Other Yukon lakes that have been surveyed to date are around or slightly above 1.0. The highest documented condition factor so far has been Lake Laberge

at 1.2 (Thompson, 1996). This high result for Quiet Lake is indicative of an excellent forage base for lake trout.

Calculated mortality rates for lake trout in Quiet Lake are well below the average for other Yukon lakes (deGraff, 1992 and 1993, Thompson, 1996 and YTG Files). The survival rates are also quite high in comparison to other lakes. This is partially due to the fact that there was a small sample size available for calculation. There was insufficient sample size for calculation on Little Salmon Lake. Ageing errors can also bias these estimates.

Lake trout are omnivorous and feed on a broad range of organisms including crustaceans, aquatic and terrestrial insects, many species of fish and even small mammals (YTG Files). Lake trout that feed primarily on plankton are slower growing, smaller and do not live as long as those that feed mainly on fish (Martin, 1966). Quiet Lake lake trout ingest a wide variety of organisms with a definite emphasis on fish. Caddisflies and other fly species are the other dominant food items in their diet. The emphasis on a fish diet explains the larger size of these fish. Little Salmon Lake lake trout are slightly more balanced in their intake of food items. They are heavily reliant on fish also, but show a trend towards utilisation of a broader range of other species. They show a higher count of more terrestrial based insects such as beetles, flies and ants/wasps. Many of the variations among surficial insects in the diets of these two stocks may be indicative of differing abundance's of species available at the time of sampling as well as regional variation. Both stocks exhibit typical lake trout diets.

In summary, both of these stocks show balanced age structures, typical growth rates, varied diets and appear quite healthy. The fish in Quiet Lake tend to be slightly more robust, grow to a larger size as well as heavier for their length and represent a larger portion of the biomass in the lake relative to other species present. This is more typical of less exploited populations that we see in the Yukon. The fish in Little Salmon Lake are also healthy fish; they are just slightly smaller and at a lower abundance relative to other (lake whitefish) species present in the system. They are at a lower overall abundance relative to Quiet

Lake, as found in the CPUE statistics, but they are still above the Yukon average. This is more typical of lightly exploited stocks that we see in the Yukon.

6.3 Lake Whitefish

The percentage of the total catch biomass that was lake whitefish differed widely between these two lakes. They represented 27% of the total catch on Quiet Lake and 49% on Little Salmon Lake (Table 4). Both of these results are fairly typical as the mean percentage found on other lakes surveyed to date in the Yukon is 40% (deGraff, 1992 and 1993, Thompson, 1996 and YTG Files). Among these lakes (n=13), Little Salmon Lake ranks fourth and Quiet Lake ranks ninth. The highest result to date is Sekulmun Lake at 66%. Although other species of forage fish were present in both lakes, none approach the abundance found for lake whitefish or lake trout. Round whitefish represented about 4% in each of the lakes, while broad whitefish not found in Quiet Lake represent about 4% in Little Salmon Lake. Burbot and least cisco were both around 4% in Quiet Lake while only found in small numbers in Little Salmon Lake.

The catch per unit effort (CPUE) data for lake whitefish shows them as the species with the highest CPUE on Little Salmon Lake at 5.32fish/100m/24hr, and on Quiet Lake at 6.23fish/100m/24hr second to lake trout. These results are the lowest recorded to date on surveyed Yukon lakes and much lower than the average (n=13) of 17.5fish/100m/24hr (deGraff, 1992 and 1993, Thompson, 1996 and YTG Files). All species combined CPUE data for these two lakes are some of the lowest results to date. Little Salmon Lake at 12.25fish/100m/24hr and Quiet Lake at 23.34fish/100m/24hr are both well below the average for other lakes surveyed to date of 39.4fish/100m/24hr.

The earliest age of lake whitefish that were sexually mature was 7 on Quiet Lake and 8 on Little Salmon Lake, with a bulk of the maturation complete by the age of 10 on Quiet Lake and 13 on Little Salmon Lake. Mean ages of maturity were only calculable for combined sexes on Little Salmon Lake at 10 years of age, sample sizes were too small for calculation on Quiet Lake. The same difficulties were encountered in determining maturity as were

with lake trout, i.e. differentiating mature non-spawning versus immature. This bias is assumed to be larger than those associated with ageing.

Lake whitefish growth is similar between lakes. The growth rates are virtually identical for both lakes at 0.142 for Little Salmon Lake and 0.143 for Quiet Lake, although fish grow heavier for their length on Quiet Lake. This is reinforced by the condition factor as Quiet Lake has a value of 1.32 while Little Salmon Lake is at 1.24. Asymptotic size is also a bit larger for Quiet Lake, calculated at 530mm compared to 520mm for Little Salmon Lake.

Mortality rates for lake whitefish were calculated for Quiet Lake only and they were extremely low, conversely survival rates were extremely high. Caution should be used in interpretation of this data, as sample sizes were very low. There was insufficient sample size to calculate these parameters for Little Salmon Lake.

Snails, clams and flies as well as a variety of other invertebrates dominate lake whitefish diets in both lakes. They in turn are a primary food source for the predators in these systems.

There was very good representation of all age classes from young to old in both lakes indicative of healthy, stable and lightly exploited populations.

6.4 Management Concerns

Lake trout is a highly sought after species by all sectors of the fishery. In spite of many of our lakes large size, the populations of lake trout are quite finite due to their low reproductive potential, slow growth, late maturity and slow turnover rate (Olver, 1988). These facts combined with the low MEI and resulting low biological productivity in many of Yukon lakes causes the forage base to be low and therefore the populations of predatory species to be even lower. This results in lake trout being very vulnerable to exploitation, the biggest factor affecting lake trout in the Yukon.

Lake trout on Little Salmon Lake are targeted primarily by the sport fishery and lightly by the domestic fishery. On Quiet Lake lake trout are targeted through the sport fishery. Both lakes have a small subsistence from First Nations. The following table compares the lake trout maximum sustainable yield (MSY) calculated for each lake and the total allowable harvest for all sectors of the fishery (sport, domestic, subsistence and commercial if allowed) at 15% MSY, the maximum percentage allowed to maintain a high quality fishery (O'Connor, 1982).

LAKE TROUT		
LAKE	MSY	15% MSY
Little Salmon	2,990 kgs	449 kgs
Quiet	2,591 kgs	389 kgs

To ensure that lake trout harvest stays well below 15% MSY, it is important to continually evaluate the sport fishery and maintain harvest records from the net fishery. Based on current information there are no major concerns for either of these lakes in regard to approaching this value. The sport fishery on Quiet Lake is considered to be relatively low due to the moderately difficult access to the lake as well as the implementation of high quality management (HQM) regulations in 1994. These regulations require barbless hooks, restrict the catch and possession limits to two lake trout and require the mandatory release of all fish between 65 and 100cms with only one fish in possession allowed to be longer than 100cms. Quiet Lake has no current domestic harvest or commercial fishery. Little Salmon Lake has a reasonable sport fishery and a light domestic fishery and no commercial fishery. The fishing derby that in past years has put large numbers of anglers onto the lake in the summer has declined in recent years to a relatively small event.

Both lakes support healthy, relatively unexploited lake trout populations. Quiet Lake is in slightly better shape due to the robustness of the stock and the limited fishery pressure. Little Salmon Lake is assumed to receive more angling pressure than Quiet Lake and without HQM regulations there can be assumed to be a higher harvest. To maintain this stock Little Salmon Lake should be considered for addition to the HQM regulations.

7.0 RECOMMENDATIONS

7.1 Little Salmon Lake

- (1) Addition of Little Salmon Lake to the list of lakes falling under the High Quality Management regulations in order to protect the current lake trout stocks and maintain a high quality fishery on this lake.
- (2) Conduct periodic surveys of the sport fishery to obtain better harvest data and to establish the extent of the lake trout harvest by the sport fishery. This data can be used as an index of lake trout abundance.
- (3) Continue to monitor the lake trout population through periodic small mesh netting surveys.

7.2 Quiet Lake

- (1) Conduct periodic surveys of the sport fishery to obtain better harvest data and to establish the extent of the lake trout harvest by the sport fishery. This data can be used as an index of lake trout abundance.
- (2) Continue to monitor the lake trout population through periodic small mesh netting surveys.

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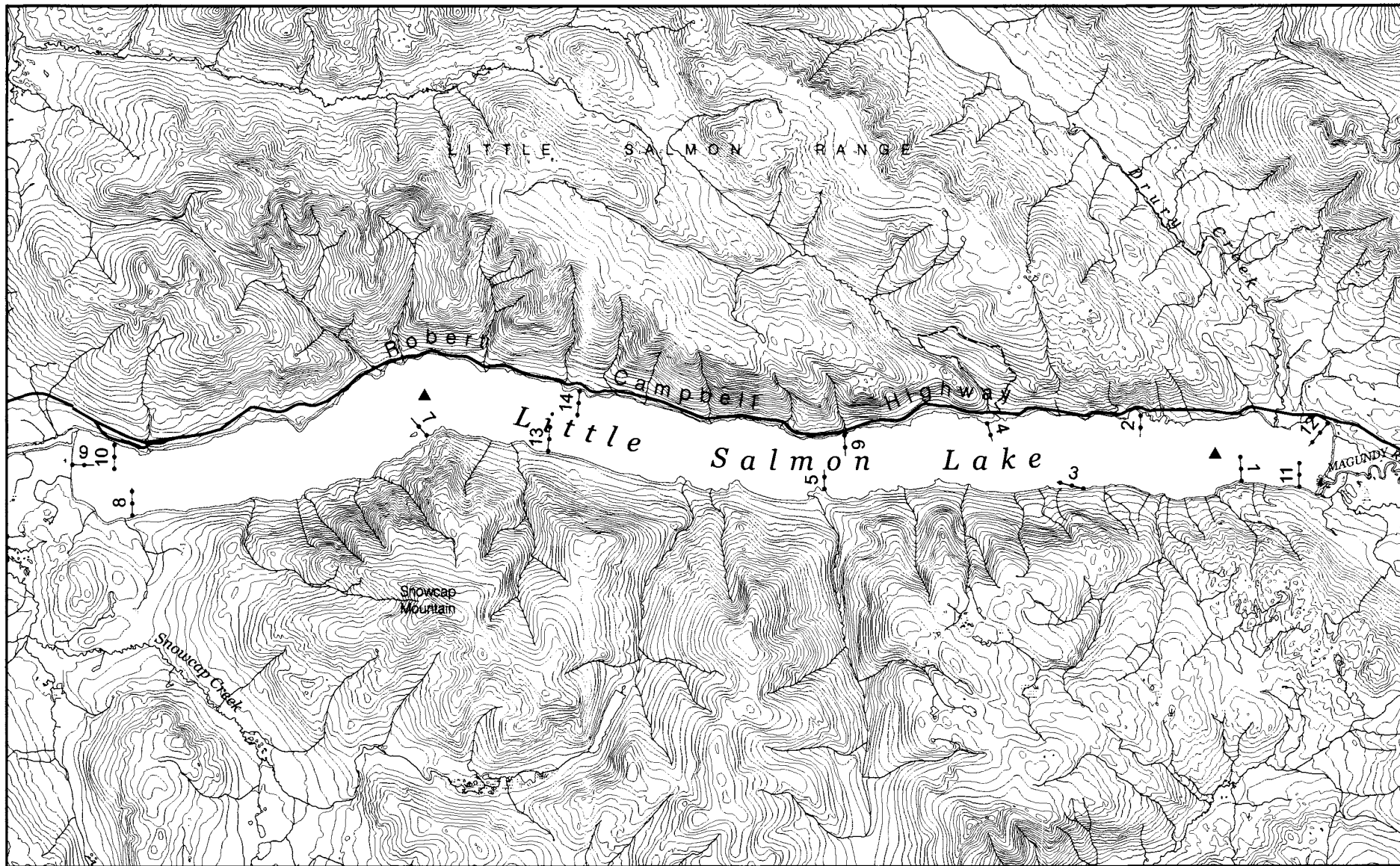
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APPENDIX I

**Gillnet Sample Sites
and
Water Chemistry Sites**



Little Salmon Lake

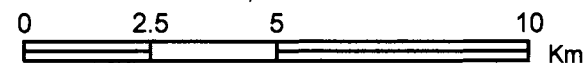
Yukon Territory

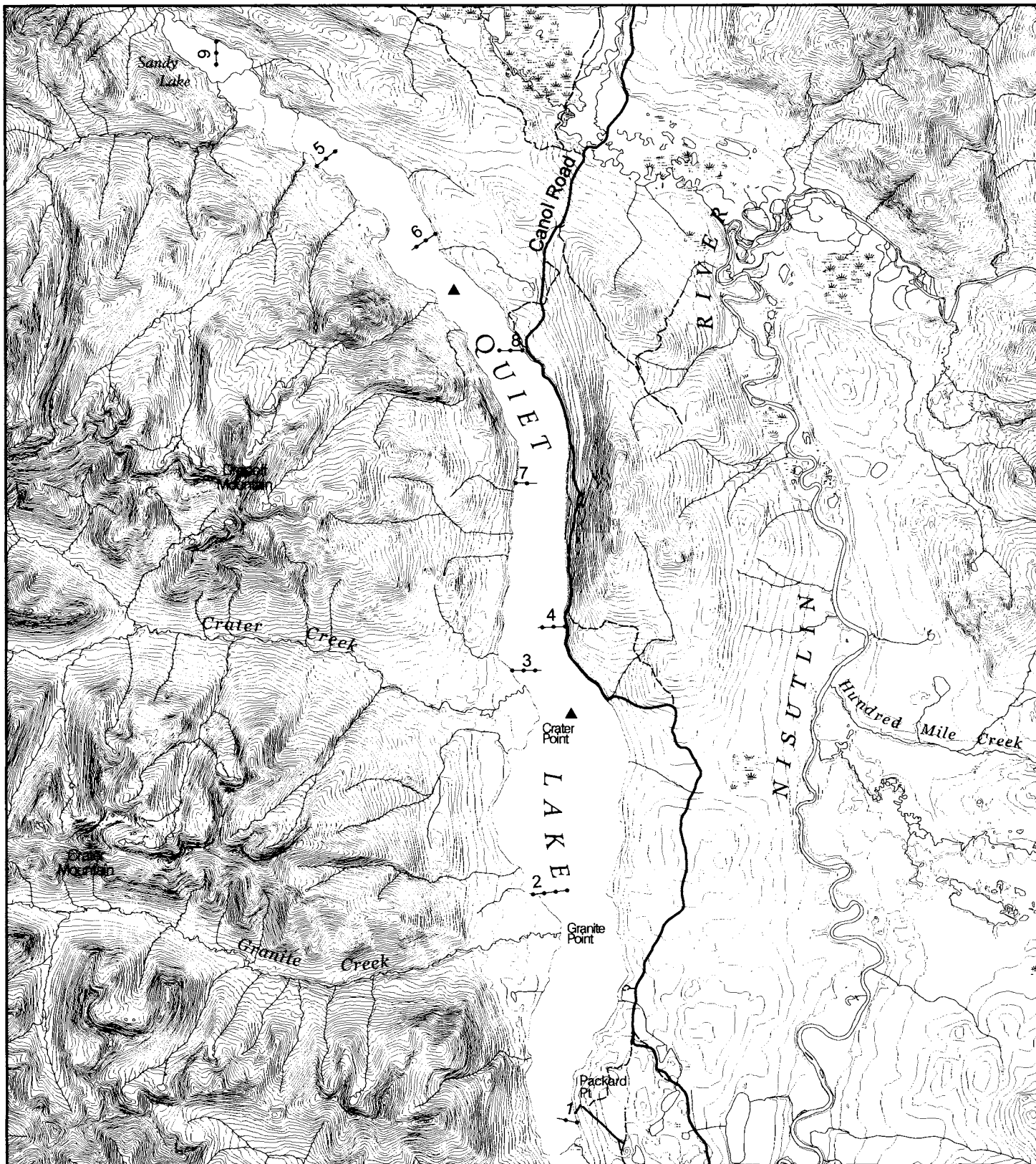
1995 Gillnet Sampling Sites

- ▲ Water Chemistry Sample Site
- 12 ● Gillnet Sampling Site
- Bathymetry Isolines at 20m intervals

MAXIMUM DEPTH - 155.0 m
 MEAN DEPTH - 93.6 m
 SURFACE AREA - 62.1 km²
 VOLUME - 5.752 km³

SCALE: 1:150,000 NTS: 105 L/12





MAXIMUM DEPTH - 170.0 m
 MEAN DEPTH - 32.9 m
 SURFACE AREA - 3.78 km²
 VOLUME - 1.245 km³

▲ Water Chemistry Sample Site
 —12— Gillnet Sampling Site

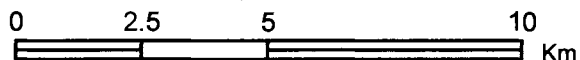
Bathymetry Isolines at 20m intervals

Quiet Lake

Yukon Territory

1995 Gillnet Sampling Sites

SCALE: 1:150,000 NTS: 105 F/03



APPENDIX II

Lake trout and lake whitefish maturity at age for each lake

Appendix II-1. Maturity schedule of lake trout from Little Salmon Lake, 1994.

Age	Immature			Mature			Percent Mature		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
2			1						
3			2						
4	1		1						
6	2	1	3						
7		2	2						
8	1	3	4						
9	1		1						
10	2		3	1	1	2	33.33	100.00	40.00
12	2	1	3		2	2		66.67	40.00
13	1		1	1		1	50.00		50.00
14	1		1	2	1	3	66.67	100.00	75.00
15				2	5	7	100.00	100.00	100.00
16	1		1	2		2	66.67		66.67
18				1	1	2	100.00	100.00	100.00
19					3	3		100.00	100.00
21	1		1	1	1	2	50.00	100.00	66.67
22					1	1		100.00	100.00
23				1	1	2	100.00	100.00	100.00
24				1	1	2	100.00	100.00	100.00
25				1	1	2	100.00	100.00	100.00
26					1	1		100.00	100.00
27				1		1	100.00		100.00
28					1	1		100.00	100.00
30				1		1	100.00		100.00
35					1	1		100.00	100.00
38					1	1		100.00	100.00

Appendix II-2. Maturity schedule of lake trout from Quiet Lake, 1994.

Age	Immature			Mature			Percent Mature		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
3			1						
4			2						
5		2	2						
6	1		1	1		1	50.00		50.00
7	2	3	5	2		2	50.00		28.57
8	2	4	6	2	2	4	50.00	33.33	40.00
9	1	4	5	1	1	2	50.00	20.00	28.57
10	1	1	2	1		1	50.00		33.33
11		1	1	3	2	5	100.00	66.67	83.33
12	1	1	2	3	5	8	75.00	83.33	80.00
13		1	1		7	7		87.50	87.50
14				2	4	6	100.00	100.00	100.00
15				2	1	3	100.00	100.00	100.00
16				2	1	3	100.00	100.00	100.00
17					2	2		100.00	100.00
18	1		1	1	1	2	50.00	100.00	66.67
19				2	3	5	100.00	100.00	100.00
20					2	2		100.00	100.00
21					3	3		100.00	100.00
22				1	5	6	100.00	100.00	100.00
23	1		1	2	1	3	66.67	100.00	75.00
24				1		1	100.00		100.00
26				2		2	100.00		100.00
28					1	1		100.00	100.00
29				1		1	100.00		100.00
32					1	1		100.00	100.00
41				1		1	100.00		100.00

Appendix II-3. Maturity schedule of lake whitefish from Little Salmon Lake, 1994.

Age	Immature			Mature			Percent Mature		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
2			2						
3		1	7						
4		1	1						
7	1		1						
8	2		2	1		1	33.33		33.33
9	1		1	2	4	6	66.67	100.00	85.71
10	1		1	1		1	50.00		50.00
11				2	3	5	100.00	100.00	100.00
12	1		1	1	2	3	50.00	100.00	75.00
13				2	1	3	100.00	100.00	100.00
14					2	2		100.00	100.00
15					2	2		100.00	100.00
16					1	1		100.00	100.00
17				2	1	3	100.00	100.00	100.00
18				1	2	3	100.00	100.00	100.00
19	1		1	3	3	6	75.00	100.00	85.71
20				2		2	100.00		100.00
21	1		1	1	2	3	50.00	100.00	75.00
22	2		2	3	5	8	60.00	100.00	80.00
23	2		2		10	10		100.00	83.33
24				1	2	3	100.00	100.00	100.00
26					2	2		100.00	100.00
27					1	1		100.00	100.00
28					1	1		100.00	100.00
30					1	1		100.00	100.00
31				1		1	100.00		100.00
32					1	1		100.00	100.00
33				1	2	3	100.00	100.00	100.00
37				1		1	100.00		100.00
39					1	1		100.00	100.00

Appendix II-4. Maturity schedule of lake whitefish from Quiet Lake, 1994.

Age	Immature			Mature			Percent Mature		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
6	1	1	2						
7		1	1	1	1	2	100.00	50.00	66.67
8	1		1						
9	1	1	2	1	5	6	50.00	83.33	75.00
10				1	2	3	100.00	100.00	100.00
11					3	3		100.00	100.00
12				4	1	5	100.00	100.00	100.00
13	1		1	2	2	4	66.67	100.00	80.00
14				4	4	8	100.00	100.00	100.00
15					2	2		100.00	100.00
16				1	3	4	100.00	100.00	100.00
17				1	1	2	100.00	100.00	100.00
18				3		3	100.00		100.00
20					1	1		100.00	100.00
21				1		1	100.00		100.00
22					1	1		100.00	100.00
23				1		1	100.00		100.00
24				2	3	5	100.00	100.00	100.00
25				1		1	100.00		100.00
28				1		1	100.00		100.00
31				1		1	100.00		100.00
40					1	1		100.00	100.00

APPENDIX III

Mesh size effects

Appendix III-1. Mesh size effects on lake trout from Little Salmon Lake, 1994.

	Mesh Size (cm)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# caught	6	23	16	16	8	8	1
CPUE (#/100m/24hr)	2.16	8.28	5.76	5.76	2.88	2.88	0.36
CPUE (kg/100m/24hr)	0.49	9.09	5.56	8.78	5.22	3.60	0.08
Mean length (mm)	254.17	438.26	436.94	513.69	570.75	531.00	254.17
Mean weight (gm)	225.00	1097.83	965.63	1525.00	1812.50	1250.00	225.00
# Immature	4	11	8	2	1		
# Mature	1	7	7	14	7	8	1
% Mature	20.00	38.89	46.67	87.50	87.50	100.00	100.00
# Unknown Maturity	1	5	1				
Mean Age	4.50	13.81	11.67	18.21	22.29	18.17	25.00
#Unknown Age		2	4	2	1	2	
Age (years)							
2	(1)16.67						
3	(2)33.33						
4	(1)16.67						
5	(1)16.67						
6		(2)9.52	(1)8.33				
7		(1)4.76	(1)8.33				
8		(4)19.05	(1)8.33	(1)7.14			
9			(1)8.33				
10	(1)16.67	(2)9.52		(1)7.14	(1)14.29		
11			(1)8.33				
12		(2)9.52	(3)25.00				
13			(1)8.33			(1)16.67	
14		(1)4.76	(1)8.33	(2)14.29			
15		(1)4.76	(1)8.33	(1)7.14	(1)14.29	(3)50.00	
16		(1)4.76		(3)21.43			
18		(2)9.52		(1)7.14			
19		(1)4.76		(1)7.14	(1)14.29		
21		(1)4.76	(1)8.33		(1)14.29		
22		(1)4.76					
23				(1)7.14	(1)14.29		
24		(1)4.76				(1)16.67	
25				(1)7.14			(1)100.00
26				(1)7.14			
27						(1)16.67	
28		(1)4.76					
30					(1)14.29		
35				(1)7.14			
38					(1)14.29		

Appendix III-2. Mesh size effects on lake trout from Quiet Lake, 1994.

	Mesh Size (cm)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# caught	11	23	16	11	28	20	6
CPUE (#/100m/24hr)	6.20	12.96	9.02	6.20	15.78	11.27	3.38
CPUE (kg/100m/24hr)	3.21	12.68	12.01	9.09	25.73	42.26	12.03
Mean length (mm)	344.73	423.57	477.06	497.82	517.11	618.30	638.17
Mean weight (gm)	518.18	978.26	1331.25	1465.91	1630.36	3750.00	3558.33
# Immature	8	16	5	4	2		
# Mature	2	6	10	7	25	20	6
% Mature	20.00	27.27	66.67	63.64	92.59	100.00	100.00
# Unknown Maturity	1	1	1		1		
Mean Age	8.30	10.43	13.92	15.11	16.79	17.31	21.00
#Unknown Age	1	2	3	2	4	4	2
Age (years)							
3	(1)10.00						
4	(2)20.00						
5		(1)4.76	(1)7.69				
6		(1)4.76					
7	(1)10.00	(3)14.29	(1)7.69				
8	(1)10.00	(4)19.05	(1)7.69	(1)11.11	(1)4.17		
9	(1)10.00	(4)19.05	(2)15.38				
10	(1)10.00	(2)9.52					
11	(1)10.00	(1)4.76	(1)7.69		(4)16.67	(1)6.25	
12		(2)9.52	(1)7.69	(1)11.11	(5)20.83	(1)6.25	
13	(1)10.00			(2)22.22	(3)12.50	(2)12.50	
14	(1)10.00			(1)11.11	(2)8.33	(2)12.50	
15				(1)11.11		(1)6.25	(1)25.00
16			(1)7.69		(1)4.17	(1)6.25	
17						(1)6.25	(1)25.00
18				(1)11.11		(1)6.25	
19			(2)15.38		(1)4.17	(2)12.50	
20		(1)4.76			(1)4.17		
21		(1)4.76		(1)11.11	(1)4.17		
22			(3)23.08	(1)11.11		(2)12.50	
23		(1)4.76			(1)4.17	(1)6.25	
24					(1)4.17		
26							(2)50.00
28					(1)4.17		
29						(1)6.25	
32					(1)4.17		
41					(1)4.17		

Appendix III-3. Mesh size effects on lake whitefish from Little Salmon Lake, 1994.

	Mesh Size (cm)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# caught	12	9	14	11	25	24	14
CPUE (#/100m/24hr)	4.32	3.24	5.04	3.96	9.00	8.64	5.04
CPUE (kg/100m/24hr)	1.98	4.32	6.08	5.18	12.92	11.92	7.60
Mean length (mm)	263.92	466.33	451.21	473.36	479.52	492.00	493.36
Mean weight (gm)	458.33	1333.33	1207.14	1309.09	1436.00	1379.17	1507.14
# Immature	9	2	1	3	3	4	1
# Mature	3	7	12	8	22	19	13
% Mature	25.00	77.78	92.31	72.73	88.00	82.61	92.86
# Unknown Maturity			1			1	
Mean Age	6.75	18.33	13.69	16.80	20.35	20.09	20.08
# Unknown Age		3	1	1	2	2	2
Age (years)							
2	(2)16.67						
3	(7)58.33						
4		(1)16.67					
7					(1)4.35		
8			(1)7.69	(1)10.00	(1)4.35		
9			(2)15.38	(1)10.00	(2)8.70	(1)4.55	(1)8.33
10			(2)15.38	(1)10.00			
11			(2)15.38	(1)10.00	(1)4.35	(1)4.55	
12			(1)7.69	(1)10.00		(1)4.55	(1)8.33
13			(1)7.69		(1)4.35		(1)8.33
14	(1)8.33					(2)9.09	
15						(1)4.55	(1)8.33
16					(1)4.35		
17					(1)4.35	(1)4.55	(1)8.33
18				(1)10.00		(2)9.09	
19		(2)33.33	(2)15.38	(1)10.00			(2)16.67
20	(1)8.33				(1)4.35		
21					(2)8.70	(2)9.09	
22	(1)8.33	(1)16.67		(1)10.00	(2)8.70	(4)18.18	(1)8.33
23		(2)33.33	(1)7.69		(3)13.04	(5)22.73	(1)8.33
24			(1)7.69		(2)8.70		
26				(1)10.00	(1)4.35		
27					(1)4.35		
28							(1)8.33
30					(1)4.35		
31							(1)8.33
32						(1)4.55	
33				(1)10.00	(1)4.35		(1)8.33
37						(1)4.55	
39					(1)4.35		

Appendix III-4. Mesh size effects on lake whitefish from Quiet Lake, 1994.

	Mesh Size (cm)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# caught	1	2	25	6	21	9	7
CPUE (#/100m/24hr)	0.56	1.13	14.09	3.38	11.83	5.07	3.94
CPUE (kg/100m/24hr)	0.95	1.02	16.06	3.99	15.24	7.63	6.73
Mean length (mm)	480.00	410.00	434.24	446.83	464.00	485.33	501.29
Mean weight (gm)	1700.00	900.00	1140.00	1179.17	1288.10	1505.56	1707.14
# Immature		1	3	1	3		
# Mature	1	1	20	5	15	9	7
% Mature	100.00	50.00	86.96	83.33	83.33	100.00	100.00
# Unknown Maturity			2		3		
Mean Age	17.00	13.00	12.17	11.40	15.47	16.75	22.86
#Unknown Age			1	1	2	1	
Age (years)							
6			(2)8.33				
7			(2)8.33		(2)10.53		
8		(1)50.00					
9			(4)16.67	(1)20.00	(3)15.79		
10			(3)12.50		(1)5.26	(1)12.50	
11			(1)4.17	(1)20.00			
12			(2)8.33	(2)40.00	(1)5.26		
13			(1)4.17	(1)20.00	(2)10.53	(1)12.50	
14			(4)16.67		(1)5.26	(1)12.50	(2)28.57
15			(1)4.17				(1)14.29
16			(2)8.33			(2)25.00	
17	(1)100.00				(1)5.26	(1)12.50	
18		(1)50.00			(2)10.53		
20					(1)5.26		
21					(1)5.26		
22					(1)5.26		(1)14.29
23					(1)5.26		
24			(1)4.17		(1)5.26	(2)25.00	(1)14.29
25			(1)4.17				
28					(1)5.26		
31							(1)14.29
40							(1)14.29

APPENDIX IV

Production records

Appendix IV-1. Production Records.

Commercial Production (Kgs)						
Quiet Lake						
Year	Lake Trout	Whitefish	Pike	Burbot	Suckers	Total
1979	849	231	0.9	22	0	1102.9
1985	21.8	41.8	0	0	0	63.6
1989	Commercial Fishery Closed					
Domestic Production (Kgs)						
Quiet Lake						
Year	Lake Trout	Whitefish	Pike	Burbot	Suckers	Total
1979	36.3	127	0	11.3	0	174.6
1981	0	2	0	0	0	2
1986	63.5	146	46.3	0	0	255.8
Little Salmon Lake						
1991	19	39	0	22	0	80
1993	34	179	17	0	95	325
1994	26.1	89	23.2	1	0	139.3
1995	26	104	12	1	5	148
1996	22	192	21	2	5	242
1997	33	284	33	5	21	376

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