THE LAKE TROUT OF TUTSHI LAKE:

LIFE HISTORY AND PRELIMINARY ASSESSMENT OF ANNUAL SUSTAINABLE YIELD

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by

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ABSTRACT

A limnological and fish sampling survey was conducted on Tutshi Lake in September 1987. It was determined that Tutshi was a large, cold, oligotrophic lake. A total of 96 lake trout (salvelinus namaycush) ranging in size from 13.0 to 88.4 cm and in age from 5 to 40 years were captured in 89 hours of gillnetting. Only four fish exceeded 50 cm, and there was some concern and speculation over the lack of larger fish in the sample. By comparison to other northern lakes surveyed in Skeena Region, lake trout from Tutshi were generally smaller. Growth rates were fairly rapid up to 11 years and 45 cm after which growth slowed markedly. Theoretically, Tutshi could provide an annual sustained yield of 1754 kg of lake trout or approximately 1763 fish weighing about one kg (average length 43 cm). Spring sampling is recommended to obtain a more representative sample of the lake trout population. Due to the vulnerability of lake trout to exploitation, more stringent angling regulations should be considered.

INTRODUCTION

Fisheries Management concerns for Tutshi Lake include a native food and/or commercial fishery and a modest but growing sport fishery. In response to these fisheries and the general lack of knowledge of lake trout biology and life history, the Fish and Wildlife Branch undertook a lake survey in 1987. The objectives of the survey were:

1. To perform a standard Fisheries Branch lake survey.
2. To obtain life history and biological information of lake trout.
3. To assess the potential yield of lake trout.
4. To prepare management recommendations specific to lake trout harvest.

DESCRIPTION OF STUDY AREA

Tutshi Lake is located in the far north-western portion of British Columbia, about 40 km south of Carcross, Yukon or 50 km northwest of Skagway, Alaska (Fig.1). It is readily accessible by the Klondike Highway 2, which parallels Tutshi Lake for about ten km along the north eastern shoreline. There are several access points to the lake, and a Ministry of Forests recreation site and boat launch is situated about 7.5 km north of the southern end of the lake. Other road access camping sites are located near the Tutshi River inlet, while numerous boat access camping areas

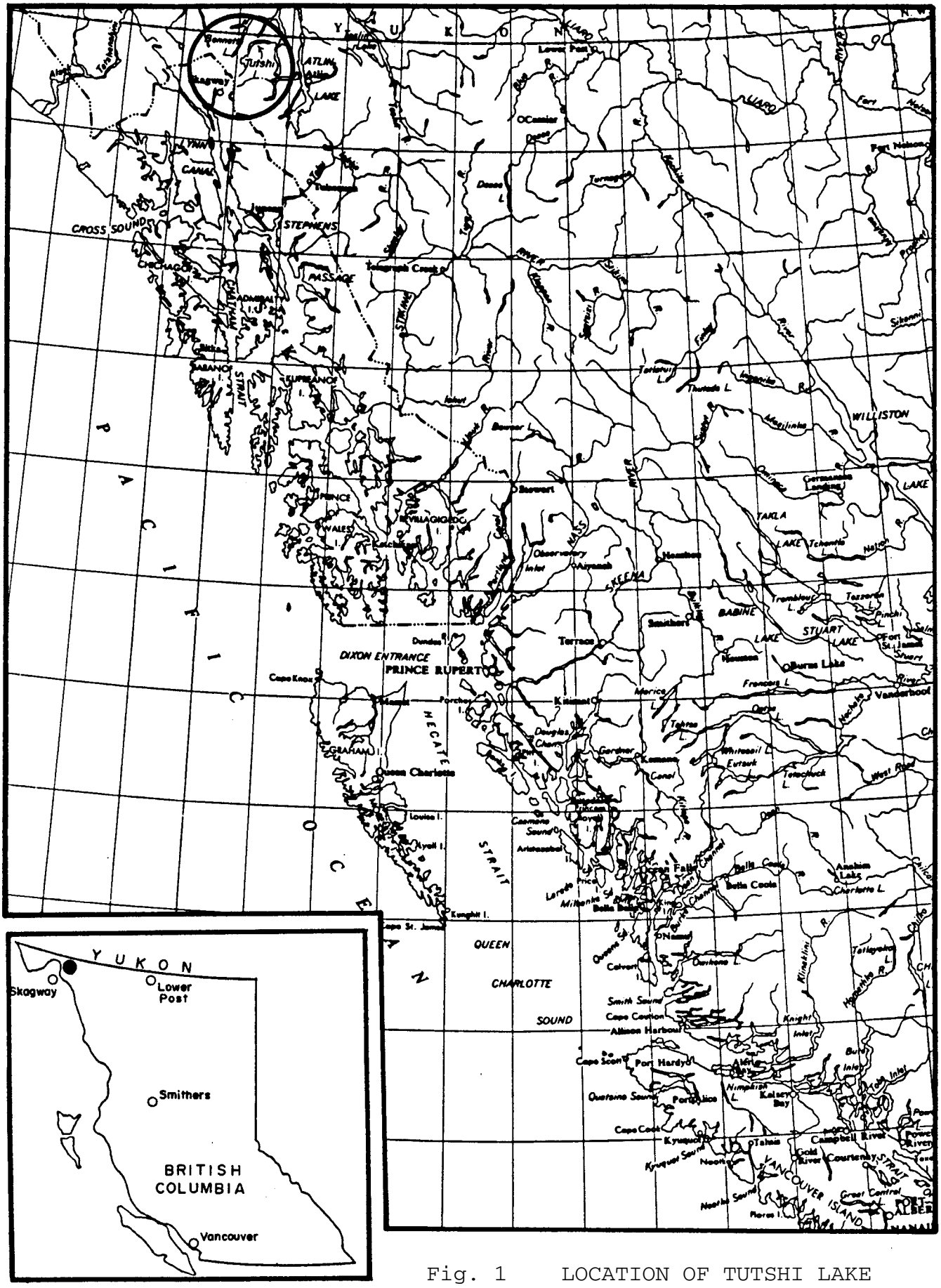

Fig. 1 LOCATION OF TUTSHI LAKE

are scattered around Tutshi Lake, generally at sandy beaches or protected bays.

The portion of Tutshi Lake lying in the east-west direction falls within the Boreal White and Black Spruce biogeoclimatic zone, while the other section of Tutshi Lake which turns in a southerly direction falls within the Spruce-Willow-Birch biogeoclimatic zone.

Tutshi Lake drains into the Taku Arm of Tagish Lake which in turn flows into the Yukon River. It is about 36 km in length and averages 1.5 km in width. It has a surface area of 5583 hectares, and is located at an elevation of 707 meters. Other morphometric and limnological features of Tutshi Lake are summarized in Table 1.

Nearby Carcross has recorded average daily temperatures of 13°C in July and -20°C in January. Average annual rainfall is 112 cm and snowfall is 104 cm. The driest month is April while the wettest month is August (Anon., 1987).

Klondike Highway 2 stretches 159 km from Whitehorse to Skagway. The highway between Carcross and Skagway (known locally as Carcross Road) was built in 1978. Previously closed in winter (October to May) the road opened year round beginning in 1986 to accommodate ore truck traffic from Faro, Yukon Territories to

Skagway, Alaska. It is a fairly wide two lane asphalt surfaced road which has been improved in recent years.

The White Pass and Yukon narrow gauge railway, connecting Skagway to Whitehorse was constructed in 1960 as a result of the historic gold rush. It was closed down in 1982 because of mine closures in Canada. Skagway is a regular port of call for cruise ships and is a terminus of the Alaska State Ferry system (Anon., 1987).

The surrounding area and communities are rich in history originating from the Klondike gold rush of 1898. Skagway, the oldest incorporated city in Alaska, once swelled to an estimated 20,000 but the population is now about 760. Nearby Dyea, once the starting point for the famed Chilkoot Pass trail, is now virtually a ghost town. Carcross, formerly called Caribou Crossing because of the herds of caribou migrating nearby, was a stopping place for Klondike gold seekers. Today it has a population of about 200. Tourism is now the main economic base for this area (Anon., 1987).

METHODS

Tutshi Lake was surveyed from September 11 to September 15, 1987. Basic limnological sampling was conducted to determine bathymetry, water volume, water chemistry, dissolved oxygen and temperature profiles, pH and light transmission. Inlet and outlet streams were electrofished, and an audio—video recording of stream parameters obtained by helicopter flights. All biophysical information was compiled and processed by the Victoria Inventory Operations section of the Recreational Fisheries Branch and presented in a report entitled "A reconnaissance Survey of Tutshi Lake" by D.J. Grant, 1987.

In addition to the above, intensive fish sampling was carried out with gillnets, and roe—baited minnow traps. All gillnets used were monofilament and sinking. The mesh sizes were hung in experimental order of 25, 76, 51, 89, 38 and 64 mm panels. The net dimension was 91.4 m in length and 2.4 m in depth. In all cases the nets were set by attaching one end to shore and stretching the other end perpendicular to the shoreline in a direction toward the centre of the lake. The end in deep water was sunk to the lake bottom with a five pound anchor. The gillnet sites were randomly located, but in relatively close proximity to the boat launch area near the centre of Tutshi Lake. Reasons for this strategy were as follows:

1. The lake was relatively unknown, so potentially favourable

gillnet set locations could not be determined readily (i.e. one place seemed as good as another; no apparent advantage could be gained by boating great distances).

2. The lake was often quite windy and hazardous for boating.
3. The length of time available to complete the required field work was limited so it was desirable to keep boat travel time to a minimum wherever possible.

The objective in fish sampling was to obtain a representative sample size of the various species of fish in Tutshi Lake, with particular emphasis on lake trout. It was hoped that reasonable numbers of lake trout over a broad spectrum of lengths would be sampled. Accordingly, gillnet sets were made until it was felt that a satisfactory sample size had been obtained. In total, three overnight net sets were made for a combined fishing effort of 89 hours.

The only other method used to catch fish in Tutshi Lake was three minnow traps baited with boraxed salmon roe, and set overnight for 26 hours in shallow water close to shore. The traps were allowed to sink to the bottom by their own weight. A line with a brightly coloured float was attached to help relocate the traps.

The following was obtained from fish captured in the gillnets: fork length, weight, sex, gonadal maturity, and stomach contents. Lake trout were grouped into various sizes, and otoliths taken from representative sub—samples of each length category. Otoliths were

hand ground and aged independently under a microscope by three experienced technicians. Where age interpretations differed, technicians collaborated until consensus was reached.

Annual fish production was estimated using the morphoedophic index (M.E.I.) (Ryder, 1974) and an adaptation described by Healey (1978).

RESULTS AND DISCUSSION

A. MORPHOLOGY AND LIMNOLOGY

Table 1 presents some morphometric and limnological features of Tutshi Lake. As anticipated, Tutshi Lake was a classic oligotrophic lake. It was very clear, as evidenced by a secchi disc reading of 9 m. Dissolved oxygen readings of 11.7 parts per million (ppm) both at the surface and at 30m in depth indicate the lake was highly oxygenated. Nutrient concentrations (N and P) were very low: N=.06 mg/1 and P=.004 mg/1 (Grant, 1987) while total dissolved solids (T.D.S.) was also very low (42 ppm.) Littoral zone was minimal as the shoreline around nearly the entire perimeter dropped off very abruptly (see photo section). Only three species of aquatic plants were noted, and they were very sparsely distributed in the shallows of the outlet and in some of the other shallow bays.

Table 1. Observed morphometric and limnological features of Tutshi Lake Sept. 11 — 15. 1987

Elevation: 707 meters (2320 feet)
Length: 36 km Average width: 1.5 km
Area: 55.83 km^2 (5583 Hectares)
Maximum Depth: 197 meters Mean Depth: 87.5 meters
Volume: 4,900,000,000 meters3
Flushing Rate: 9.7 years
T.D.S.: 42 mg/l pH: 7 (surface)
Secchi Disc: 9 meters
Water Temperature: (1430 hours)
Surface: 8.3°C 30 meters: 7.8°C
Dissolved Oxygen: Surface: 11.7 ppm 30 meters: 11.7 ppm

Table 2 provides some morphometric and productivity comparisons for five northern lakes which have been surveyed within the last few years in Skeena Region. Further indications of the low productivity of Tutshi Lake are readily discernible. Tutshi Lake had the lowest percentage littoral zone, the highest secchi disc reading, and perhaps of most importance, the lowest Morphoedaphic Index value (M.E.I.). M.E.I. will be discussed in more detail later in this report.

Together, these features typify Tutshi Lake as being a cold, north temperate highly unproductive lake.

Table 2. A comparison of some morphometric features and productivity indicators between five northern lakes in the Skeena Region.

Lake	Surface Area (Hectares)	Max Depth (m)	Mean Depth (m)	% Littoral Zone	Secchi Disc (m)	T.D.S. (ppm)	M.E.I. *
Cry	2461	152	76	Unknown	7.4	40	0.53
Klinkut	872	24	8	35.4	4.6	46	5.75
Jennings	940	27	6	59.6	4.7	26	4.33
Tatsamenie	1595	142	63.4	7.2	4.2	104	1.64
Tutshi	5583	197	87.5	6.4	9.0	42	0.48

*M.E.I. - "morphoedaphic index" (Ryder, 1974)

B. GILLNET SAMPLING AND MINNOW TRAPPING

In total, three net sets were made for a combined fishing effort of 89 hours. Net set locations are shown in Figure 2. The total catch included 96 lake trout, 24 round whitefish *(Prosopium cylindraceum)*, 4 arctic grayling *(Thymallus arcticus)*, 1 longnose sucker *(Catastomus catastomus)*, and 1 burbot *(Lota lota)*. Gillnet catches are summarized in Table 3. Detailed individual fish data are presented in Appendix I.

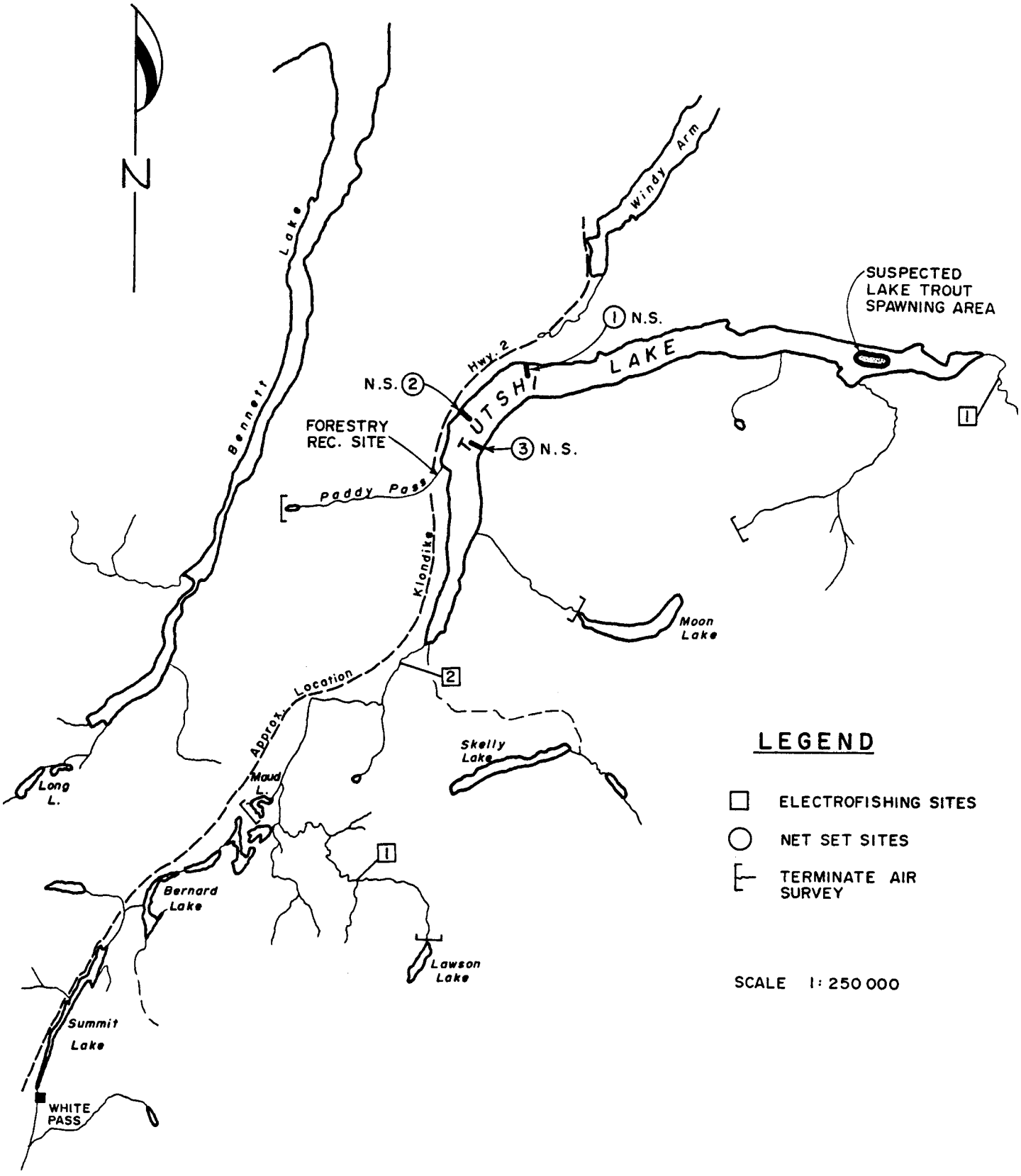

Fig. 2 Net Set Location, Electrofishing Sites, Streams Flown and other feature of Tutshi Lake

Table 3. Gillnet catches from Tutshi Lake September 11 to September 14, 1987.

Net Set No.	Date & Time Set	Date & Time Retrieved	Fishing Effort Hours	Number of Fish Caught					
				Lake Trout	Round Whitefish	Arctic Grayling	Longnose Suckers	Burbot	Totals
1	Sept 11 10:30	Sept 13 11:30	49	36	12	4	-	1	53
2	Sept 13 14:60	Sept 15 11:35	21	32	6	-	1	-	39
3	Sept 15 15:15	Sept 15 10:30	19	28	6	-	-	-	34
	Totals		89	96	24	4	1	1	126

Table 4 presents lengths and weights of lake trout taken from the gillnet sampling.

Table 4. Lengths and weights of Lake Trout from Tutshi Lake, September 11-15, 1987.

	Length (cm)				Weight (g)		
	N	Mean	S.D.	Range	Mean	S.D.	Range
(All Fish) Males & Females	96	35.3	11.8	13 - 88.4	670	840	20 - 7,500
Males	34	42.6	9.9	28 -88.4	1035	1190	200 - 7,500
Females	25	42.6	5.6	30.4 - 57.5	941	399	250 - 2,200
Immature	37	23.7	5.4	13 - 32.3	152	8.8	20 - 300
Mature Males and Females	59	42.6	8.3	28 - 88.4	995	935	200 - 7,500

Sex Ratio - 1.36 Males to 1.0 Females

In Table 5 a comparison of mean lengths and weights of lake trout is made for five northern lakes which have been surveyed during the last few years in Skeena Region. From this table, it seems apparent that Tutshi produces smaller lake trout than most northern lakes. Tutshi Lake trout had the shortest mean length of 353 mm and the lowest mean weight of 670 g.

The catch rate of lake trout per hour of net set (C.P.U.E.) in Tutshi Lake was 1.1, which was the lowest of the six lakes in Table 5. By comparison recent gillnet sampling of these Alaska lakes indicated catch rates of lake trout from three lakes averaged .36 CPUE for 25 mm gill—nets and .34 CPUE for 38 mm (square mesh) gillnets (Burr 1987). Well established recreational fisheries existed on the Alaskan lakes, while the extent of the present recreational fishery on Tutshi Lake is relatively unknown.

Table 5. Comparison of gillnet catches of lake trout from six northern B.C. Lakes.

Lake	Sample Date	n	C.P.U.E. L.T/net hour	Length (mm)			Weight (g)		
				Mean	S.D.	Range	Mean	S.D.	Range
Cry	85/09/12	31	2.6	381	95	192-488	792	453	65-1560
Eaglehead	80/09/08	50	3.9	432	113	275-835	1180	1377	235-7700
Jennings	84/09/15	30	2.1	364	113	117-725	678	880	12-4500
Klinkut	84/09/18	19	1.5	518	111	340-710	1581	1032	350-4300
Tatsamenie	85/07/15	26	5.7	374	124	188-720	762	980	50-4800
Tutshi	87/09/15	96	1.1	353	118	130-884	670	841	20-7500

Figure 3 presents length-frequency distribution of lake trout netted from Tutshi Lake. It is readily apparent that the 60 cm to 80 cm sized fish were absent from the sampling. In fact, only four of the 96 fish caught exceeded 50 cm in length. Possible explanations for this absence of larger fish included sampling bias, non—representative sampling location, and time of the year. Sampling occurred in mid September when older, larger, lake trout may have been spawning. Consequently, many of these fish would therefore be concentrated in spawning areas and not as likely to be caught in randomly set gillnets. In fact, near the completion of field work, a seemingly knowledgeable angler (who had regularly fished Tutshi for eight years) informed us that lake trout were spawning near the islands at the west end of the lake (see Fig. 2). Lack of time precluded investigating this report. Nonetheless, (see Table 5) sampling on three of the five previously surveyed lakes occurred about mid September, during suspected spawning time, yet large fish were captured on Klinkut and Eaglehead Lakes. Sampling bias could have tended to select smaller fish in Tutshi. However, the same net set methods were employed on all of the six lakes in Table 5.

Three roe baited minnow traps were set over 26 hours at depths of 1.5 to 2 m over sand/gravel and boulder substrates and failed to produce a single fish.

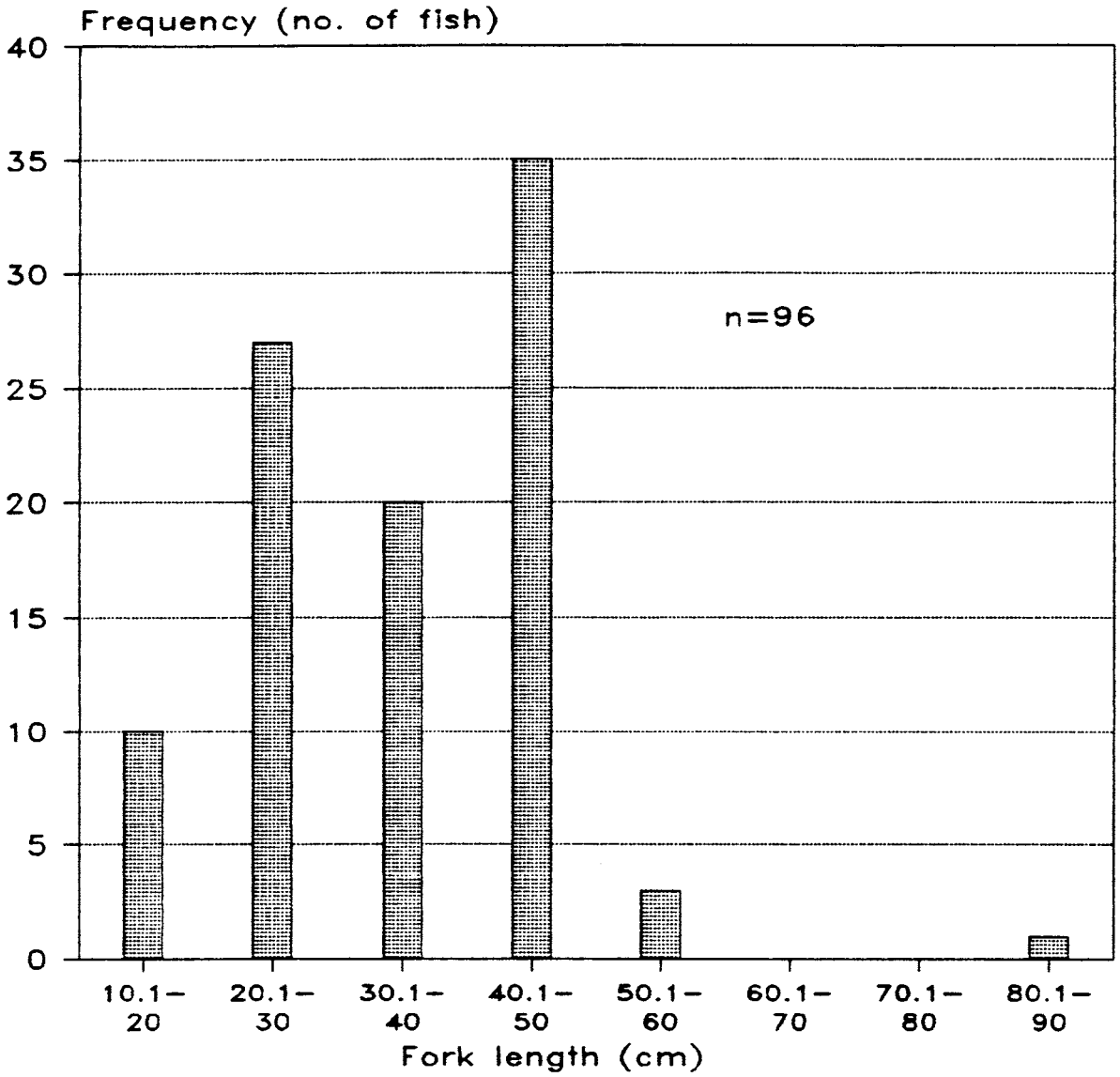

Fig. 3. Length - frequency distribution of lake trout caught in Tutshi Lake, September 13 - 15, 1987.

C. LAKE TROUT BIOLOGY

a. Population Age Structure

Figure 4 presents length-weight relationship of lake trout from Tutshi Lake, while Figure 5 depicts age frequency distributions. The most common age class was the 10 to 12 year group which comprised 28% of the 39 fish aged. The 13 to 15 year group were the second most frequent at 20%, followed closely by 7-9 year age class at 18%. The lone fish over 21 years old was aged at 40 years! Of particular interest was the fact that no fish under five years of age were captured. This reflected the general sampling experience whereby younger lake trout are rarely encountered.

b. Growth

The age—length relationships of 39 lake trout from Tutshi Lake are presented in Figure 6. Growth appeared to be fairly rapid from ages 5 to 11, but static from ages 11 to 21 ($\geq$ 45 cm). This factor could be important in future considerations given to implementing minimum size catch restrictions. Figure 6 also illustrates the great variability in growth of similarly aged lake trout. For example, a 45 cm lake trout caught in Tutshi Lake could be anywhere from 11 years to 19 years of age.

Healey (1978) compiled data on the growth of lake trout from five populations north of 60^0 latitude (Fig. 7). Average lengths of lake trout by age class from Tutshi Lake were calculated and

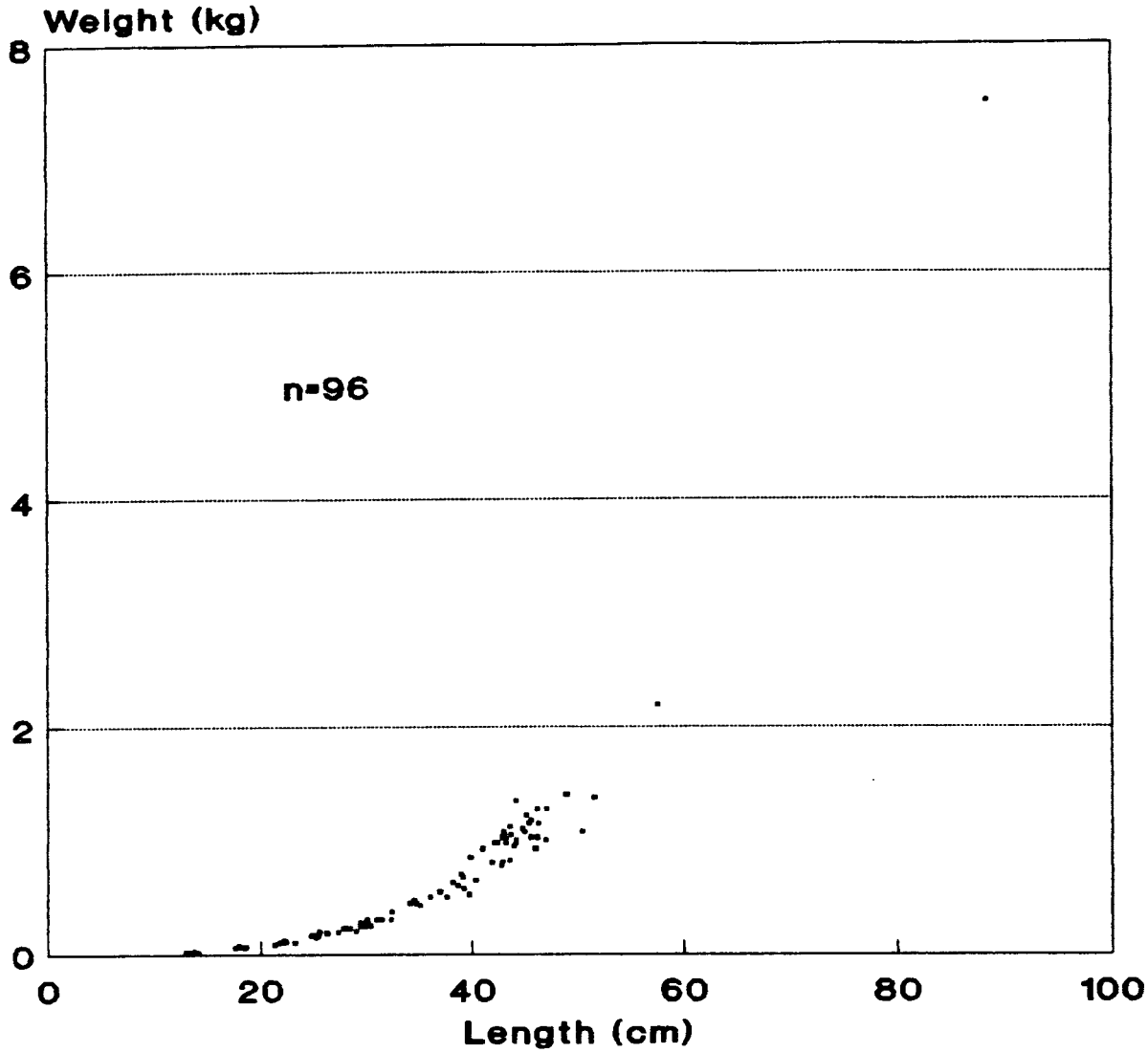

Fig. 4. Length - weight relationship of lake trout caught in Tutshi Lake, September 13 - 15, 1987.

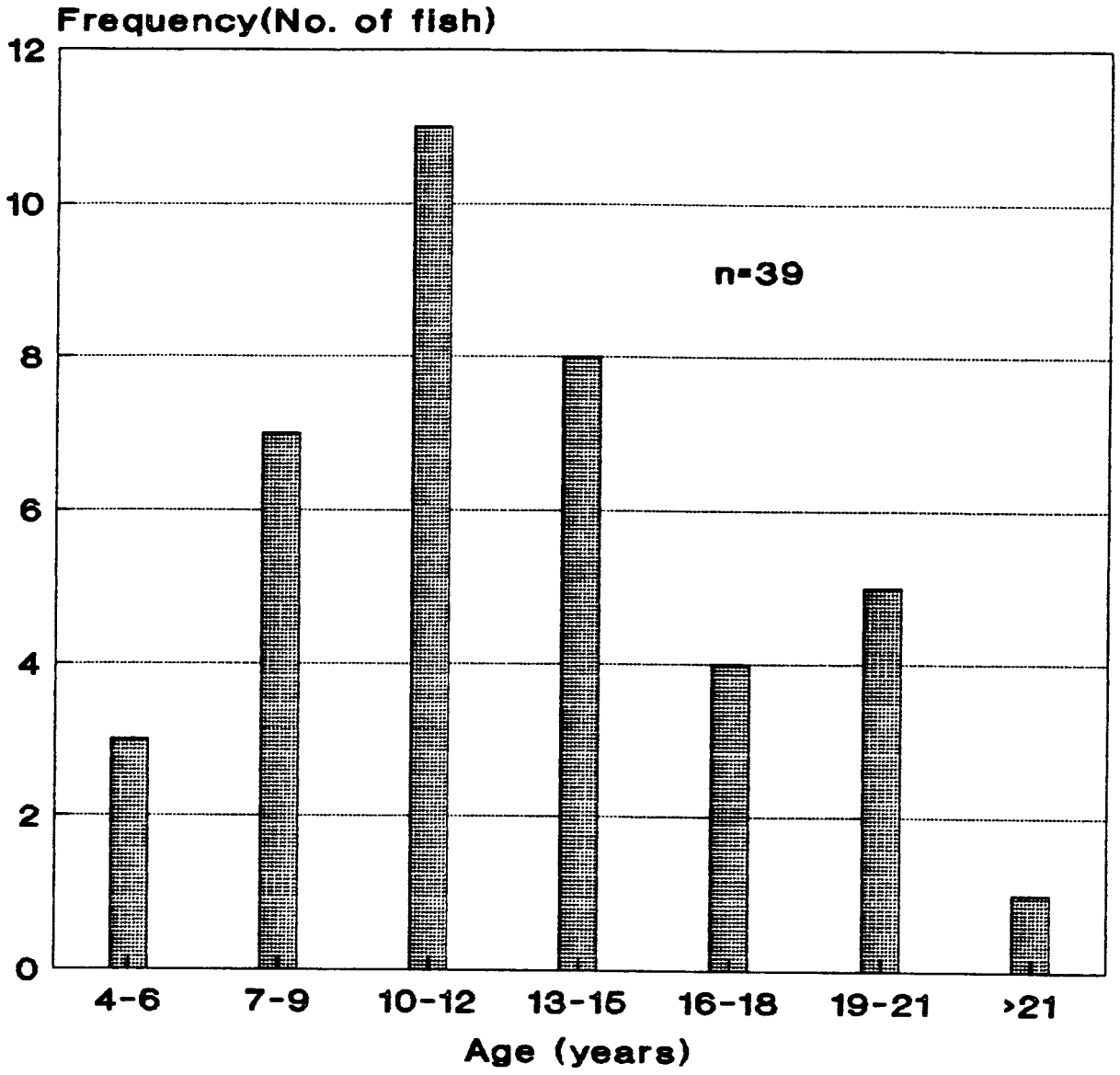

Fig. 5. Age - frequency distribution of lake trout caught in Tutshi Lake, September 13 - 15, 1987.

plotted against Healey's data. It was readily apparent that the growth curve for lake trout from Tutshi Lake was generally typical of the slow growth curve line, and in fact, below it beyond the 16 year age class. Healey also examined growth curves for lake trout from Great Slave and Great Bear Lakes pre—and post—exploitation. In both lakes, lake trout grew more rapidly after a period of exploitation. This suggested that increased exploitation in Tutshi might be expected to increase lake trout growth rates. Furthermore, their slow growth rate may imply either Tutshi Lake is relatively un-exploited or lake trout in Tutshi Lake are intrinsically slow growing.

c. Length and Age at Maturity

Table 6 presents lengths, weights, sex, and gonadal maturity for the 39 aged lake trout from Tutshi Lake. A fish was considered mature if the gonads were developed to the extent that it appeared the fish would spawn in the year of capture. The first mature fish was noted at 11 years of age. At 12 years, 50% of the age class were mature, at 13 years 75% of the fish were mature and at age 14 all of the fish were mature. However, there was a fish at age 18 years and another at age 19 which were immature. From these data, it appeared that lake trout from Tutshi Lake first mature between the ages of 11 to 14 years. Ages of lake trout at first spawning are related to growth rates. If growth is rapid, fish can mature between ages 5 to 8 years, whereas if growth is slow, fish may not

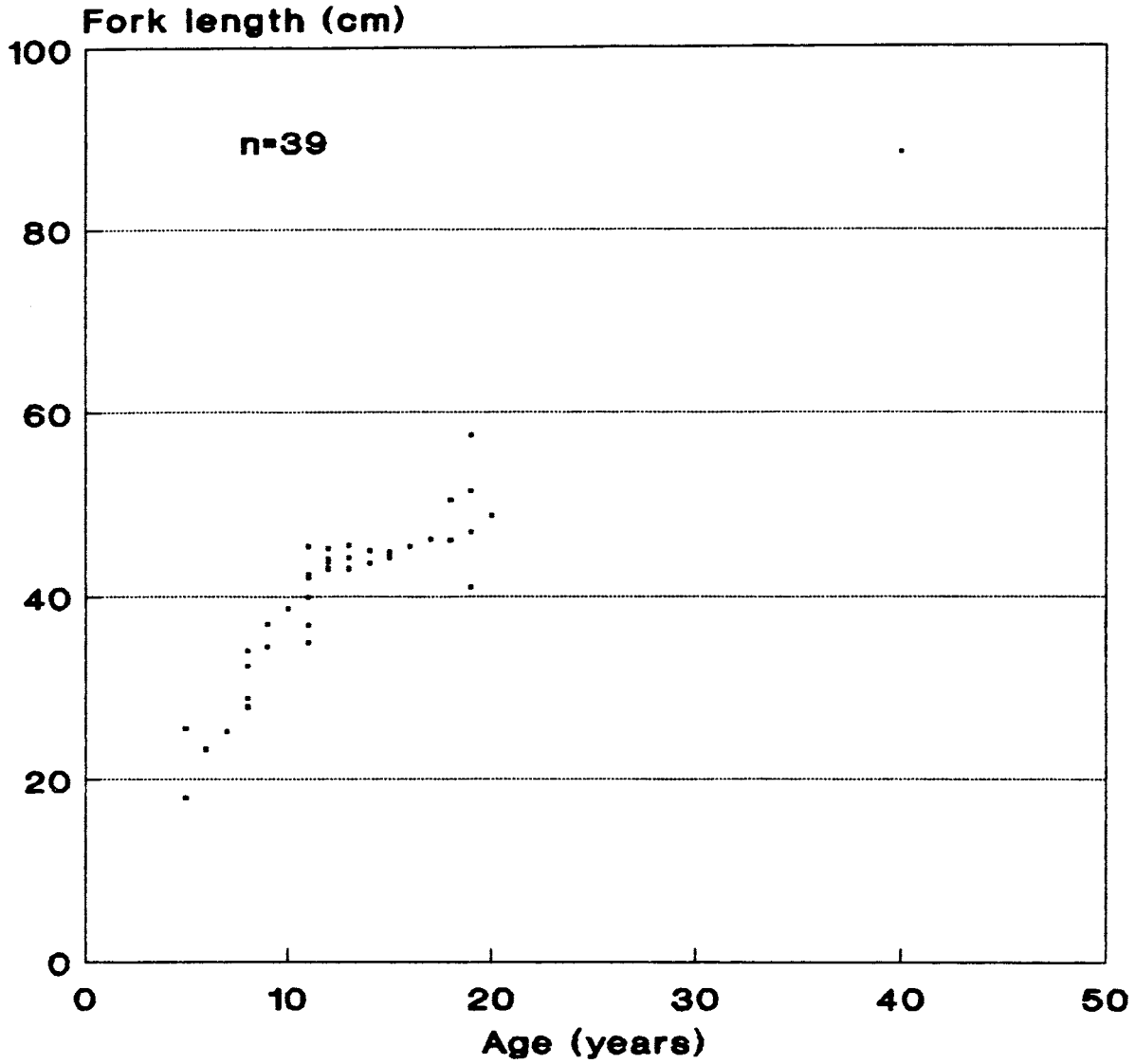

Fig. 6. Age - length relationship of lake trout caught in Tutshi Lake, September 13 - 15, 1987.

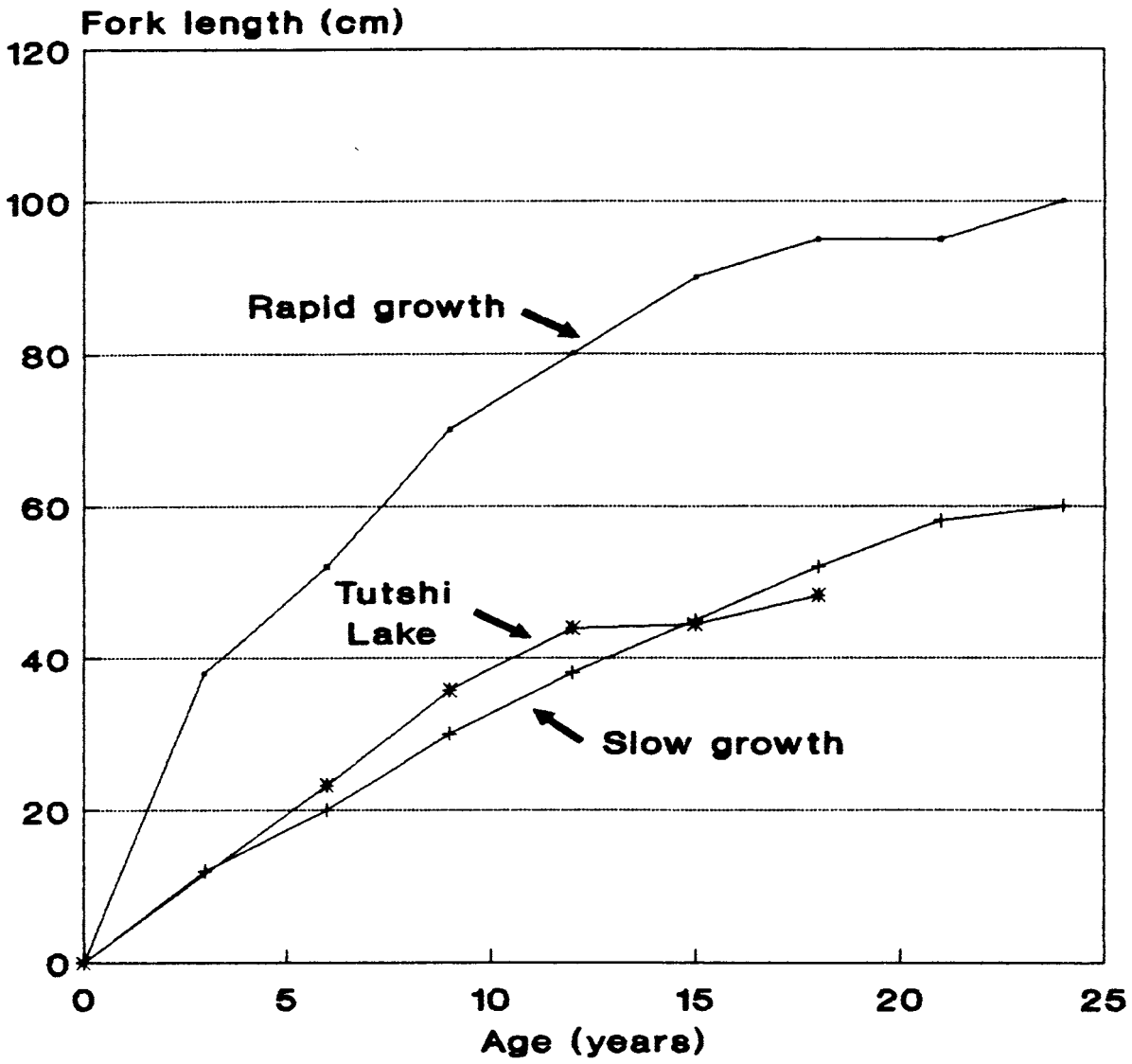

Fig. 7. Growth rates of lake trout from Tutshi Lake and from populations of lakes north of Yukon border (adapted from Healey, 1978).

mature until 13 to 17 years (Marcus et al 1984). The age at first maturity of the lake trout from Tutshi Lake fit more closely to the latter description, lending support to the analysis that lake trout from Tutshi Lake are slow growing.

The sample size (39 aged fish) was not large enough to warrant an attempt at determining ages at first maturity by sexes. Table 7 presents frequencies of mature fish at various length groupings. Mature fish first appeared in the 30.1 to 40 cm length grouping (one individual at 39.9 cm) while the vast majority of mature fish were noted in the 40.1 to 50 cm length group. Of the 16 mature fish in this group, the average length was 44.8 cm. This would suggest that if a minimum size restriction is to be considered for Tutshi Lake, the length should be at least 45 cm.

Table 6. Lengths, weights, sex and gonadal maturity, by age class, of 39 lake trout netted from Tutshi Lake, September 13—15, 1987.

Age	Length	Weight	Sex	Gonad* Maturity	% of Age Class Mature
5	25.6	200	Unk	IMM	0
	18.0	75	Unk	IMM	0
Mean	21.8	138			
6	23.3	100	Unk	IMM	0
7	25.3	150	Unk	IMM	0
8	29.0	200	M	IMN	
	28.0	225	M	IMM	
	34.1	450	M	IMM	
	32.4	375	M	IMN	0
Mean	30.9	313			
9	37.0	550	F	IMM	
	34.5	475	F	IMM	0
Mean	35.8	513			
10	38.7	600	F	IMM	0
11	35.0	425	M	IMM	
	45.4	1150	M	MT	
	42.4	975	F	IMM	
	42.1	975	M	SP	
	39.9	850	M	MT	
	36.9	550	F	IMM	50
Mean	40.3	821			
12	45.2	1225	F	MT	
	44.0	950	F	IMM	
	43.0	1025	M	MT	
	43.7	1050	F	IMM	50
Mean	44.0	1063			
13	44.2	975	F	MT	
	45.5	1175	F	IMM	
	42.9	1025	M	MT	
	43.0	1075	M	MT	75
Mean	43.9	1063			
14	43.6	1125	M	MT	
	44.3	1075	M	MT	100
Mean	45.0	1100			
15	44.8	1100	M	MT	
	44.2	1000	M	MT	100
Mean	44.5	1050			
16	45.4	1150	F	MT	100
17	46.2	1150	F	MT	100
18	50.4	1075	F	IMM	
	46.1	1275	F	GV	50
Mean	48.3	1175			
19	51.5	1375	M	MT	
	47.0	1275	F	MT	
	41.0	925	F	IMM	
	57.5	2200	F	MT	75
Mean	49.3	1444			
20	48.8	1400	M	MT	100
40	88.4	7500	M	MG	100

*IMM = Immature
MG = Maturing
MT = Mature
GV = Gravid
SP = Spent

Table 7. Incidence of maturity among length groups of lake trout netted from Tutshi Lake, September 13-15, 1987.

Length (cm)	Sample	Mature Fish	Percent Mature Fish
10-20	1	0	0
20.1-30	5	0	0
30.1-40	8	1	12.5
40.1-50	21	16	76.2
50.1-60	3	1	66.7
80.1-90	1	1	100
ALL	39	20	51

d. Theoretical Yield

Four methods were used to calculate annual lake trout yields (surplus) for Tutshi Lake (Healey, 1988).

The formulae and yields are presented below:

Methods	Formulae	Yield (kg)
1	y = area (ha) x 0.25	1256
2	$Y = [1.384 \times MEI^{.4461} \times \text{area (ha)}] \times 0.23$	2466
3	$Y = -0.1 + [0.263 \times MEI] - [0.026 \times MEI^2 \times \text{area (ha)}]$	1675
4	$Y = -0.094 + [0.085 \times \text{LN(mean depth)} \times \text{area (ha)}]$	1619
M.E.I.	= T.D.S. (mg/l) ÷ mean depth (m) = $\frac{42}{86}$ = .48	
Area	= 5583 ha.	

Healey studied catch data for 19 Canadian Lakes which had documented commercial fisheries. He determined the average yield was 0.255 kg/ha with 95% confidence limits of 0.165 — 0.345 kg/ha (Method 1). His second approach was to take the average percentage of total fish yield that is lake trout and apply this to estimates of potential yield by morphoedophic index (M. E. I.). This

percentage was 23% with 95% confidence limits of 12.5% - 33.5% (Method 2). Healey also plotted lake trout yield against M.E.I. and determined that some quadratic function fitted the data (Method 3). And finally, there was a weak positive correlation between trout yield and mean depth of the lakes. The linear regression describing this relationship was also used as a predictor of trout yield (Method 4).

Method 1 produced the lowest estimated yield of 1256 kg while Method 2 gave the highest yield of 2466 kg.

Yield estimates determined by these formulae should be used with caution. They are intended to provide ranges of yields rather than absolute values. Generally, yields based on M.E.I. tend to be higher than those calculated from just surface area. A reasonable approach may be to use the mean of these four yields, which is 1754 kg.

Healey (1978) predicts that yields exceeding 0.5 kg of lake trout per ha are unlikely to be sustained, and will eventually result in declining fish populations. In fact, Healey elaborates that "the setting of quotas for trout stocks might be based initially on estimates of relative size of standing stock of reproducing fish from standard netting gangs, and estimates of growth rate". He further elaborates that "slow growth and low standing stock of mature fish would indicate a very low potential yield, say less than 0.2 kg/ha".

As previously mentioned, lake trout sampled from Tutshi Lake were slow growing (see figure 7). However, if sampling was biased

because mature fish were concentrated on spawning grounds, then no evaluation can be made about standing stocks of mature fish.

SUMMARY AND CONCLUSIONS

1. An intensive limnological and fish sampling survey was conducted on Tutshi Lake in September, 1987. Detailed limnological data are presented in a Fisheries Branch lakes survey entitled "A Reconnaissance Survey of Tutshi Lake" by D.J. Grant".

2. This report provides life history and biological information of lake trout and addresses annual sustained yield of lake trout.

3. Tutshi can be briefly described as a large, cold, oligotrophic, north temperate, lake.

4. Experimental monofilament gillnets were set a total of 89 hours. The catch was 96 lake trout, 24 round whitefish, 4 arctic grayling, 1 longnose sucker and 1 burbot. The catch rate was 1.08 lake trout per gillnet hour.

5. The average length of lake trout was 35.3 cm and the average weight 620 g. The 59 mature lake trout, averaged 42.6 cm and 995 g. The largest lake trout caught was an 88.4 cm male

weighing 7500 g. Of the 96 lake trout caught, only four exceeded 50 cm in length. The paucity of larger fish in the sample probably did not reflect their status in the population.

6. In comparison to several other northern lakes in Skeena Region, lake trout from Tutshi Lake were generally smaller.

7. Of the 96 lake trout, 39 fish were aged. The most common age class was 10—12 (28%) followed by 13—15 (20%). The largest fish (88.4 cm) was 40 years old. No fish under five years of age were sampled.

8. Growth was quite rapid from ages 5 to 11 years, but then became static beyond 45 cm in length. Lake trout 45 cm in length ranged from 11 to 19 years of age.

9. A comparison of growth rates of lake trout from Tutshi Lake to lake trout of other northern lakes indicated that Tutshi Lake fish were very slow growing.

10. Lake trout from Tutshi Lake generally matured between ages 11 and 14. However, two fish, aged at 18 years and 19 years respectively, were immature.

11. First spawning lake trout from Tutshi Lake exceeded 40 cm fork

length. The vast majority of mature fish sampled were between 40 and 50 cm (x 44.8 cm). This information had important implications for sportfishing regulations.

12. Four methods were used to calculate yields for Tutshi Lake. They ranged from a low of 1256 kg of lake trout to a high of 2466 kg. The mean of the four yields was 1754 kg. This would allow a harvest of 1763 fish weighing about .995 kg each with an average length of 43 cm. Yield estimates are intended to provide a range of yields rather than absolute harvest rates.

MANAGEMENT RECOMMENDATIONS

1. More fish sampling should be done on Tutshi Lake to expand the existing data base and to determine if the 1987 sampling obtained representative lake trout samples or was biased toward smaller fish. It would be particularly desirable to obtain fish in the 50 to 80 cm length category. Sampling should be done in early spring when lake trout are likely disbursed throughout the lake and readily catchable because they are near the surface (i.e. they have not descended to great depths as they often do in the summer when water temperature rises). All fish caught should be aged.

2. Suspected spawning areas at the west end of Tutshi should be investigated in the fall.

3. As part of our ever increasing awareness to the vulnerability of lake trout to exploitation, consideration should be given to implementing angling restrictions within the next few years. Some aspects to consider are minimum and/or maximum catch size, daily quota and possession reduction, and fall closures. It should be determined whether Tutshi falls into the category of providing lots of small fish (high use fishery) or a variety of sizes in which case it may provide a trophy fishery.

Regulations which promote a high use fishery entail placing minimum size limits based on length at maturity. This helps to maintain larger numbers of smaller fish.

If additional sampling determined Tutshi provided significant numbers of older larger fish then it may be desirable to manage it as a trophy lake. In this case a maximum size limit ensures the survival of large fish in the fishery. Additionally, reduced catch quotas for large fish should be implemented.

ACKNOWLEDGEMENTS

S. Hawthorne and D. Grant helped with the limnological survey and fish sampling conducted on Tutshi Lake in September, 1987. G. Schultze and T. Eichner assisted in interpreting otolith ages. B. Potulicki prepared two figures; while C. Spence assisted in preparing all other figures. R. Hooton and D. deLeeuw edited the report and E. Bouvier and M. Barnard typed it.

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PHOTOGRAPH SECTION

(All photos taken September 13 — 15, 1987)

A. Tutshi Lake

Photo 1. Looking north, about 5 km from south end of Tutshi Lake.

Photo 2. Looking towards island at east end of Tutshi Lake. The shoals around the islands are suspected spawning areas for lake trout.

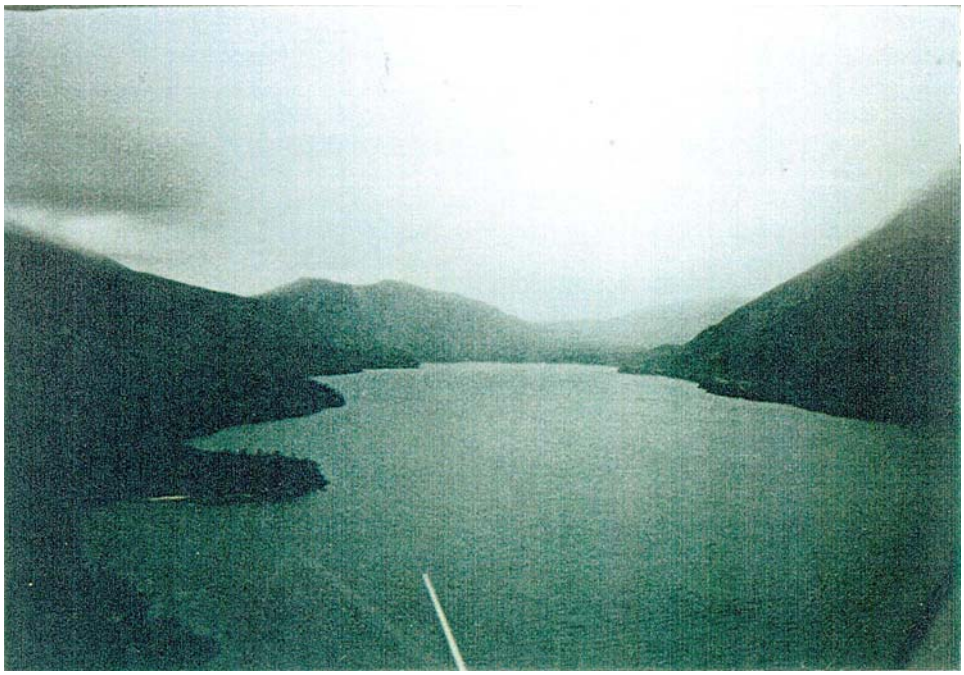

Photo 3. Looking toward south end of Tutshi Lake.

Photo 4. Looking toward the south from about mid point on the lake. Dall sheep and goats were sometimes observed on the mountains adjacent to Tutshi Lake.

Photo 5. Narrow shoals with steep drop-offs were typical of most of the lake shoreline.

Photo 6. Sand and gravel beach on south side of east end of lake.

B. Tutshi River - inlet at south end of lake.

Photo 7. Looking south toward Tutshi River delta.

Photo 8. Looking upstream on Tutshi River about 3 km from Tutshi Lake.

Photo 9. Looking upstream on Tutshi River about 8.5 km from Tutshi Lake. Klondike highway to Skagway is on the right.

Photo 10. Tutshi River inlet about 11 km upstream from Tutshi Lake. Looking south.

C. Tutshi River - outlet at east end of Tutshi Lake

Photo 11. Tutshi River outlet at east end of Tutshi Lake

Photo 12. Tutshi River outlet, looking upstream, about 1 km below Tutshi Lake.

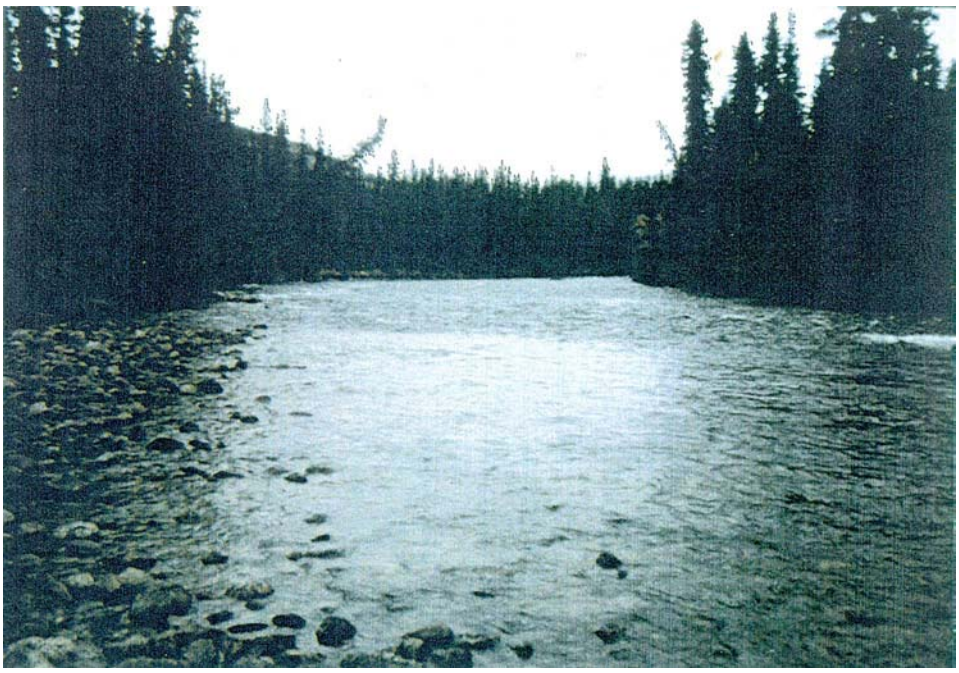

Photo 13. Looking upstream on Tutshi River at ground sample site No. 1.

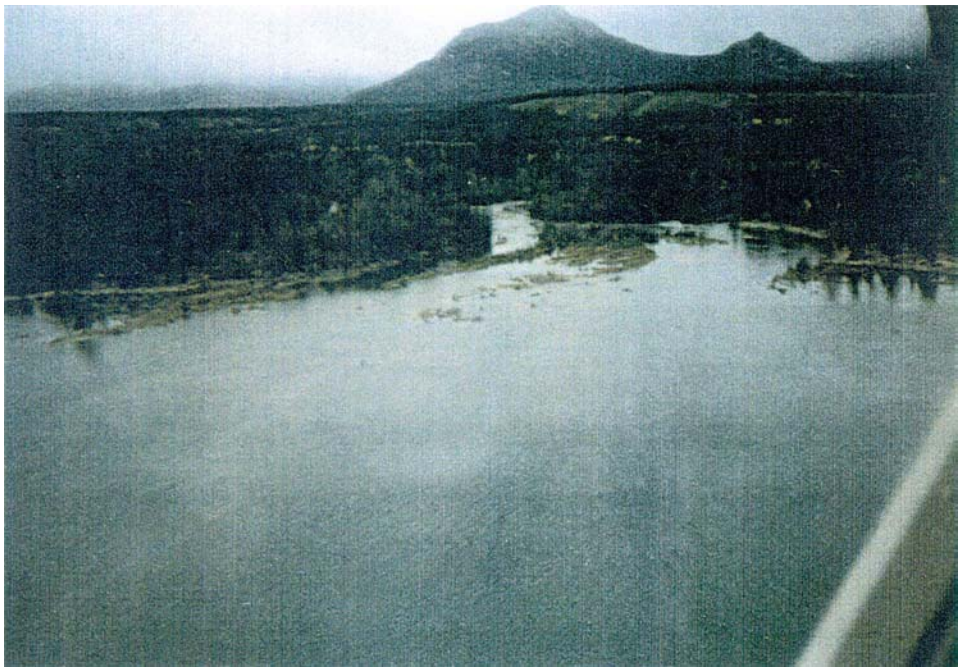

Photo 14. Looking upstream at mouth of Tutshi River entering Taku Arm of Tagish Lake.

D. Lake trout from Tutshi Lake

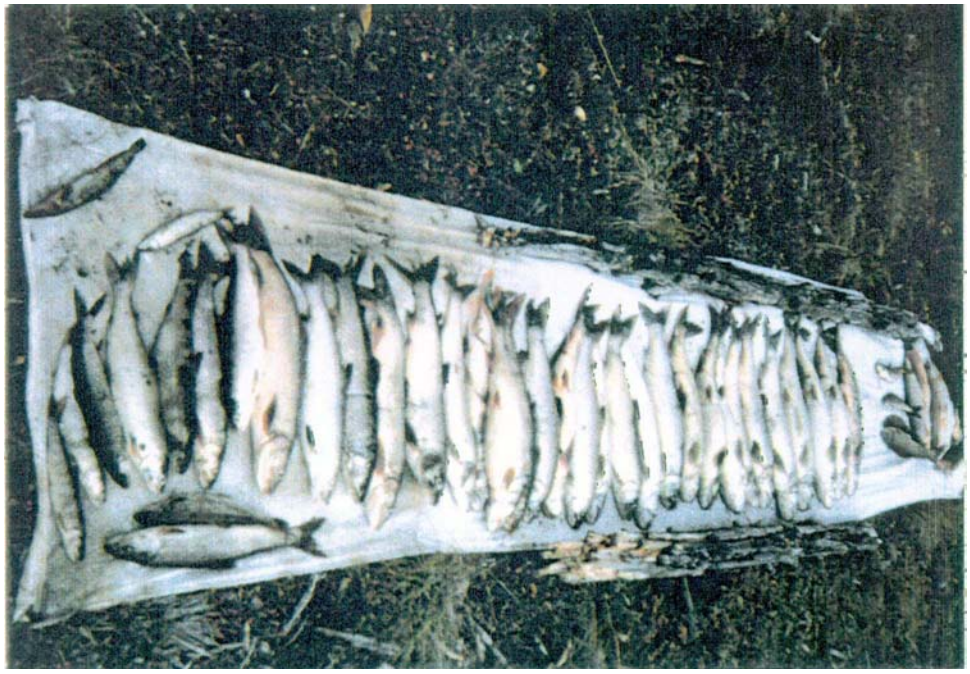

Photo 15. Total catch of lake trout in the set se No.1. Note relative uniformity of size.

Photo 16. Coloration and size typical of many of the lake trout caught in gill nets.

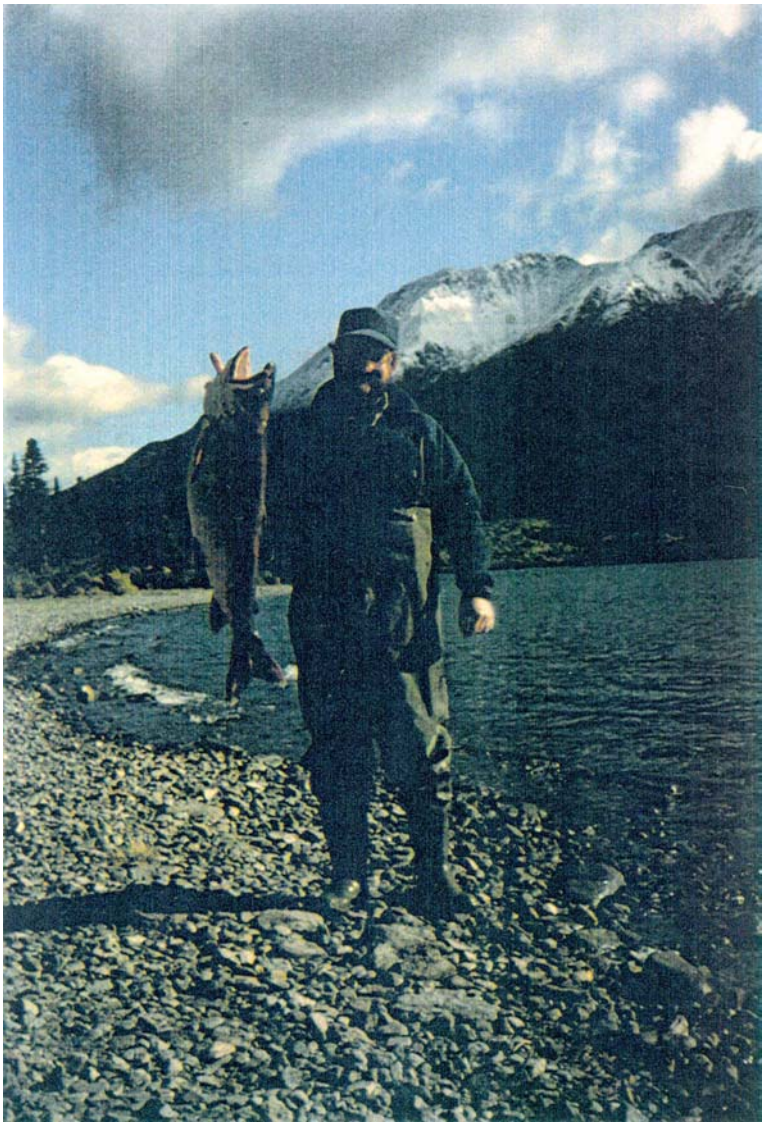

Photo 17. The largest lake trout caught in our sampling. It weighed 7.5 kg and was 88.4 cm in length.

APPENDIX I

Individual fish data from gill net catches in Tutshi Lake, September 13—15, 1987 (from Grant, 1988).

Tutshi Lake

LAKE CATCH SUMMARY

SPECIES	NETTING SITE NO. 1	2	3	4	ANGLED	OTHER	TOTAL	NO. SAMP.	NO. PRES.	SIZE RANGE (cm)
Lake Trout	36	32	28	-	0	0	96	96	0	13.0-88.4
Arctic grayling	4	0	0	-	0	0	4	4	0	30.6-37.1
Round whitefish	12	6	6	—	0	0	24	24	0	20.0—46.2
Burbot	1	0	0	-	0	0	1	1	0	23.4
Longnose sucker	0	1	0	—	0	0	1	1	0	41.0

Minnow Traps:

Bait: Boraxed salmon roe

#	HOURS	DEPTH(m)	SUBSTRATE	SPECIES
1	26	1.5	sand/gravel	no fish caught
2	26	2.0	boulders	no fish caught
3	26	2.0	sand/gravel	no fish caught

Tutshi Lake

INDIVIDUAL FISH DATA

Date Captured: September 13, 1987
Method of Capture: Sinking monofilament gill net

Netting site #1

SPEC	FORK LGTH (cm)	WT (g)	SEX	GON MAT	SAMPLE TYPE	AGE	STOMACH CODE	STOMACH CONTENTS	COMMENTS
LT	18.0	75	?	IMM	OT				white flesh; many nodules on gut
	23.3	100	?	IMN	OT				white flesh
	25.3	150	?	IMN	0T				white flesh
	25.6	200	?	IMN	0T				white flesh
	28.0	225	M	IMN	0T				
	32.4	375	M	IMN	OT				
	34.1	450	M	IMN	0T				
	34.5	475	F	IMN	0T				full of tapeworms
	36.9	550	F	IMN	0T				
	37.0	550	F	IMN	OT				Tapeworms present
	38.7	600	F	IMN	0T				
	39.9	850	M	MT	0T				
	41.0	925	F	IMN	0T				very few nodules
	42.1	975	M	SP	OT				Unidentifiable mush in Stomach
	42.4	975	F	IMM	OT				Stomach full of Unidentifiable mush
	42.9	1025	M	MT	OT				few nodules; unidentifiable mush in stomach
	43.0	1025	M	MT	OT				Nodules present
	43.0	1075	M	MT	OT				
	43.6	1125	M	MT	OT				white worms in stomach, full of unidentifiable mush
	43.7	1050	F	IMM	OT		B	snails	many nodules on gut; many worms in stomach
	44.0	950	F	IMM	OT				full of white worms

B-Bottom organisms	GV-Gravid	MG-Maturing	RB-Rainbow trout
CO-Coho	I-Insects	MT-Mature	SC-Scale
CT-Cutthroat trout	IMM-Immature	MW-Mountain whitefish	SP-Spent
DV-Dolly Varden	KO-Kokanee	O-Other	T#-Tissue sample
F-Female	LT-Lake trout	OT-Otolith	UN-Unknown
FI-Fish	M-Male	P-Plankton	WF-Whole fish

Tutshi Lake

INDIVIDUAL FISH DATA CONT'D

Date Captured: September 13, 1987
Method of Capture: Sinking monofilament gill net

Netting site #1

SPEC	FORK LGTH	WT (g)	SEX	GON MAT	SAMPLE TYPE	AGE	STOMACH CODE	STOMACH CONTENTS	COMMENTS
LT	44.2	975	F	MT	OT				White worms on pyloric
					T1				Caeca
	44.2	1000	M	MT	OT				Nodules on stomach and Liver
	44.2	1350	F	MT	OT				Nodules on gut
	44.8	1100	M	MT	OT				Spawning coloration
	45.0	1075	M	MT	OT		FI	burbot	
	45.2	1225	F	MT	OT				Stomach partly full
	45.4	1150	F	MT	OT				Nearly gravid; nodules Present on gut
	45.4	1150	M	MT	OT				Stomach empty
	45.5	1175	F	IMM	OT				
	46.1	1275	F	GV	OT				many white nodules on gut
	46.2	1150	F	MT	OT		P	gammarids	Nodules on gut
					T2				
	47.0	1275	F	MT	OT		P	gammarids	Nodules on gut
	48.8	1400	M	MT	OT				White nodules present;
					T3				pink flesh
	50.4	1075	F	IMM	OT				poor condition; white
					T5				nodules on gut
	51.5	1375	M	MT	OT		FI	whitefish	
					T4				
GR	30.6	275	M	IMM	SC				
	34.8	200	M	IMM	SC				
	35.0	180	M	IMM	SC				
	37.1	600	F	MG	SC		I	caddis fly	
BB	23.4	70	?	IMM	OT				
RW	20.0	60	?	IMM	SC				
	20.8	60	?	IMM	SC				

B-Bottom organisms
BB-Burbot
CO-Coho
CT-Cutthroat trout
DV-Dolly Varden
F-Female
FI-Fish
GR-Ar.Grayling
GV-Gravid
I-Insects
IMM-Immature
KO-Kokanee
LT-Lake trout
M-Male
MG-Maturing
MT-Mature
MW-Mountain whitefish
O-Other
OT-Otolith
P-Plankton
RB-Rainbow trout
RW-Round Whitefish
SC-Scale
SP-Spent
T#-Tissue sample
UN-Unknown
WF-Whole fish

Tutshi Lake

INDIVIDUAL FISH DATA CONT'D

Date Captured: September 13, 1987
Method of Capture: Sinking monofilament gill net

Netting site #1

SPEC	FORK LGTH (cm)	WT (g)	SEX	GON MAT	SAMPLE TYPE	AGE	STOMACH CODE	STOMACH CONTENTS	COMMENTS
RW	33.1	325	M	IMM	SC				
	34.7	350	M	IMM	SC				Wormy
	35.2	450	F	IMM	SC				much body fat
	37.5	525	F	IMM	SC				Stomach empty
	38.8	515	M	MG	SC T4				
	38.8	575	M	MG	SC				body fat present
	40.0	650	F	MG	SC T5				
	42.3	800	F	MG	SC T3		B	snails	Nodules on gut wall
	45.5	925	F	MG	SC T2				many nodules on gut
	45.8	900	M	MG	SC T1		B	snails	Nodules on gut wall

Netting Site #2, September 15, 1987

LT	13.0	20	?	IMM
	13.2	20	?	IMM
	14.2	20	?	IMM
	17.6	55	?	IMM
	18.5	55	?	IMM
	21.9	100	?	IMM
	22.5	115	?	IMM
	24.8	165	?	IMM
	25.0	165	?	IMM
	25.5	155	?	IMM
	26.3	195	?	IMM
	27.4	190	?	IMM
	28.0	225	?	IMM

B-Bottom organisms
CO-Coho
CT-Cutthroat trout
DV-Dolly Varden
F-Female
FI-Fish
GV-Gravid
I-Insects
IMM-Immature
KO-Kokanee
LT-Lake trout
M-Male
MG-Maturing
MT-Mature
MW-Mountain whitefish
O-Other
OT-Otolith
P-Plankton
RB-Rainbow trout
RW-Round Whitefish
SC-Scale
SP-Spent
T#-Tissue sample
UN-Unknown
WF-Whole fish

Tutshi Lake

INDIVIDUAL FISH DATA CONT'D

Date Captured: September 15, 1987
Method of Capture: Sinking monofilament gill net

Netting site #2

SPEC	FORK LGTH (cm)	WT (g)	SEX	GON MAT	SAMPLE TYPE	AGE	STOMACH CODE	STOMACH CONTENTS	COMMENTS
LT	28.4	230	?	IMM					
	29.4	250	?	IMM					
	29.5	250	?	IMM					
	29.8	250	?	IMM					
	30.9	300	M	IMM					
	31.4	300	?	IMM					
	34.7	450	F	IMM					
	36.0	500	M	IMM					
	37.6	500	M	IMM					
	38.2	625	M	MG					
	39.0	700	F	MT					eggs resorbing
	39.2	675	M	IMM					
	39.3	575	F	IMM					
	40.4	650	M	MG					
	42.8	775	F	IMM					
	42.9	800	M	MG					
	43.2	975	M	MG					
	43.6	825	F	MT					
	57.5	2200	F	MT					eggs resorbing
RW	30.6	450	F	IMM	OT				
	31.0	275	M	IMM					
	39.0	600	F	MG					
	41.5	725	F	MG					
	44.5	850	F	MG					
	46.2	1000	M	MG					
LSU	41.0	800							

Netting Site #3, September 15, 1987

LT	13.8	25	?	IMM				white flesh	
	18.1	65	?	IMM				white flesh	

B-Bottom organisms
CO-Coho
CT-Cutthroat trout
DV-Dolly Varden
F-Female
FI-Fish
GV-Gravid
I-Insects
IMM-Immature
KO-Kokanee
LSU-Longnose Sucker
LT-Lake trout
M-Male
MG-Maturing
MT-Mature
MW-Mountain whitefish
O-Other
OT-Otolith
P-Plankton
RB-Rainbow trout
RW-Round Whitefish
SC-Scale
SP-Spent
T#-Tissue sample
UN-Unknown
WF-Whole fish

Tutshi Lake

INDIVIDUAL FISH DATA CONT'D

Date Captured: September 15, 1987
Method of Capture: Sinking monofilament gill net

Netting site #3

SPEC	FORK LGTH (cm)	WT (g)	SEX	GON MAT	SAMPLE TYPE	AGE	STOMACH CODE	STOMACH CONTENTS	COMMENTS
LT	18.2	65	?	IMM					White flesh
	18.7	65	?	IMM					White flesh
	21.4	85	?	IMM					White flesh
	22.0	100	?	IMM					White flesh
	22.3	115	?	IMM					White flesh
	22.5	105	?	IMM					White flesh
	26.3	180	?	IMM					White flesh
	26.4	180	?	IMM					White flesh
	27.9	225	?	IMM					Orange flesh
	29.0	200	M	IMM	OT				White flesh
	29.4	275	?	IMM					White flesh
	29.9	250	?	IMM					White flesh
	30.0	300	?	IMM					White flesh
	30.4	250	D	IMM					
	32.3	300	?	IMM					Orange flesh
	35.0	425	M	IMM	OT				
	39.8	525	M	IMM					
	41.9	800	M	MG					
	43.2	1000	M	IMM	OT				
	45.5	1025	M	MG					
	46.0	925	M	MG					
	46.1	1025	F	MT					Eggs resorbing
	46.2	1150	M	MG					
	46.9	1000	M	MG					
	49.0	1400	M	IMM					
	88.4	7500	M	MG	OT				
RW	31.2	275	M	IMM	SC				
	33.0	325	M	MG	SC				
	34.1	275	M	MG	SC				
	38.3	550	F	MT	SC				
	40.4	675	F	MG	SC				
	40.9	700	F	MG	SC				

B-Bottom organisms
CO-Coho
CT-Cutthroat trout
DV-Dolly Varden
F-Female
FI-Fish
GV-Gravid
I-Insects
IMM-Immature
KO-Kokanee
LT-Lake trout
M-Male
MG-Maturing
MT-Mature
MW-Mountain whitefish
O-Other
OT-Otolith
P-Plankton
RB-Rainbow trout
RW-Round Whitefish
SC-Scale
SP-Spent
T#-Tissue sample
UN-Unknown
WF-Whole fish