



**FISH STOCK ASSESSMENT OF
BENNETT, FRANCES AND KLUANE LAKES,
1990.**

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September 1992

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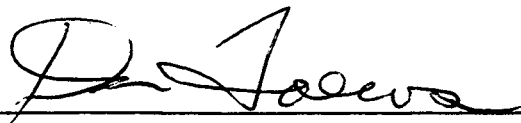


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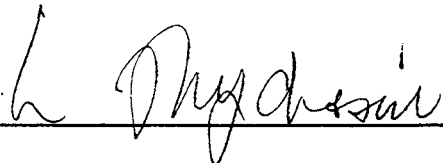


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Nick de Graff



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Supervisor

September 1992

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TABLE OF CONTENTS

1.0		INTRODUCTION	1
2.0		OBJECTIVES	2
3.0		STUDY AREAS	2
	3.1	Bennett Lake	2
	3.2	Frances Lake	3
	3.3	Kluane Lake	5
4.0		MATERIALS AND METHODS	6
	4.1	Lake Morphometry	6
	4.2	Physical and Chemical Limnology	7
	4.3	Morphoedaphic Index and Yield	7
	4.4	Index Gillnetting	8
	4.5	Other Calculations	9
5.0		RESULTS	10
	5.1	Lake Morphometry	10
	5.2	Physical and Chemical Limnology	10
	5.3	Morphoedaphic Indices and Yield	10
	5.4	Species Composition and Catch per Unit Effort	15
	5.5	Age and Growth	19
	5.5.1	Lake Trout	19
	5.5.2	Lake Whitefish	29
	5.6	Mortality	38
	5.7	Maturity	44
	5.9	Mesh Size Effects	44
	5.10	Lake Whitefish Cyst Infestation	46
6.0		DISCUSSION	46
	6.1	Lake Productivity	46
	6.2	Lake Trout	49
	6.3	Lake Whitefish	51
	6.4	Management Implications	53
7.0		RECOMMENDATIONS	55
	7.1	Bennett Lake	55
	7.2	Frances Lake	56
	7.3	Kluane Lake	57
8.0		REFERENCES	57

LIST OF TABLES

- Table I. Morphometric data for Bennett, Frances and Kluane Lakes.
- Table II. Water chemistry data collected between August 24 and September 20, 1990 from Bennett, Frances and Kluane Lakes.
- Table III. Calculated morphoedaphic indices (MEI), mean annual temperatures and maximum sustainable yields (MSY) for lake trout within Bennett, Frances and Kluane Lakes.
- Table IV. Species composition, presented as percentage of the total catch biomass from index netting, 1990.
- Table V. Relative catch per unit effort data (#/24 hr/100m) from index netting, summer 1990.
- Table VI. Age specific mean fork lengths and weights of lake trout from Bennett Lake, 1990.
- Table VII. Age specific mean fork lengths and weights of lake trout from Frances Lake, 1990.
- Table VIII. Age specific mean fork lengths and weights of lake trout from Kluane Lake, 1990.
- Table IX. Sex specific length - weight relationships of lake trout from Bennett, Frances and Kluane Lakes, 1990.
- Table X. Von Bertalanffy growth variables of lake trout from Bennett, Frances and Kluane Lakes, 1990.
- Table XI. Age specific mean fork lengths and weights from lake whitefish from Bennett Lake, 1990.
- Table XII. Age specific mean fork lengths and weights from lake whitefish from Frances Lake, 1990.
- Table XIII. Age specific mean fork lengths and weights from lake whitefish from Kluane Lake, 1990.
- Table XIV. Sex specific length - weight relationships of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.
- Table XV. Von Bertalanffy growth variables of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Table XVI. Robson - Chapman mortality and survival rates of lake trout and lake whitefish caught in index nets on Bennett, Frances and Kluane Lakes, 1990.

Table XVII. Mean ages of maturity of lake trout and lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

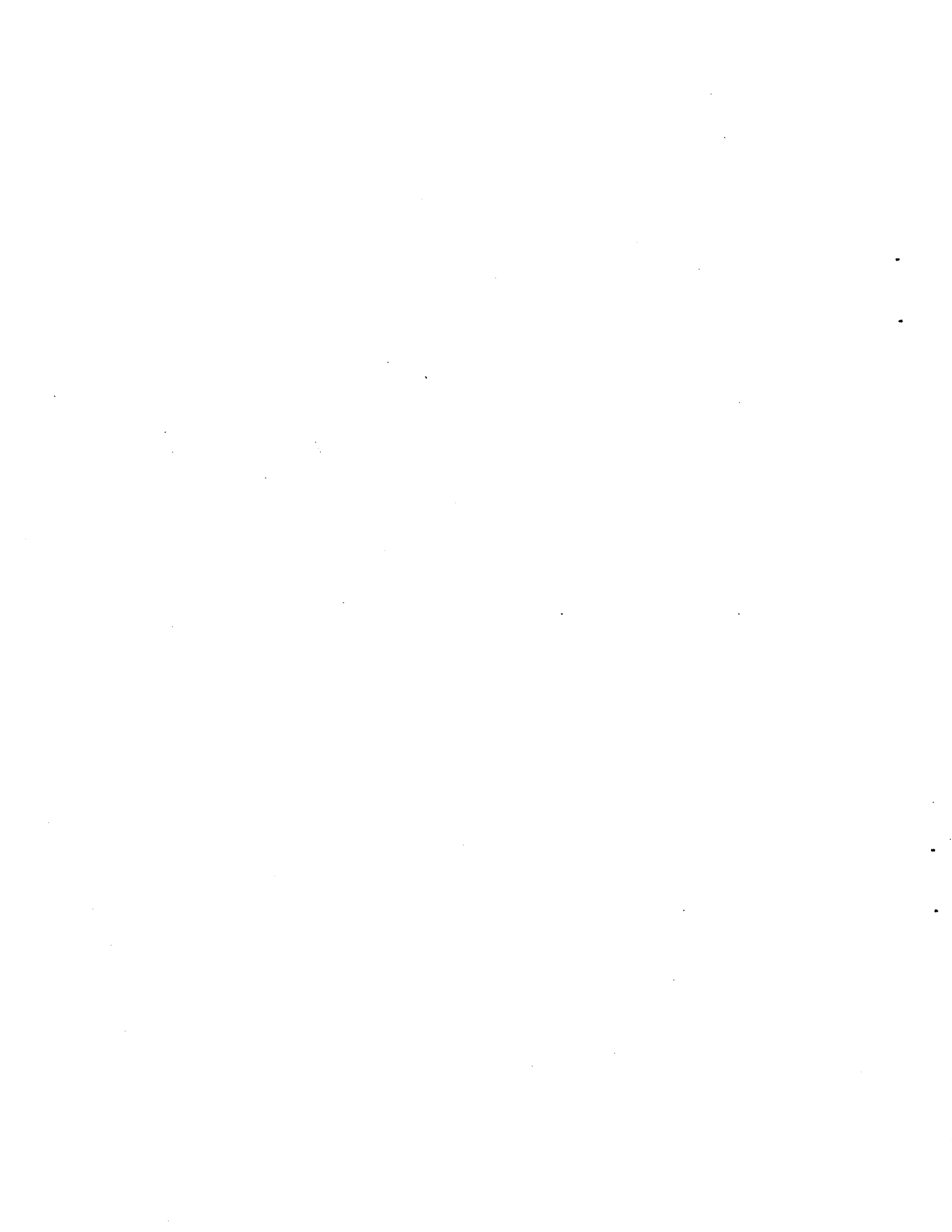
Table XVIII. Lake whitefish infestation rates of Trianophorus crassus cysts from Bennett, Frances and Kluane Lakes, 1990.

LIST OF FIGURES

- Figure 1. Bathymetric map of Bennett Lake, Yukon Territory.
- Figure 2. Bathymetric map of Kluane Lake, Yukon Territory.
- Figure 3. Bathymetric map of Frances Lake, Yukon Territory.
- Figure 4. Age frequencies for lake trout caught in index nets on Bennett, Frances and Kluane Lakes, 1990.
- Figure 5. Length-weight scatter plots of lake trout from Bennett, Frances and Kluane Lakes, 1990.
- Figure 6. Length frequencies lake trout caught in index nets on Bennett, Frances and Kluane Lakes, 1990.
- Figure 7. Age-length scatter plots of lake trout from Bennett, Frances and Kluane Lakes, 1990.
- Figure 8. Length-weight relationships and Von Bertalanffy growth curves of lake trout from Bennett, Frances and Kluane Lakes, 1990.
- Figure 9. Diet composition of lake trout caught in index nets in Bennett, Frances and Kluane Lakes, summer 1990.
- Figure 10. Age frequency for lake whitefish caught in index nets on Bennett, Frances and Kluane Lakes, 1990.
- Figure 11. Length-weight scatter plots of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.
- Figure 12. Length frequencies of lake whitefish caught in index nets on Bennett, Frances and Kluane Lakes, 1990.
- Figure 13. Age-length scatter plots of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.
- Figure 14. Length-weight relationships and Von Bertalanffy growth curves of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.
- Figure 15. Mesh size effects of catches of lake trout and lake whitefish from index netting within Bennett, Frances and Kluane Lakes, summer 1990.

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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. To this end, lakes where conflicts between user groups were acknowledged and where little stock information was available, became assessment priorities. Consequently, Bennett Lake, Frances Lake and Kluane Lake, due to their active subsistence, domestic, sport and commercial fisheries were targeted during the summer of 1990.

Historically, each of these lakes were used solely for subsistence purposes prior to Eurasian contact in the mid 1700's (Siegel and McEwan, 1984). Aboriginal harvests continue, although records of harvests are sporadic and largely unknown, With the integration of domestic and commercial netting, coincidence with the "gold rush" at the turn of the century, harvests escalated within many lakes throughout the territory. The establishment of fur farming and the construction of the Alaska Highway during the 1940's further increased harvest and utilization of the resource. Presently, it is felt that sport and commercial sectors take the majority of the harvest from these lakes (The DPA Group, 1988).

2.0 OBJECTIVES

The general objective of these surveys was to determine the status of the dominant fish species within Bennett, Frances and Kluane Lakes. The specific objectives of this study were:

- (1) Collect information on lake morphometry and limnology and evaluate it in light of potential for fish production and current quotas.
- (2) Determine the population dynamics of the dominant species within each lake.
- (3) Present commercial lake trout quotas as maximum sustainable yields, as predicted by Schlesinger and Regier's (1982) MEI model of fish production.
- (4) Based on the findings of objectives 1 to 3, make recommendations on new quotas and management plans for these three lakes.

3.0 STUDY AREAS

3.1 Bennett Lake

Bennett is a headwater lake of the Yukon River and is located in the south-central portion of the Yukon Territory at 60°05' N lat. and 134°52' W long. The south-eastern arm extends into the

province of British Columbia. Some of the most productive areas are associated with alluvial deposits at creek mouths, Millhaven Bay and the outlet into Nares Lake. The littoral zone is generally limited to a very narrow band along the shoreline due to the steep shoreline gradient. The south-east arm is fed by glacial meltwater which contributes a significant amount of suspended particulate matter during the summer snow-melt. Access to the lake is by an all weather highway. The community of Carcross is located at the extreme north-east corner of the lake.

3.2 Frances Lake

Frances is a headwater lake of the Frances River, a tributary of the Liard River system (MacKenzie River watershed), in south eastern Yukon at $51^{\circ}15'$ N lat. and $129^{\circ}30'$ W long. The lake is composed of four distinct basins. Each is unique and linked by shallow low gradient riverine type habitat. For purposes of discussion the four basins are referred to as east arm, west arm (north and south basins) and Six mile lake.

The largest expanse of littoral zones occurs in the section that links the east arm and the south basin of the west arm. This area has a very irregular shoreline, shallow productive bays, lagoons and is continually replenished with surface waters originating from the east arm.

The east basin (east arm) is among the most unproductive habitat within the lake. Its large mean depth, steep shoreline gradient and lack of shoreline development are contributing factors. Productive habitat is limited to a few alluvial fans and the mouth of the Anderson River.

The two basins within the west arm are separated by a narrows and associated islands. Expanses of emergent aquatic vegetation and sand bars, some extending a significant distance from shore are characteristic of this area. The southern basin has a very irregular bathometry with large alluvial deposits associated with the inlet of the Tyres River and the narrows connecting the east arm. Most of the commercial fishing effort was concentrated in this basin. The northern basin of the west arm is similar in morphology to the east arm, with a large mean depth, steep shoreline gradient and little shoreline development.

Six mile lake, although physically separated by a short low gradient stream, has a similar morphometry as the northern basin of the west arm. Productive zones are limited to the inlet and outlet of the lake.

The lake is accessible by an all weather road with the access point located at the central portion of the west arm. The lake is situated approximately 150 kms north of Watson Lake, Yukon.

3.3 Kluane Lake

Kluane is a headwater lake of the Donjek River, a large tributary of the Yukon River and is located in the south west portion of the Yukon Territory at $61^{\circ}15'$ N lat. and $138^{\circ}43'$ W long. It is the largest lake, both in volume and surface area, that is totally contained within the Territorial boundaries.

The deepest portions of the lake are confined to a long trough within Talbot Arm and a large deep basin in the southeast portion of the lake. The Slims River is located in the latter, contributing large amounts of glacial sediment to the lake (Bostock, 1969). Little commercial fishing effort is expended within the estuary as it is thought to be an area of low fish abundance (LaRocque, pers. com.). The north west portion of the lake has a flat gentle relief. The gradient from the deeper midwater areas to shoreline is low, culminating into shallow productive zones contained at the Kluane River mouth and within the confines of Brooks Arm. The north west basin is thought to be one of the most productive zones in the lake.

Several steep gradient streams enter Kluane Lake along the west shoreline, originating from the St. Elias range. These small watersheds are generally unstable and are characterized in having a mountainous type of hydrological regime. At freshet these streams can contribute varying amounts of sediment to the lake. Watersheds

along the eastern shoreline have generally lower gradients and more stability. Productive estuaries include Christmas Bay and the mouths of the Jarvis and Gladstone watersheds.

Talbot Arm transects the mountains of the Ruby Range. The arm is relatively deep and unproductive. Contributing factors include steep shoreline gradients and low shoreline development. Two small communities, Burwash Landing and Destruction Bay, are located on the western shore. They are linked by the Alaska Highway that skirts the western shoreline of the lake.

4.0 MATERIALS AND METHODS

4.1 Lake Morphometry

Each lake was depth sounded with either a Furuno FGII MK3 echo sounder or Lowrance Model X-50 sonar. Transducers were mounted on the transom of the survey boat. Sounding transects were drawn in the field on a 1:50,000 scale topographic map and later transferred to a 1:50,000 drafting film base map for each lake. The bathygraphic map was used to determine lake area, volume and mean depth according to procedures described by Wetzel (1975).

4.2 Physical and Chemical Limnology

Field measurements of water quality were collected between August 24 and September 20 for all study sites. Variables included water temperature, dissolved oxygen, pH, alkalinity, total hardness, carbon dioxide, total dissolved solids (TDS), conductivity and transparency. Temperature, TDS and conductivity profiles were determined with a HACH model 44600 instrument. Transparency was estimated using a 20-cm diameter Secchi disc. All other chemical profiles were determined using a HACH water ecology test kit, model AI-36B. Water chemistry locations on each lake are shown in Appendix I.

4.3 Morphoedaphic Index and Yield

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

$$\log_{10} \text{MSY} = .050 \text{ TEMP} + .280 \log_{10} \text{MEI} + .236 \text{ (Schlesinger, 1982)}$$

The temperature variable used in the above equation are from mean annual air temperature data collected from atmospheric weather stations (Environment Canada, 1982). The weather stations that were chosen were those within the closest proximity to each study area. The calculated all species MSY was then partitioned using

the experimental gillnet catch data (percent lake trout biomass) to determine a lake trout MSY and yield.

4.4 Index Gillnetting

Gillnetting was performed during the months of June, July and August within all study sites. The intensity of experimental gillnetting was dependent upon obtaining a minimum of 250 lake trout from each lake. Gillnet gangs were largely set off points of land, perpendicular to the shoreline. Each standard gang consisted of seven sinking gillnets with mesh sizes arranged in the following order: 3.8 cm, 12.7 cm, 6.4 cm, 11.4 cm, 7.6 cm, 10.2 cm, and 8.9 cm. Each gillnet was 22.9 meters long and 2.4 meters deep. Gangs were set overnight for approximately 24 hours. Efforts were made to sample a variety of locations within each lake, however prevailing winds limited sampling on Bennett and Kluane Lakes. Set locations within each lake are presented in Appendix I.

Lake trout, lake whitefish and northern pike were sampled for fork length, weight, sex and maturity. Stomach contents were examined on all lake trout. All other fish species were sampled for fork length and weight. For age determination, otoliths were used for lake trout and lake whitefish. Otoliths were embedded in epoxy resin and cross sectioned on a Isomet low-speed saw. A microfiche reader was used to read the annuli of mounted otolith sections.

Lake whitefish were sampled for the parasite Triaenophorus crassus. Fish were sampled by filleting the fish and shaving the fillets into thin slices at right angles to the backbone. The number of cysts were totalled for all samples and the rate of infestation (cysts/100 lbs) was determined using the following equation:

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

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 were 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.

Length-weight scatter plots were curve fitted by least squares regression of logarithmically transformed data. Von Bertalanffy growth curves were derived from age/length scatter plots using an empirical method as described by Payne (1990). For comparative purposes with Ontario lake trout data an additional curve was developed using only ages 4 to 7 years.

5.0 RESULTS

5.1 Lake Morphometry

The net water areas, volumes and depth variables for each lake are presented in Table I. Kluane Lake is four times the surface area of either Frances or Bennett Lakes. With respect to volume, however, Bennett is nearly half that of Kluane Lake. Bennett Lake had both the largest mean and maximum depths. Bathymetric maps for each lake are presented in Figures 1 to 3.

5.2 Physical and Chemical Limnology

All three lakes were isothermic with the greatest range of 6°C between surface and bottom temperatures observed on Frances Lake. Each lake was comprised of relatively soft water with a total hardness ranging from 3-22 mg/L (Table II). Secchi depths varied between and within each lake. Lower values on Bennett and Kluane Lakes were generally associated with glacial meltwater.

5.3 Morphoedaphic Indices and Yield

A calculated MEI, all species MSY, lake trout MSY and yield for

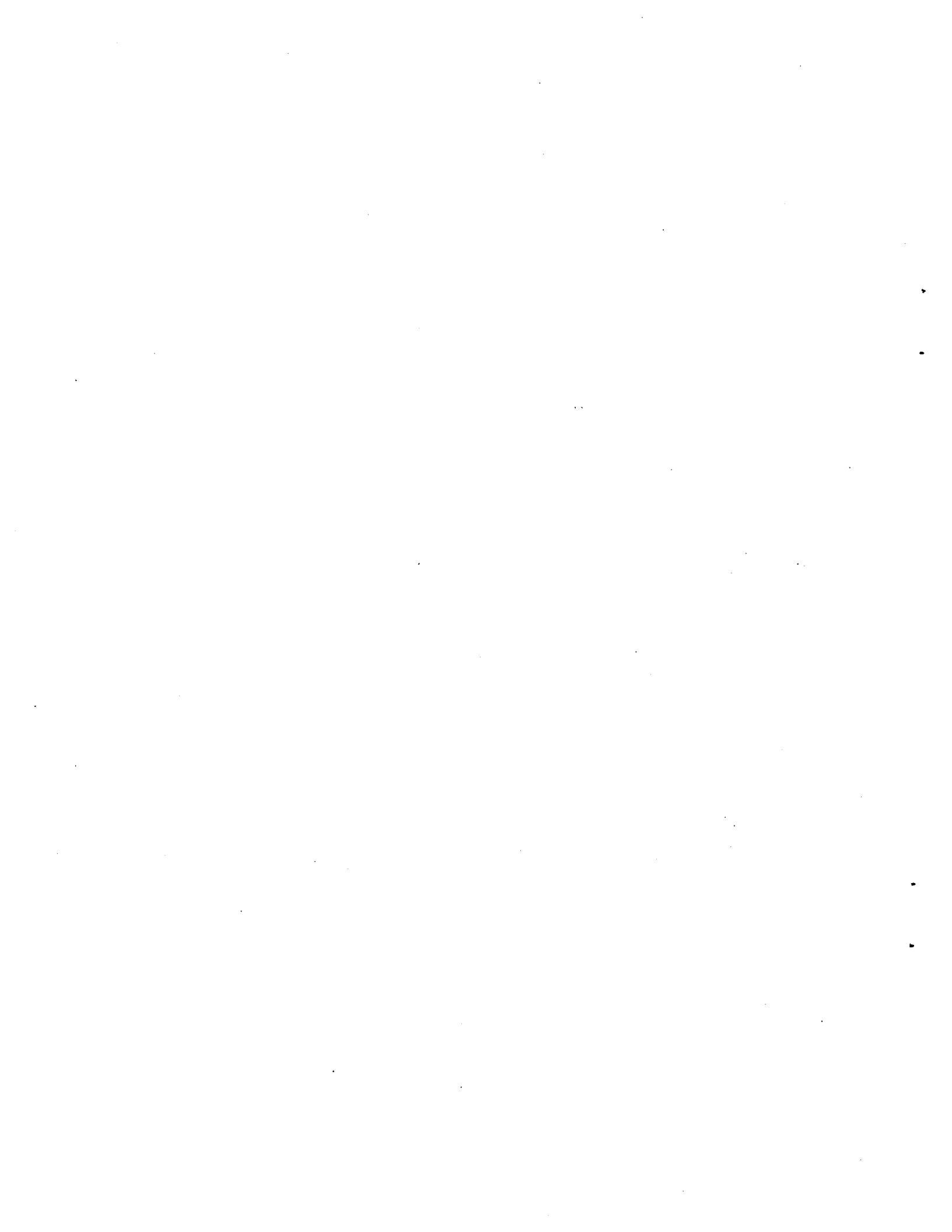
Table I Morphometric data for Bennett, Frances and Kluane Lakes.

Variable	Bennett	Frances	Kluane
Surface Area (km ²)	96.80	99.41	392.75
Volume (km ³)	5.99	3.12	12.65
Mean Depth (m)	61.9	31.3	31.1
Maximum Depth (m)	123	93	91

Table II Water chemistry data collected between August 24 and September 20, 1990 from Bennett, Frances and Kluane Lakes.

Variable	Bennett	Frances	Kluane
Secchi Depth Range (m)	2.4-8.5	6.4-9.8	4.6-10.7 ¹
Total Alkalinity (mg/L)	2	4	3
Total Hardness (mg/L)	3	22	10
Carbon Dioxide(mg/L)	5	20	10
TDS (mg/L)	28	71	130
Conductivity (μ mho/cm)	54	155	260
pH	7.25	7.75	7.75
Stations	4	6	1

¹ Secchi data collected from gillnet sample sites



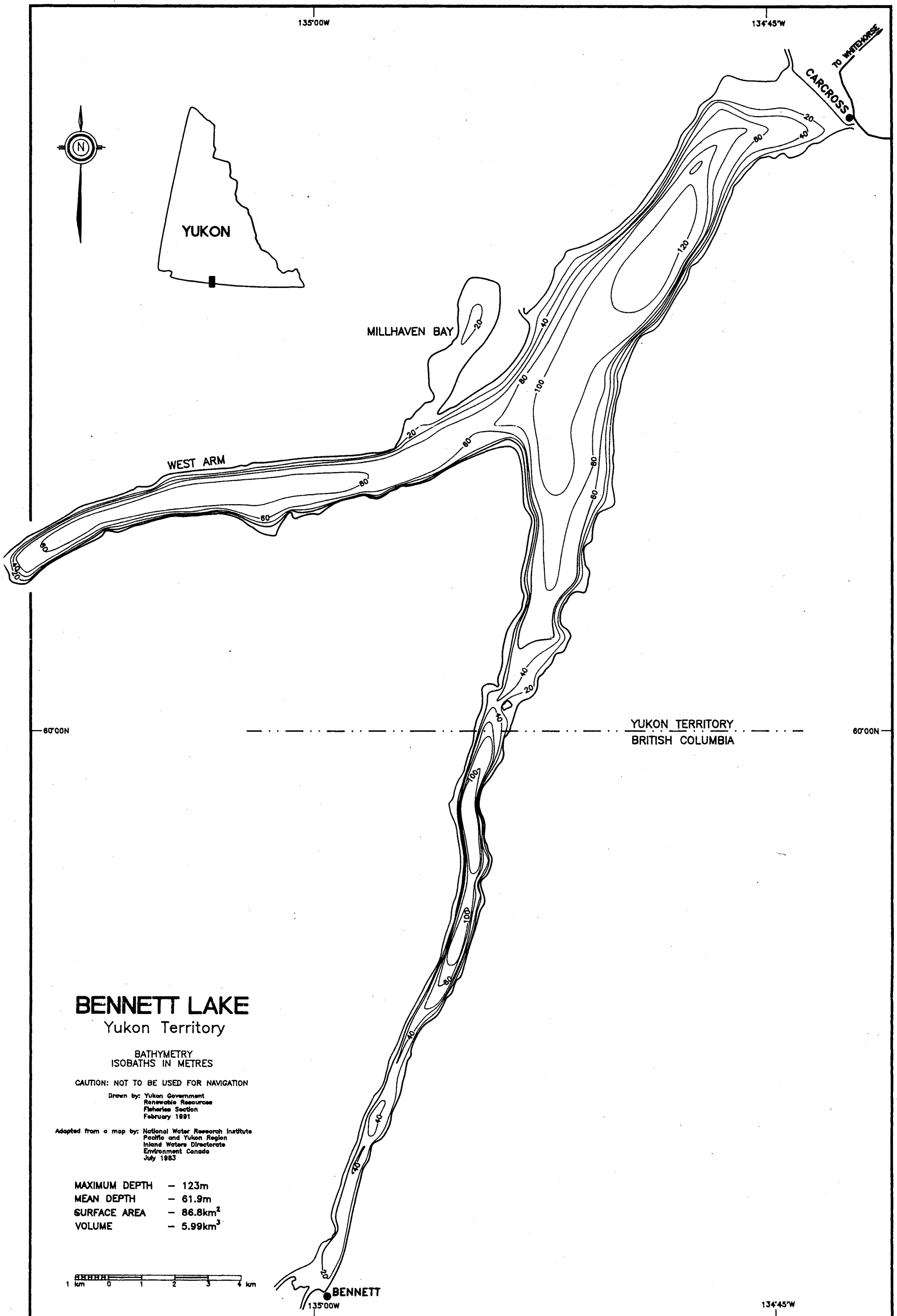


Figure 1

Bathymetric map of Bennett Lake, Yukon Territory

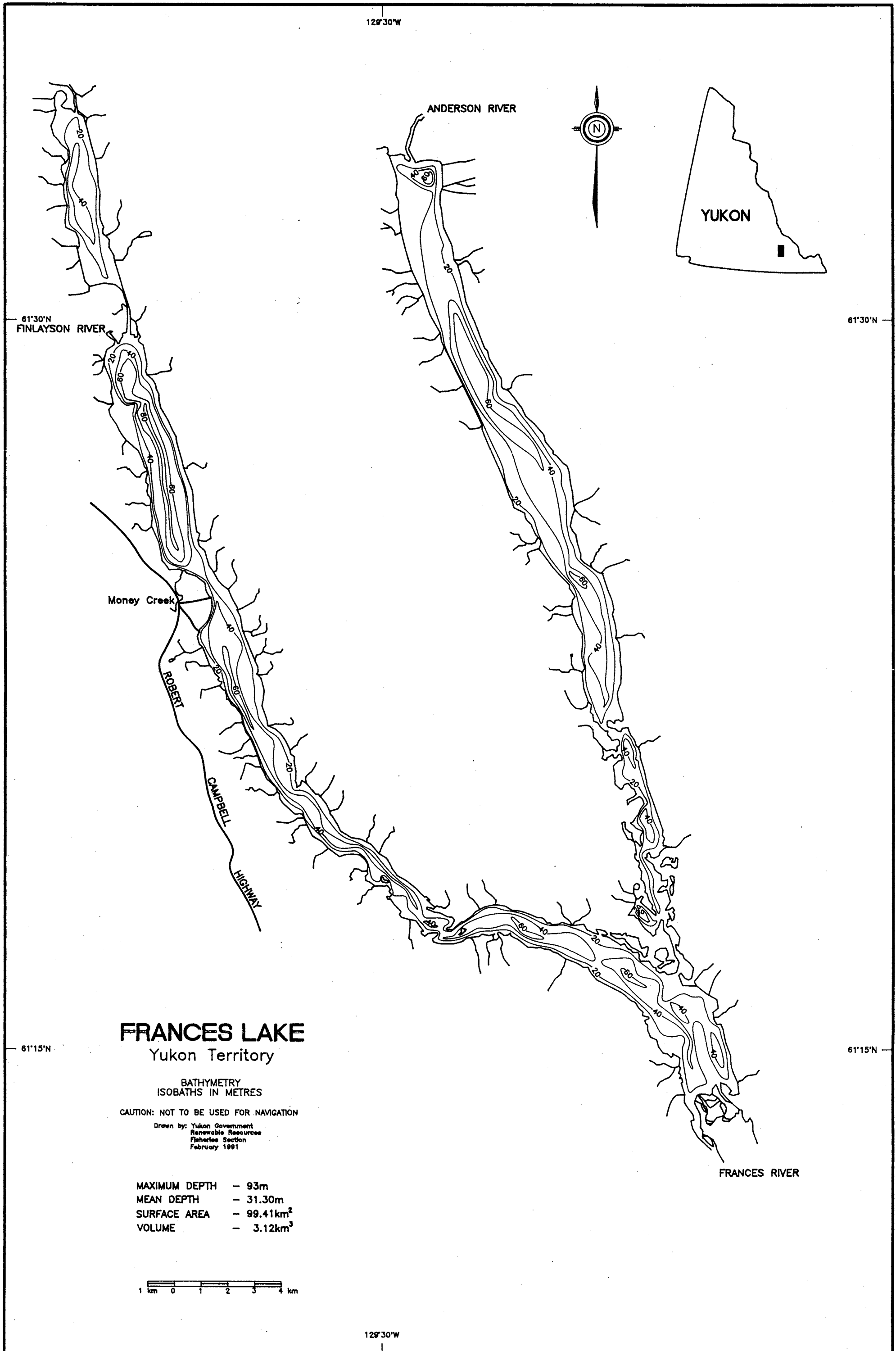


Figure 2

Bathymetric map of Frances Lake, Yukon Territory

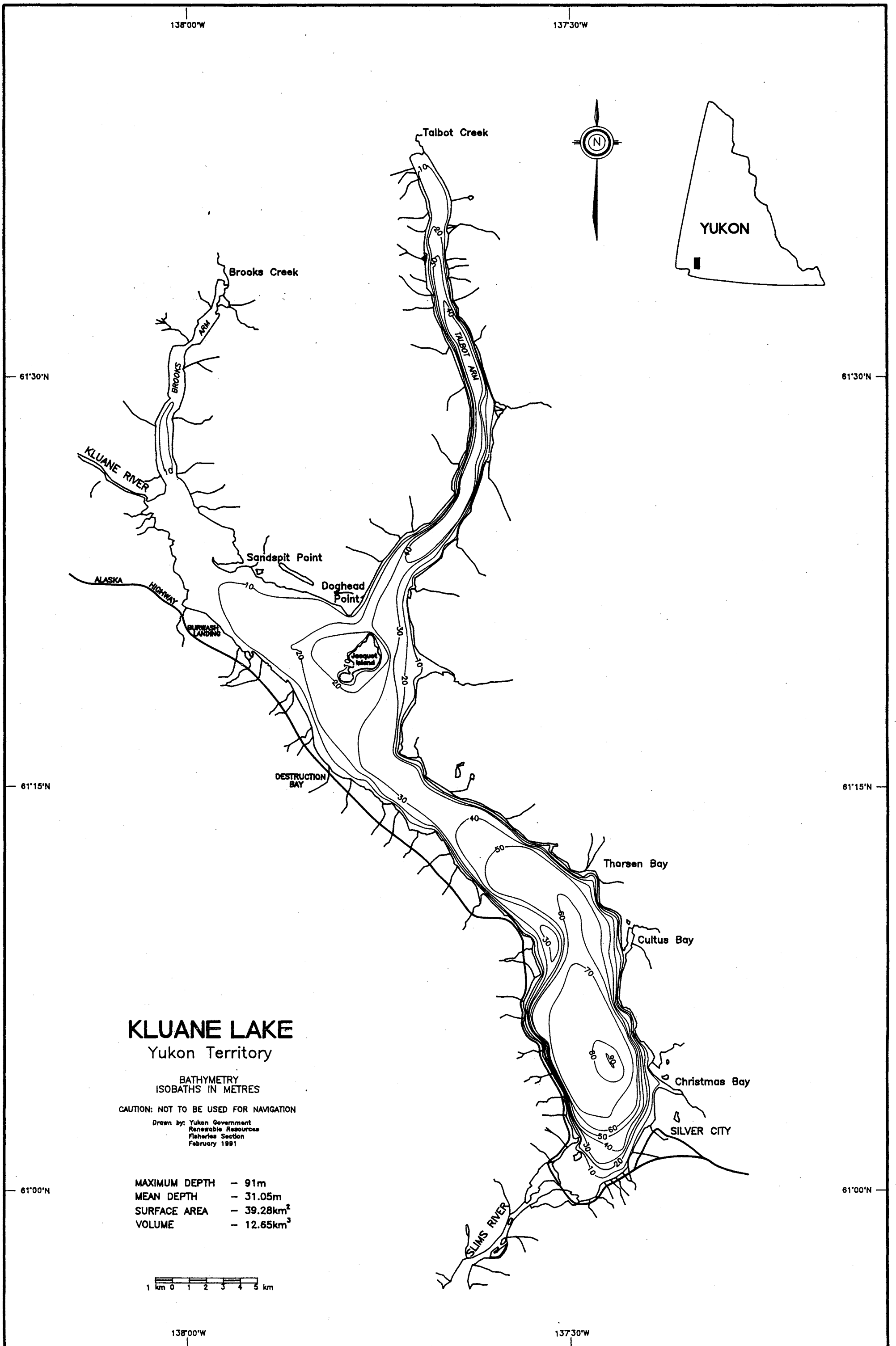


Figure 3

Bathymetric map of Kluane Lake, Yukon Territory

each lake is shown in Table III. Kluane lake had the highest MEI (4.19) and the largest lake trout MSY (18,559 kg). The Bennett Lake MEI (.45) was approximately a third of the Frances Lake value (1.33), however the resulting lake trout MSY's were comparable due largely to the influence of the climatic (temperature) variable. Resulting MSY's for lake trout, expressed in kilograms per hectare, ranged from .38 (Frances Lake) to a high of .47 (Kluane Lake).

5.4 Species Composition and Catch per Unit Effort

Lake trout and lake whitefish were the dominant species in the catches in all three lakes (Table IV). Lake whitefish was the most abundant species in Frances and Kluane Lakes occupying 47.5 and 58.7 percent of the biomass, respectfully. Round whitefish and longnose suckers were strongly represented on Bennett Lake. Burbot, although present in all three lakes, represented a small percentage of the catch. Incidental catches of inconnu in Kluane Lake, least ciscoe in Bennett Lake and dolly varden in Frances Lake were unique in each lake, respectively.

The relative catch per unit effort of lake trout was lowest on Frances Lake (Table V). Catches approximated half those recorded on Bennett and Kluane Lakes. Frances Lake had the overall lowest combined species catch per unit effort. The highest single species catch per unit effort were lake whitefish on Kluane Lake.

Table III Calculated morphoedaphic indices (MEI), mean annual temperatures and maximum sustainable yields (MSY) for lake trout within Bennett, Frances and Kluane Lakes.

VARIABLE	LAKE		
	Bennett	Frances	Kluane
MEI	.45	1.33	4.19
Temperature ¹ (C°)	-1.4	-4.2	-4.4
Surface Area (ha)	9,680	9,941	39,275
MSY ² all species (kgs)	11,361	13,262	60,848
Lake Trout Biomass (%)	32.0	31.5	30.5
MSY Lake Trout (kgs)	3,635	4,177	18,559
MSY Lake Trout (kgs/ha)	.38	.42	.47

¹ mean annual air temperature (Environment Canada, 1982)

² calculated from the product of surface area and the equation $\log_{10}MSY = .050 \text{ TEMP} + .280 \log_{10}MEI + .236$ (Schlesinger and Regier, 1982)

Table IV Species composition, presented as percentage of the total catch biomass from index netting, 1990.

SCIENTIFIC NAME	SPECIES	LAKE		
		Frances	Bennett	Kluane
<u>Salvelinus namaycush</u>	lake trout	31.5	32.0	30.3
<u>Coregonus clupeaformis</u>	lake whitefish	47.5	27.1	58.8
<u>Prosopium cylindraceum</u>	round whitefish	1.0	10.5	.8
<u>Catostomus catostomus</u>	longnose sucker	13.3	29.7	8.9
<u>Lota lota</u>	burbot	.6	.2	<.1
<u>Esox lucius</u>	northern pike	5.4		
<u>Stenodus leucichthys</u>	inconnu			1.0
<u>Coregonus sardinella</u>	least ciscoe		.1	
<u>Salvelinus malma</u>	dolly varden	.5		
<u>Thymallus arcticus</u>	arctic grayling	.2	.4	

Table V Relative catch per unit effort data (#/24 hr/100 m) from index netting, summer 1990.

SPECIES	LAKE		
	Frances	Bennett	Kluane
Lake Trout	3.6	8.5	7.1
Lake Whitefish	11.6	6.8	32.2
Round Whitefish	1.0	5.9	2.2
Longnose Sucker	2.7	10.7	4.0
Other species	.9	.6	.3
Total	19.8	32.5	45.8

5.5 Age and Growth

5.5.1 Lake Trout

Age specific mean fork lengths and mean weights of lake trout from experimental gillnet catches for each lake are presented in Tables VI to VIII. Overall catches of lake trout ranged in age from 3 to 39 years, with modal ages ranging from 9 (Frances Lake) to 13 (Bennett Lake) years. Age frequencies are presented in Figure 4. Mean age of catch were 11 years for Bennett Lake, 12.4 years for Frances Lake and 14.5 years for Kluane Lake.

Length-weight scatter plots and relationships are presented in Figure 5 and Table IX for each lake. For any given length, fish from Kluane Lake averaged the greatest weight, while Bennett Lake averaged the least. Length frequency histograms are presented in Figure 6. Sampled fish ranged in fork length from 160 mm to 940 mm. Modal lengths were 480 mm for Bennett Lake, 450 mm for Frances Lake and 480/500 mm for Kluane Lake.

Age-length scatter plots and Von Bertalanffy growth variables are presented in Figure 7 and Table X. Growth coefficients were consistently higher for females, than males. With sexes combined, growth coefficients varied little between lakes. Conversely, analysis of growth using only age groups 4 to 7 years, show lake trout from Kluane Lake having the greatest rate of growth. The

Table VI Age specific mean fork lengths and weights of lake trout from Bennett Lake, 1990.

AGE	MALE			FEMALE			COMBINED ¹		
	N	Mean	Mean	N	Mean	Mean	N	Mean	Mean
		Length	Weight		Length	Weight		Length	Weight
		(mm)	(gm)		(mm)	(gm)		(mm)	(gms)
3	1	240.00	150.00	0			5	230.00	120.00
4	1	200.00	100.00	2	230.00	137.50	10	202.00	87.50
5	2	187.50	180.00	6	318.33	366.67	15	254.33	230.67
6	4	331.25	500.00	6	307.50	362.50	12	301.25	368.75
7	8	351.25	500.00	9	343.33	505.56	19	339.47	476.32
8	6	401.67	750.00	12	359.17	562.50	21	368.33	595.24
9	7	445.71	913.57	8	421.25	868.75	15	432.67	889.67
10	9	436.67	994.44	20	440.75	1210.00	29	439.48	1143.10
11	9	437.22	1005.56	7	443.57	1042.86	16	440.00	1021.88
12	3	485.00	1333.33	8	472.50	1250.00	11	475.91	1272.73
13	10	451.00	1119.00	6	514.17	1575.00	16	474.69	1290.00
14	7	486.43	1535.71	8	498.75	1567.50	15	493.00	1552.67
15	6	516.67	1641.67	4	523.75	1975.00	10	519.50	1775.00
16	13	526.54	2250.00	3	510.00	1733.33	16	523.44	2153.13
17	10	525.50	1875.00	5	544.00	1810.00	15	531.67	1853.33
18	8	554.38	1575.38	1	595.00	2200.00	9	558.89	1644.78
19	1	470.00	1250.00	0			1	470.00	1250.00
20	6	572.50	2783.33	3	561.67	2600.00	9	568.89	2722.22
21	3	443.33	983.33	0			3	443.33	983.33
22	1	440.00	1000.00	1	820.00	7800.00	2	630.00	4400.00
23	3	548.33	1333.33	0			3	548.33	1333.33
24	1	480.00	1250.00	1	615.00	3000.00	2	547.50	2125.00
25	2	522.50	1700.00	0			2	522.50	1700.00
26	0			1	520.00	1500.00	1	520.00	1500.00
28	1	840.00	7100.00	0			1	840.00	7100.00
31	1	485.00	1200.00	0			1	485.00	1200.00
32	0			2	592.50	2700.00	2	592.50	2700.00

¹ includes fish of unknown sex

Table VII Age specific mean fork lengths and weights of lake trout from Frances Lake, 1990.

AGE	MALE			FEMALE			COMBINED ¹		
	N	Mean	Mean	N	Mean	Mean	N	Mean	Mean
		Length	Weight		Length	Weight		Length	Weight
		(mm)	(gm)		(mm)	(gm)		(mm)	(gms)
3	0			0			1	210.00	100.00
4	2	267.00	225.00	1	348.00	500.00	4	275.50	262.50
5	5	296.80	305.00	1	210.00	100.00	8	291.50	278.13
6	5	342.80	480.00	4	341.75	387.50	10	349.60	465.00
7	10	401.10	810.00	9	353.44	433.33	23	382.87	645.65
8	7	414.14	807.14	12	437.08	945.83	20	424.70	872.50
9	13	425.23	980.77	17	434.76	922.06	32	428.53	930.47
10	10	452.20	1105.00	15	483.67	1320.67	25	471.08	1234.40
11	9	479.22	1522.22	15	481.60	1243.33	25	476.60	1314.80
12	9	464.00	1111.11	11	523.55	1845.45	20	496.75	1515.00
13	12	528.00	1900.00	7	578.14	2585.71	20	544.75	2110.00
14	4	441.50	1050.00	7	511.43	1514.29	11	486.00	1345.45
15	12	574.50	2583.33	7	550.57	2014.29	19	565.68	2373.68
16	4	587.75	2135.00	4	504.25	1468.75	8	546.00	1801.88
17	1	730.00	5700.00	2	677.00	4400.00	3	694.67	4833.33
18	2	523.50	1642.50	1	561.00	1650.00	3	536.00	1645.00
19	4	574.25	2165.00	0			4	574.25	2165.00
20	2	688.00	3672.50	2	542.00	1642.50	4	615.00	2657.50
21	4	616.00	3100.00	6	602.83	3458.33	10	608.10	3315.00
22	3	626.33	2833.33	1	623.00	3350.00	4	625.50	2962.50
23	1	646.00	3900.00	0			1	646.00	3900.00
24	2	555.00	2300.00	0			2	555.00	2300.00
25	2	598.50	3475.00	2	609.50	3375.00	4	604.00	3425.00
26	1	752.00	7000.00	2	517.00	1595.00	3	595.33	3396.67
28	2	646.50	3537.50	1	436.00	825.00	3	576.33	2633.33
30	1	856.00	10500.00	0			1	856.00	10500.00
33	0			1	844.00	9850.00	1	844.00	9850.00
34	0			1	666.00	3600.00	1	666.00	3600.00
37	1	832.00	8170.00	1	576.00	2000.00	2	704.00	5085.00

¹ includes fish of unknown sex

Table VIII Age specific mean fork lengths and weights of lake trout from Kluane Lake, 1990.

AGE	MALE			FEMALE			COMBINED ¹		
	N	Mean	Mean	N	Mean	Mean	N	Mean	Mean
		Length	Weight		Length	Weight		Length	Weight
	(mm)	(gm)		(mm)	(gm)		(mm)	(gm)	
3	0			1	165.00	50	2	182.50	75.00
4	0			0			3	270.00	200.00
5	3	341.67	516.67	8	343.75	531.25	12	338.33	507.08
6	7	392.14	764.29	10	372.50	635.00	18	379.17	677.78
7	7	384.29	646.43	3	380.00	733.33	11	382.73	656.82
8	4	425.00	925.00	5	453.00	1120.00	10	431.00	970.00
9	4	437.50	1087.50	3	401.67	716.67	7	422.14	928.57
10	7	464.29	1235.71	9	486.67	1538.89	16	476.88	1406.25
11	5	495.00	1490.00	7	521.43	1835.71	13	500.38	1615.38
12	3	568.33	2366.67	7	490.00	1521.43	10	513.50	1775.00
13	10	476.50	1380.00	13	536.54	2107.69	23	510.43	1791.30
14	6	521.67	1833.33	4	497.50	1812.50	10	512.00	1825.00
15	5	503.00	1520.00	4	535.00	2012.50	9	517.22	1738.89
16	5	554.00	2240.00	14	559.29	2329.64	19	557.89	2306.05
17	5	539.00	2140.00	5	522.00	1830.00	10	530.50	1985.00
18	3	566.67	2300.00	1	655.00	3100.00	4	588.75	2500.00
19	2	497.50	1625.00	3	691.67	5066.67	5	614.00	3690.00
20	1	555.00	2450.00	4	590.00	2812.50	5	583.00	2740.00
21	2	490.00	1700.00	1	630.00	2750.00	3	536.67	2050.00
22	2	522.50	2000.00	3	553.33	2283.33	5	541.00	2170.00
23	7	591.43	3157.14	1	595.00	2650.00	8	591.88	3093.75
24	1	660.00	4000.00	2	712.50	5250.00	3	695.00	4833.33
25	4	520.00	1800.00	1	480.00	1600.00	5	512.00	1760.00
26	5	527.00	1904.00	2	542.00	2100.00	7	531.43	1960.00
27	2	620.00	2975.00	2	732.50	5297.50	4	676.25	4136.25
28	3	628.33	4200.00	2	555.00	2600.00	5	599.00	3560.00
29	1	560.00	2100.00	2	545.00	2050.00	3	550.00	2066.67
30	1	515.00	2000.00	1	555.00	2100.00	2	535.00	2050.00
31	1	540.00	2400.00	0			1	540.00	2400.00
32	0			2	522.50	1825.00	2	522.50	1825.00
35	1	520.00	2200.00	0			1	520.00	2200.00
39	1	505.00	1500.00	0			1	505.00	1500.00

¹ includes fish of unknown sex

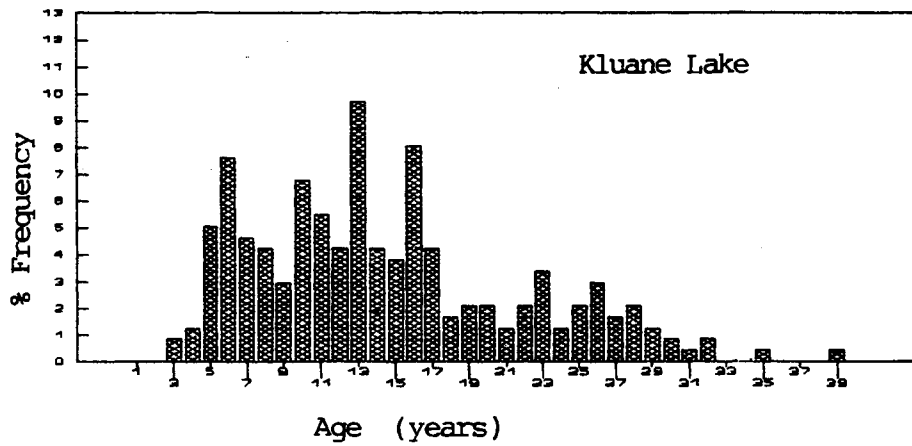
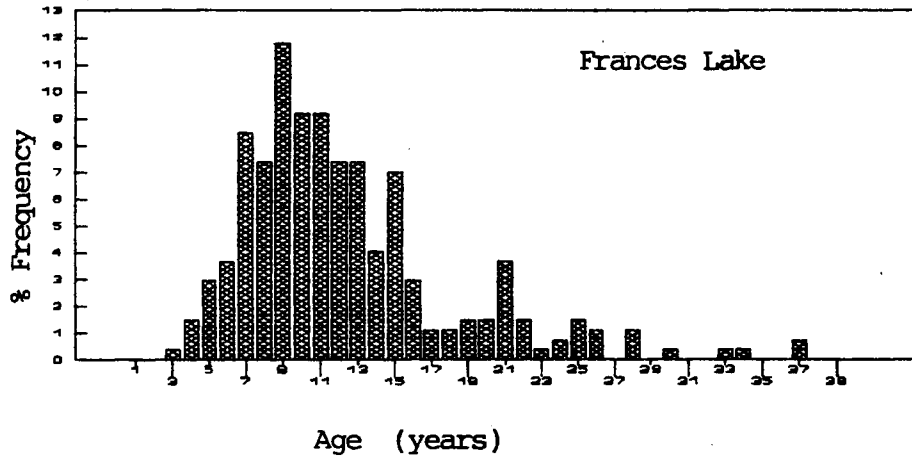
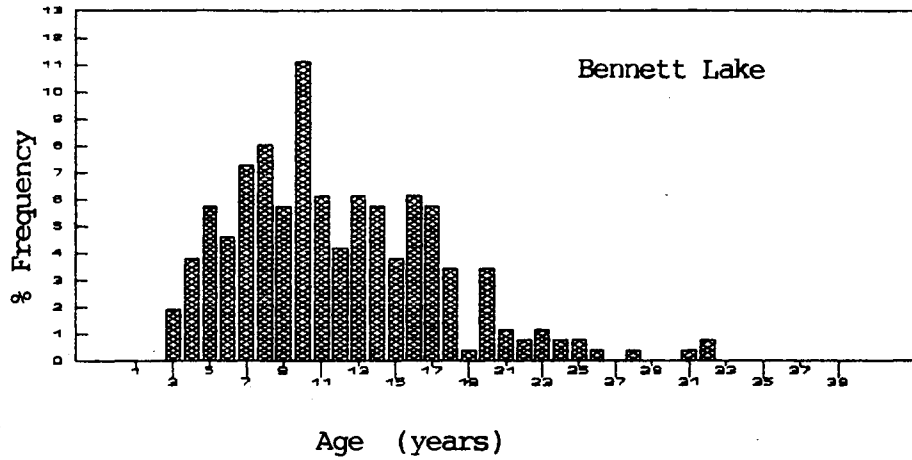


Figure 4 Age frequencies for lake trout caught in index nets on Bennett, Frances and Kluane Lakes, 1990.

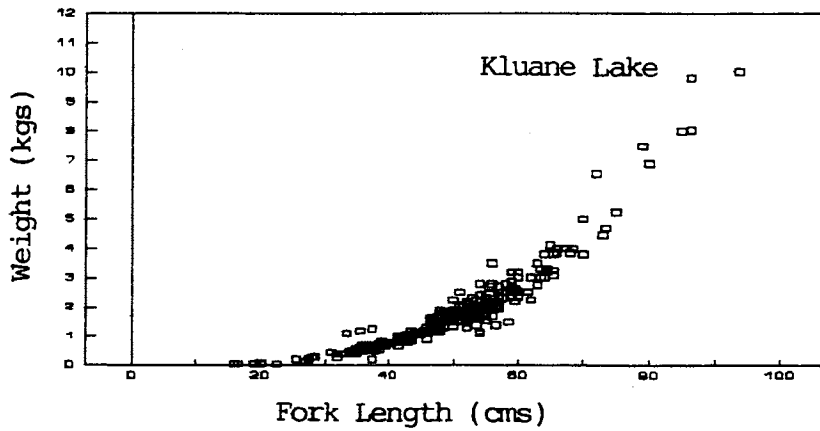
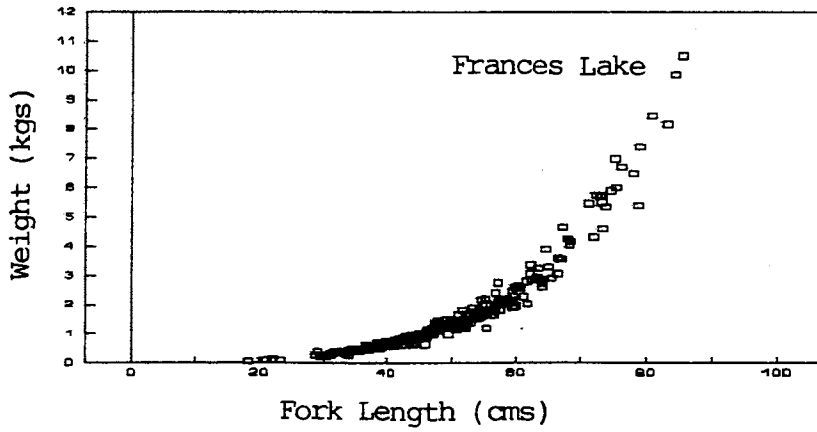
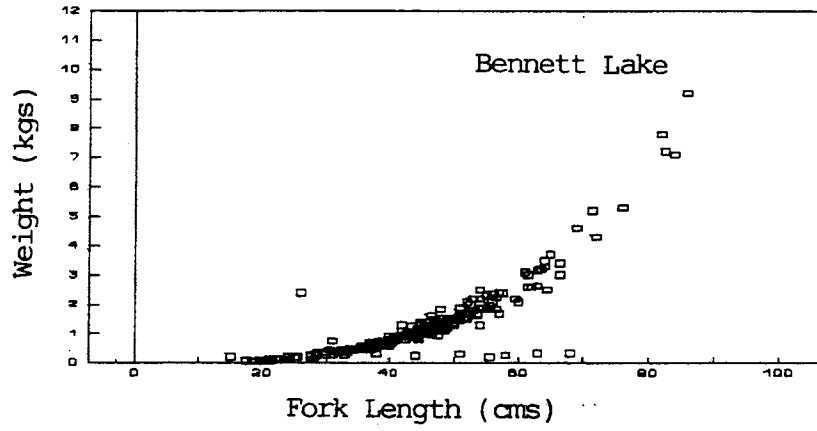


Figure 5 Length-weight scatter plots of lake trout from Bennett, Frances and Kluane Lakes, 1990.

Table IX Sex specific length - weight relationships of lake trout from Bennett, Frances and Kluane Lakes, 1990.

Lake	Sex	Length-Weight Equation	N	r ²
Bennett	Male	$\text{Log}_{10}\text{weight} = -4.58 + \text{Log}_{10}\text{length}(2.57)$	147	.7158
	Female	$\text{Log}_{10}\text{weight} = -4.34 + \text{Log}_{10}\text{length}(2.77)$	128	.8030
	Combined	$\text{Log}_{10}\text{weight} = -4.58 + \text{Log}_{10}\text{length}(2.86)$	302	.8519
Frances	Male	$\text{Log}_{10}\text{weight} = -5.60 + \text{Log}_{10}\text{length}(3.24)$	130	.9796
	Female	$\text{Log}_{10}\text{weight} = -5.79 + \text{Log}_{10}\text{length}(3.30)$	130	.9763
	Combined	$\text{Log}_{10}\text{weight} = -5.65 + \text{Log}_{10}\text{length}(3.25)$	274	.9792
Kluane	Male	$\text{Log}_{10}\text{weight} = -5.15 + \text{Log}_{10}\text{length}(3.09)$	124	.9363
	Female	$\text{Log}_{10}\text{weight} = -5.33 + \text{Log}_{10}\text{length}(3.16)$	147	.9208
	Combined	$\text{Log}_{10}\text{weight} = -5.52 + \text{Log}_{10}\text{length}(3.23)$	285	.9481

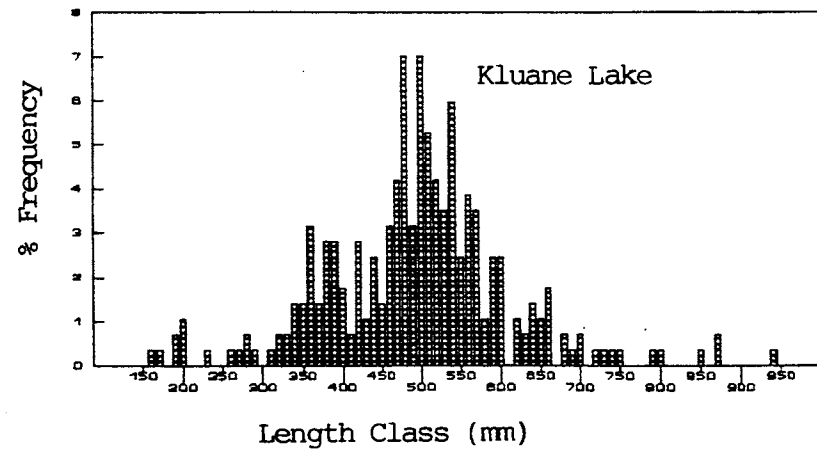
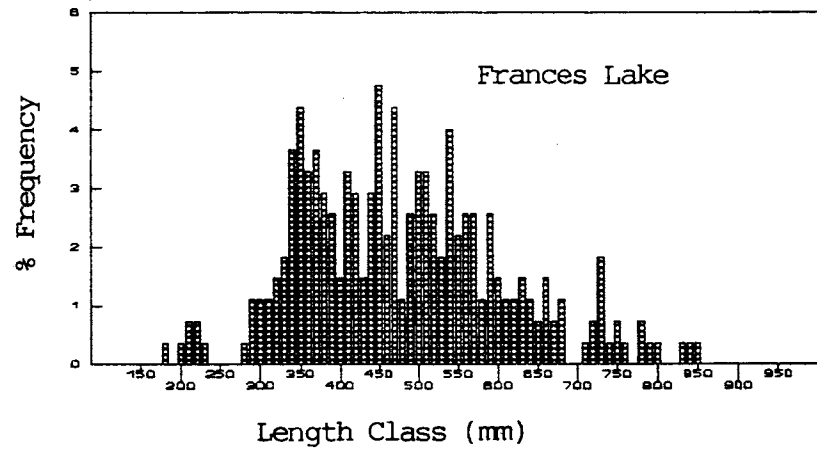
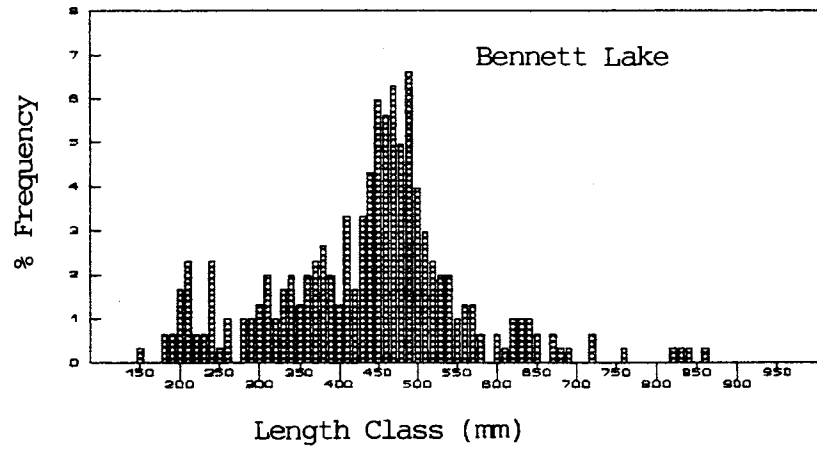


Figure 6 Length frequencies lake trout caught in index nets on Bennett, Frances and Kluane Lakes, 1990.

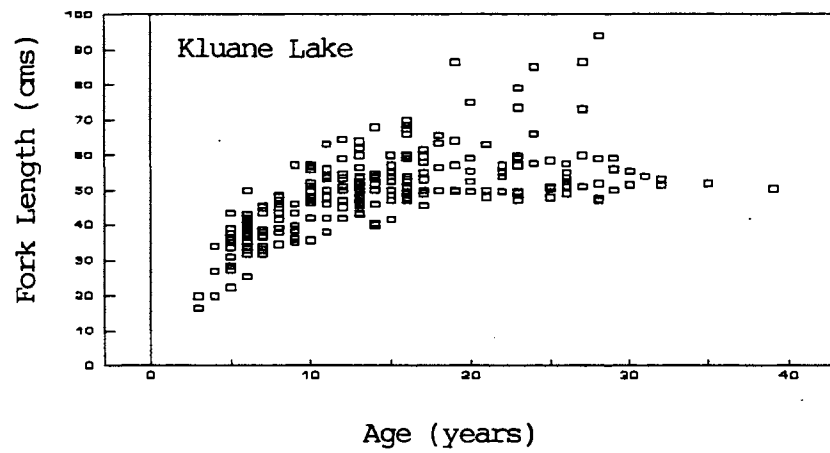
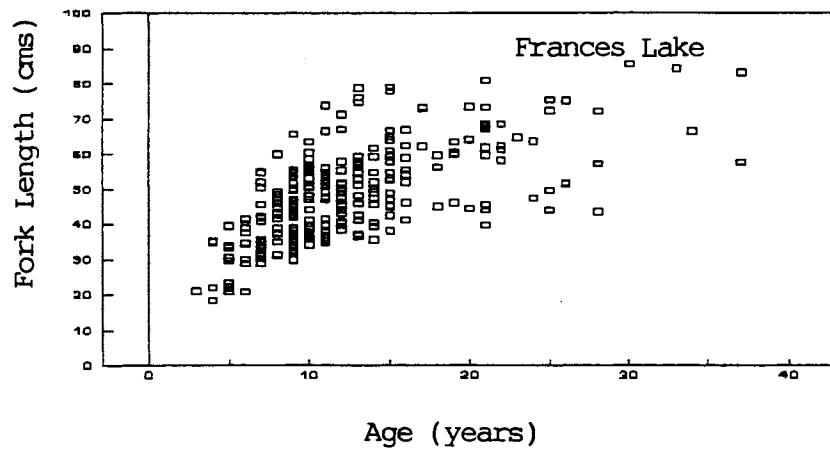
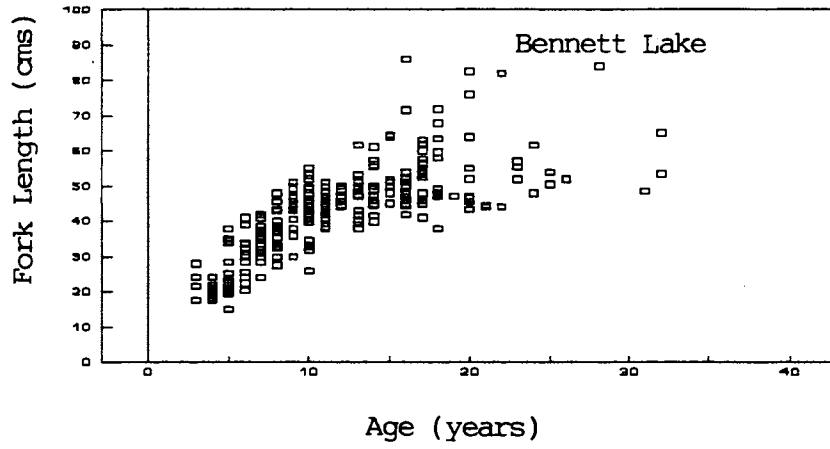


Figure 7 Age-length scatter plots of lake trout from Bennett, Frances and Kluane Lakes, 1990.

Table X Von Bertalanffy growth variables of lake trout from Bennett, Frances and Kluane Lakes, 1990.

Lake	Sex	L_{∞} (mm)	K'	Age Range	r^2	N
Bennett	Male	720	.083	7-11, 13-18	.8609	99
	Female	664	.105	5-14,17	.9574	95
	Combined	756	.076	3-18,20	.9471	243
		756	.083	4-7	.9829	56
Frances	Male	773	.089	5-13,15	.9277	92
	Female	738	.094	7-15,21	.7301	85
	Combined	797	.078	5-16,21	.8258	231
		797	.095	4-7	.9283	45
Kluane	Male	719	.077	6,7,10, 11,13-17, 23,26	-.1304	69
	Female	757	.089	5,6,8,10- 13,16,17	.4502	78
	Combined	805	.075	5-17,19, 20,22,23, 25,26,28	.3127	208
		805	.101	4-7	.8238	54

largest calculated asymptotic size (L_{∞}) was for Kluane Lake. Fitted growth and length-weight relationships are presented graphically in Figure 8.

Of observed stomachs containing food items, invertebrates predominated the diet of lake trout within Bennett and Kluane Lakes (Figure 9). Conversely, lake trout within Frances Lake had a largely piscivorous diet, feeding mainly on lake whitefish. In many instances within all lakes diet could not be determined as stomachs were devoid of any food items.

5.5.2 Lake Whitefish

Age specific mean fork lengths and mean weights of lake whitefish from experimental gillnet catches for each lake are presented in Tables XI to XIII. Overall catches of lake whitefish ranged in age from 2 to 33 years, with modal ages ranging from 8 (Kluane Lake) to 14 (Bennett Lake) years. Age frequencies are presented in Figure 10. Mean age of catch were 13.9 years for Bennett Lake, 11.4 years for Frances Lake and 12.7 years for Kluane Lake.

Length-weight scatter plots and relationships are presented in Figure 11 and Table XIV for each lake. Lake whitefish within Frances Lake averaged the lowest weights for any given length. Length-weight relationships were comparable between Bennett and

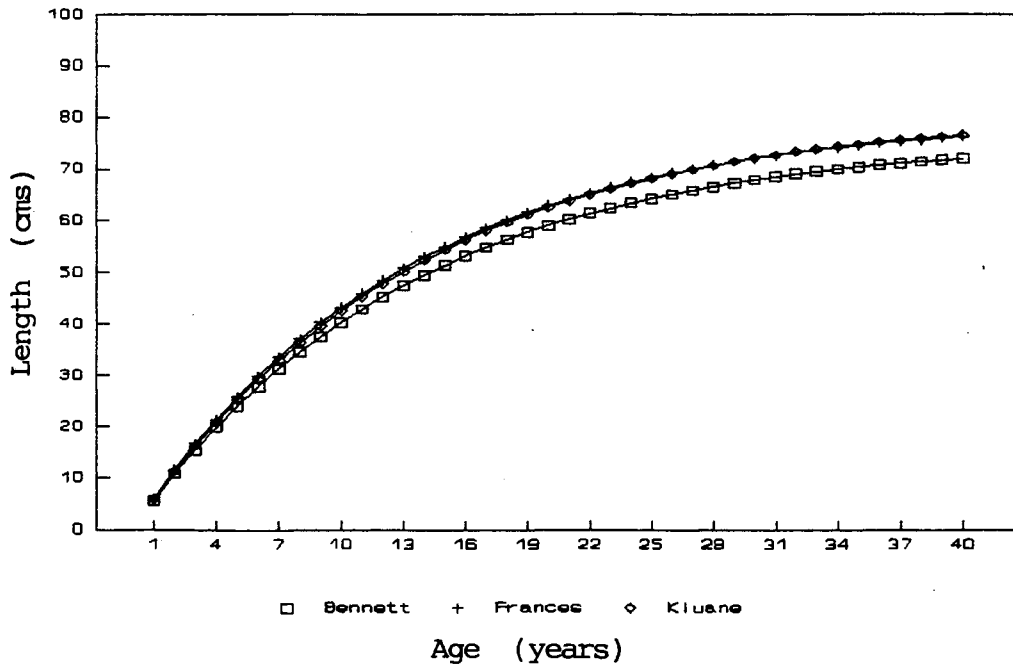
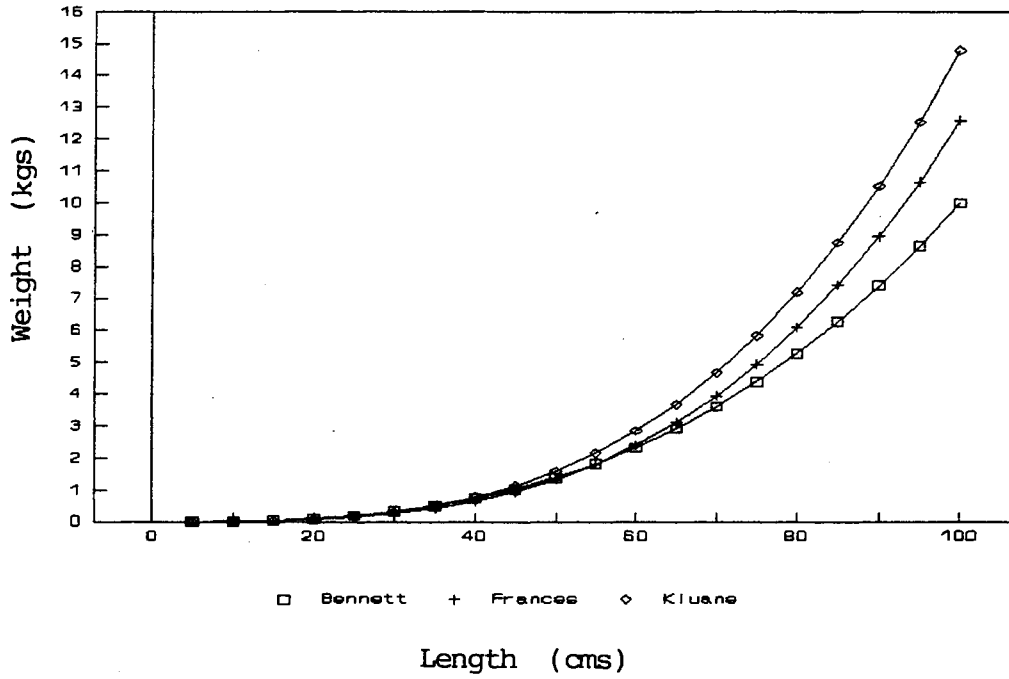


Figure 8 Length-weight relationships and Von Bertalanffy growth curves of lake trout from Bennett, Frances and Kluane Lakes, 1990.

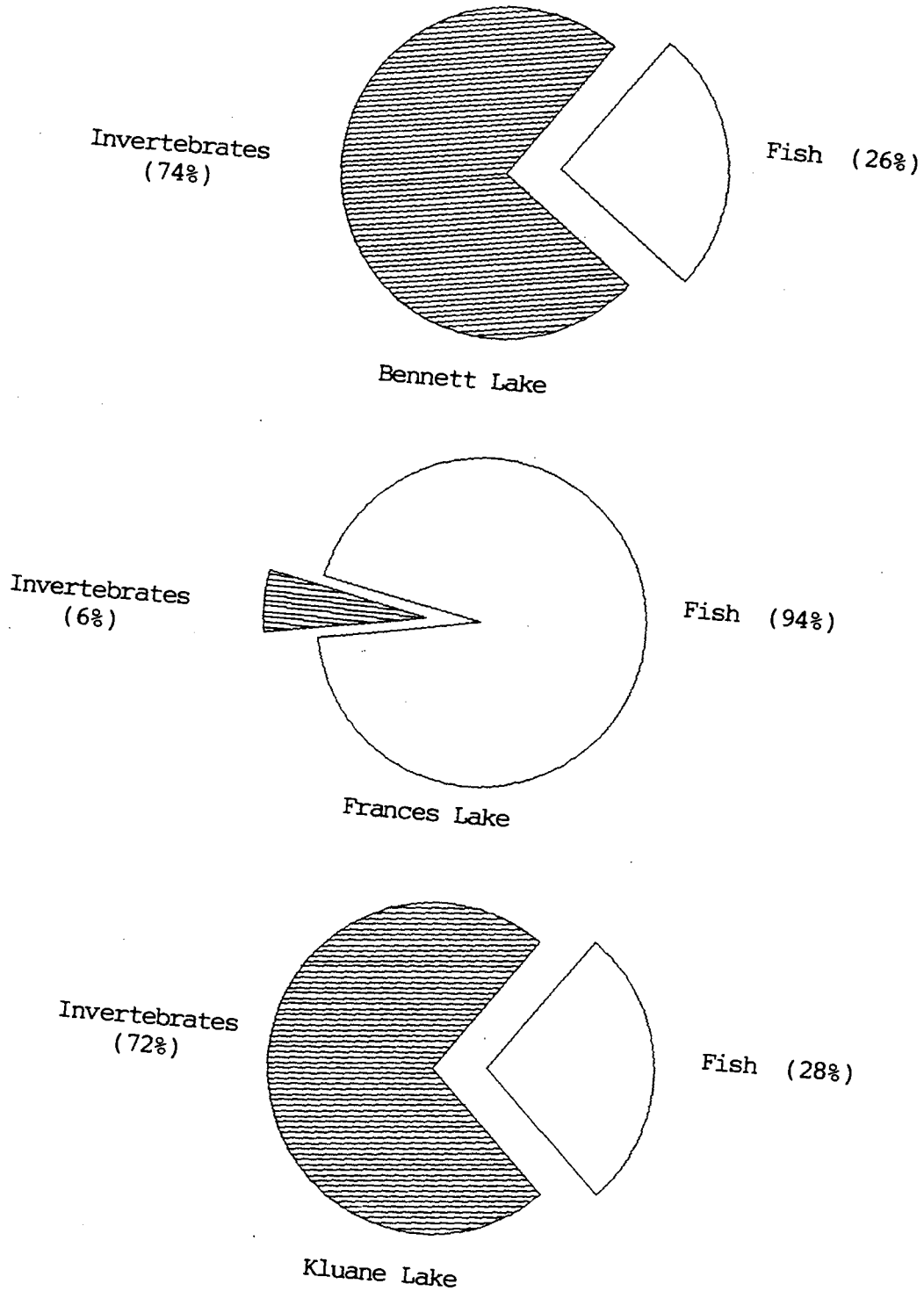


Figure 9 Diet composition of lake trout caught in index nets in Bennett, Frances and Kluane Lakes, summer 1990.

Table XI Age specific mean fork lengths and weights from lake whitefish from Bennett Lake, 1990.

AGE	MALE			FEMALE		COMBINED ¹			
	N	Mean	Mean	N	Mean	Mean	N	Mean Length	Mean
		Length	Weight		Length	Weight		(mm)	Weight
		(mm)	(gm)		(mm)	(gm)		(mm)	(gms)
5	3	366.67	733.33	1	380.00	500.00	4	370.00	675.00
6	2	410.00	725.00	0			2	410.00	725.00
7	5	385.00	820.00	2	385.00	725.00	7	385.00	792.86
8	5	381.00	840.00	5	443.00	1049.60	11	406.36	908.91
9	9	373.33	783.33	5	418.00	1200.00	14	389.29	932.14
10	9	412.78	1050.00	8	387.50	793.75	17	400.88	929.41
11	12	415.00	970.83	8	428.75	1225.00	20	420.50	1072.50
12	13	461.92	1476.92	4	410.00	1050.00	17	449.71	1376.47
13	10	444.50	1245.00	1	400.00	950.00	11	440.45	1218.18
14	15	447.67	1306.67	6	441.67	1300.00	21	445.95	1304.76
15	11	470.00	1519.09	5	482.00	1780.00	16	473.75	1600.63
16	8	455.00	1431.25	2	495.00	1875.00	10	463.00	1520.00
17	3	468.33	1466.67	4	475.00	1537.50	7	472.14	1507.14
18	4	483.75	1675.00	2	492.50	1875.00	6	486.67	1741.67
19	1	520.00	2000.00	7	488.57	1735.71	8	492.50	1768.75
20	3	458.33	1283.33	2	470.00	1425.00	5	463.00	1340.00
21	3	480.00	1466.67	2	475.00	1525.00	5	478.00	1490.00
22	0			2	510.00	2325.00	2	510.00	2325.00
23	2	512.50	2025.00	0			2	512.50	2025.00
24	1	495.00	1500.00	1	510.00	2050.00	2	502.50	1775.00
25	2	480.00	1425.00	1	500.00	1500.00	3	486.67	1450.00
26	1	380.00	755.00	1	440.00	1550.00	2	410.00	1152.50
27	1	480.00	1850.00	1	525.00	2450.00	2	502.50	2150.00
28	3	468.33	1466.67	0			3	468.33	1466.67
30	0			1	420.00	900.00	1	420.00	900.00
32	1	525.00	2350.00	0			1	525.00	2350.00

¹ includes fish of unknown sex

Table XII Age specific mean fork lengths and weights from lake whitefish from Frances Lake, 1990.

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 (gms)
2	1	230.00	100.00	1	236.00	150.00	8	209.50	75.00
3	1	270.00	250.00	2	201.00	100.00	14	205.43	94.64
4	1	216.00	100.00	2	284.00	300.00	5	251.80	200.00
5	3	305.33	350.00	3	263.33	216.67	6	284.33	283.33
6	3	340.67	483.33	0			3	340.67	483.33
7	7	379.43	671.43	4	384.75	750.00	11	381.36	700.00
8	4	374.75	675.00	4	377.50	687.50	8	376.13	681.25
9	13	398.46	784.62	7	376.57	682.14	20	390.80	748.75
10	15	398.67	790.00	23	378.61	700.00	39	385.95	732.05
11	19	362.63	609.21	13	395.85	815.38	32	376.13	692.97
12	13	397.08	824.62	12	417.08	1009.17	25	406.68	913.20
13	4	463.50	1350.00	6	429.00	1141.67	10	442.80	1225.00
14	4	459.50	1200.00	3	458.33	1341.67	7	459.00	1260.71
15	0			3	481.00	1450.00	3	481.00	1450.00
16	3	504.00	1450.00	3	417.00	968.33	6	460.50	1209.17
17	6	422.83	1000.00	7	464.14	1400.00	13	445.08	1215.38
18	6	499.67	1608.33	0			6	499.67	1608.33
19	4	433.00	1106.25	2	460.00	1400.00	6	442.00	1204.17
20	4	450.50	1091.25	0			4	450.50	1091.25
21	3	452.67	1083.33	4	429.50	1025.00	7	439.43	1050.00
22	1	516.00	1600.00	1	504.00	1650.00	2	510.00	1625.00
24	1	465.00	1300.00	0			1	465.00	1300.00
25	1	482.00	850.00	1	524.00	2350.00	2	503.00	1600.00
27	0			1	518.00	1950.00	1	518.00	1950.00
30	1	490.00	1700.00	1	514.00	1550.00	2	502.00	1625.00
32	1	478.00	1400.00	0			1	478.00	1400.00

¹ includes fish of unknown sex

Table XIII Age specific mean fork lengths and weights from lake whitefish from Kluane Lake, 1990.

AGE	MALE			FEMALE			COMBINED ¹		
	N	Mean	Mean	N	Mean	Mean	N	Mean	Mean
		Length	Weight		Length	Weight		Length	Weight
		(mm)	(gm)		(mm)	(gm)		(mm)	(gms)
3	0			0			4	157.50	50.00
4	6	286.67	316.67	1	290.00	300.00	7	287.14	314.29
5	7	289.29	265.71	3	266.67	200.00	10	282.50	246.00
6	10	309.50	380.00	5	323.00	420.00	17	301.18	357.35
7	6	361.67	916.67	5	340.00	500.00	11	351.82	727.27
8	18	355.28	605.56	16	353.44	565.63	34	354.41	586.76
9	8	368.13	637.50	7	355.71	614.29	15	362.33	626.67
10	10	370.00	675.00	10	379.00	685.00	20	374.50	680.00
11	8	385.00	738.75	5	384.00	740.00	13	384.62	739.23
12	9	392.22	736.11	8	387.50	825.00	17	390.00	777.94
13	11	411.36	963.64	4	403.75	862.50	15	409.33	936.67
14	8	420.00	956.25	7	411.43	985.71	15	416.00	970.00
15	3	400.00	883.33	6	405.83	941.67	9	403.89	922.22
16	3	401.67	900.00	3	423.33	1116.67	6	412.50	1008.33
17	1	425.00	1200.00	3	430.00	1133.33	4	428.75	1150.00
18	4	436.25	1200.00	6	422.50	1016.67	10	428.00	1090.00
19	8	435.63	1243.75	5	418.00	1120.00	13	428.85	1196.15
20	0			3	441.67	1100.00	4	432.50	1075.00
21	1	460.00	1400.00	3	410.00	983.33	4	422.50	1087.50
22	4	435.00	1175.00	0			4	435.00	1175.00
23	3	443.33	1266.67	1	395.00	950.00	4	431.25	1187.50
24	3	443.33	1183.33	6	442.50	1158.33	9	442.78	1166.67
25	1	500.00	1800.00	2	450.00	1375.00	3	466.67	1516.67
26	1	540.00	2350.00	2	445.00	1125.00	3	476.67	1533.33
28	0			3	458.33	1300.00	3	458.33	1300.00
29	2	467.50	1300.00	0			2	467.50	1300.00
30	1	420.00	900.00	0			1	420.00	900.00
33	0			1	435.00	1000.00	1	435.00	1000.00

¹includes fish of unknown sex

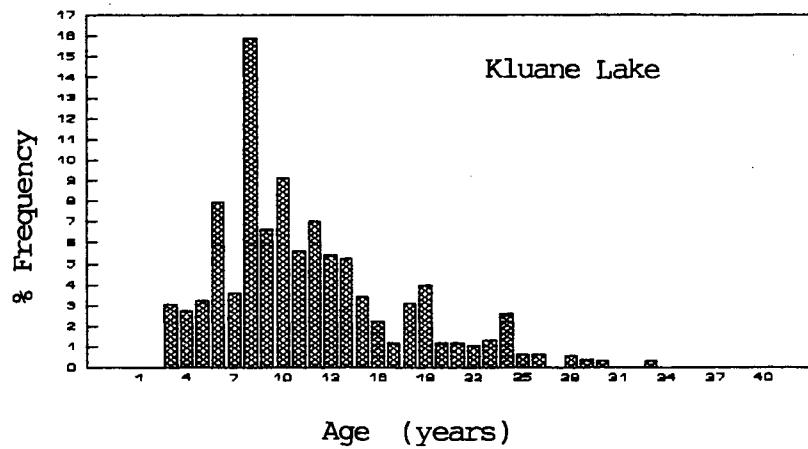
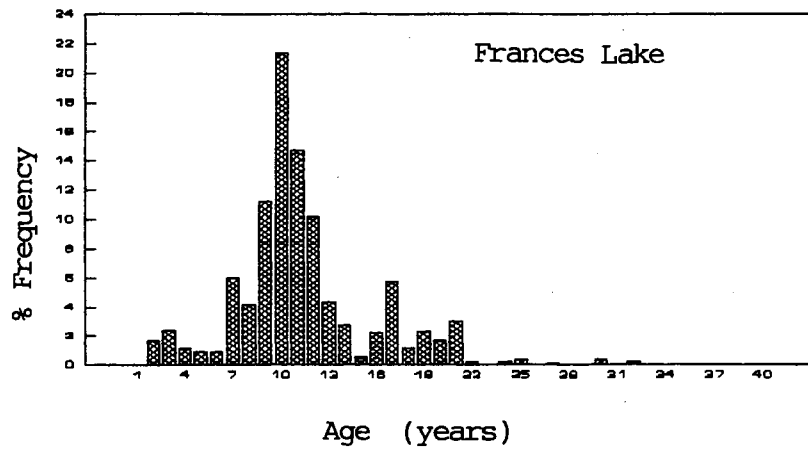
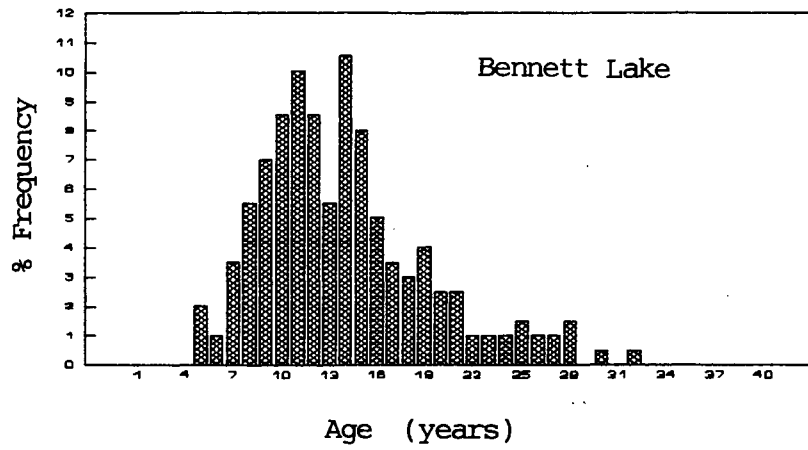


Figure 10 Age frequency for lake whitefish caught in index nets on Bennett, Frances and Kluane Lakes, 1990.

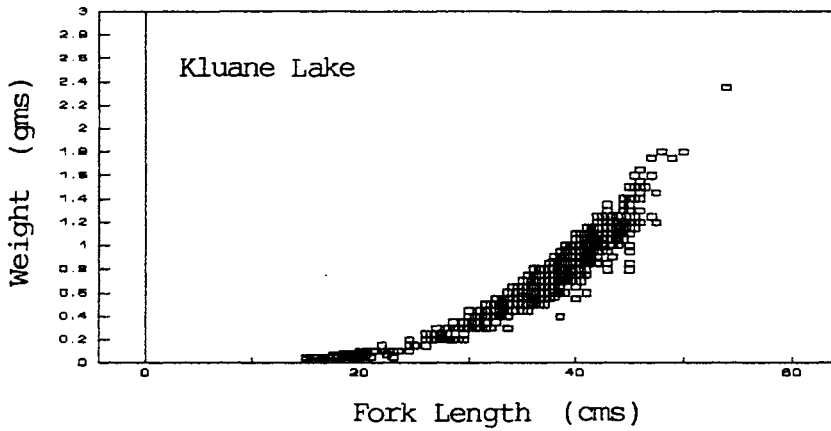
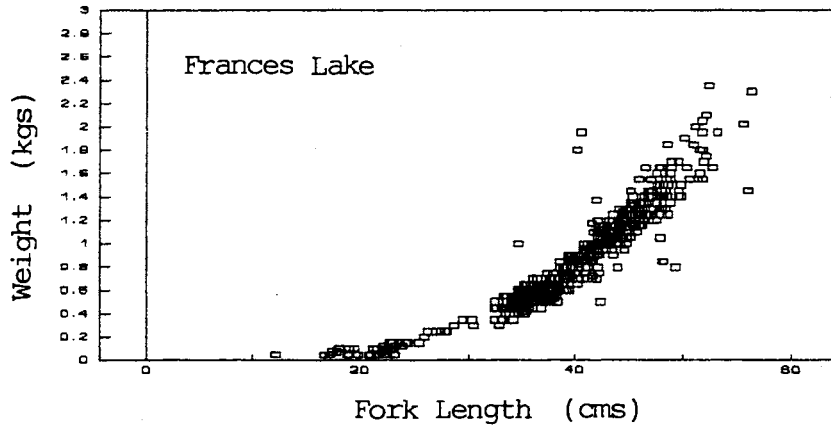
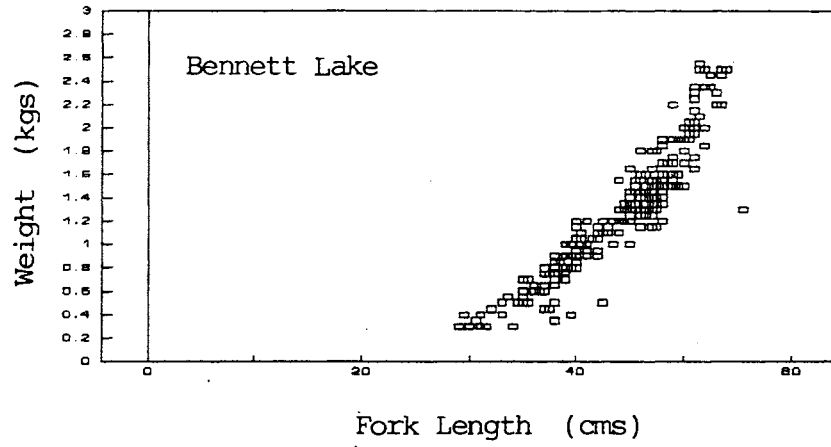


Figure 11 Length-weight scatter plots of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Table XIV Sex specific length - weight relationships of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Lake	Sex	Length-Weight Equation	N	r ²
Bennett	Male	$\text{Log}_{10}\text{weight} = -5.60 + \text{Log}_{10}\text{length}(3.28)$	151	.9102
	Female	$\text{Log}_{10}\text{weight} = -6.41 + \text{Log}_{10}\text{length}(3.59)$	90	.8748
	Combined	$\text{Log}_{10}\text{weight} = -5.91 + \text{Log}_{10}\text{length}(3.40)$	242	.8952
Frances	Male	$\text{Log}_{10}\text{weight} = -5.15 + \text{Log}_{10}\text{length}(3.09)$	413	.9137
	Female	$\text{Log}_{10}\text{weight} = -5.24 + \text{Log}_{10}\text{length}(3.13)$	438	.9308
	Combined	$\text{Log}_{10}\text{weight} = -5.69 + \text{Log}_{10}\text{length}(3.30)$	888	.9374
Kluane	Male	$\text{Log}_{10}\text{weight} = -5.91 + \text{Log}_{10}\text{length}(3.40)$	162	.9360
	Female	$\text{Log}_{10}\text{weight} = -5.98 + \text{Log}_{10}\text{length}(3.43)$	143	.9459
	Combined	$\text{Log}_{10}\text{weight} = -5.98 + \text{Log}_{10}\text{length}(3.43)$	1260	.9588

Kluane Lakes. Length frequencies are presented in Figure 12. Sampled fish ranged in length from 130 mm to 600 mm. Modal lengths were 470/480 mm for Bennett Lake, 350 mm for Frances Lake and 400 mm for Kluane Lake.

Age-length scatter plots and Von Bertalanffy growth variables are presented in Figure 13 and Table XV. Growth coefficients were generally higher on Bennett Lake for each sex category. Calculated asymptotic sizes (L_{∞}) for Bennett and Frances Lakes were comparable and greater than those for Kluane Lake. Fitted growth curves and length-weight relationships are presented graphically in Figure 14.

5.6 Mortality

Mortality and survival rates for lake trout and lake whitefish by lake are presented in Table XVI. Annual survival rates calculated as outlined by Robsen and Chapman varied from .768 (Frances Lake) to .831 (Kluane Lake) for lake trout and .707 (Bennett Lake) to .825 (Kluane Lake) for lake whitefish. The overall highest instantaneous mortality rate was associated with lake whitefish on Bennett Lake (.347).

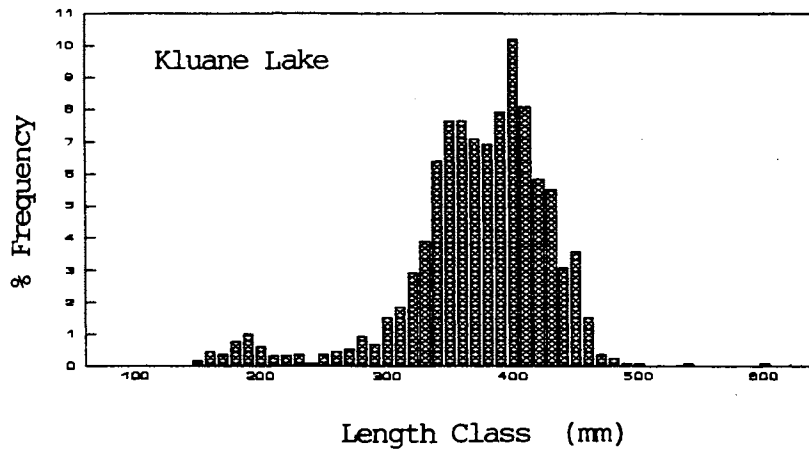
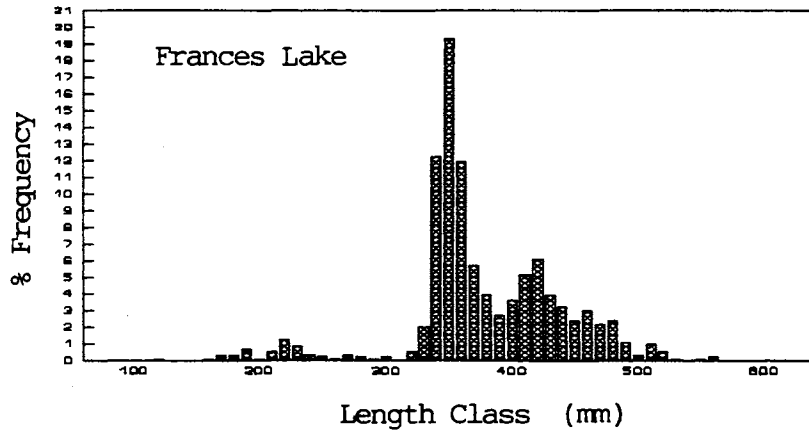
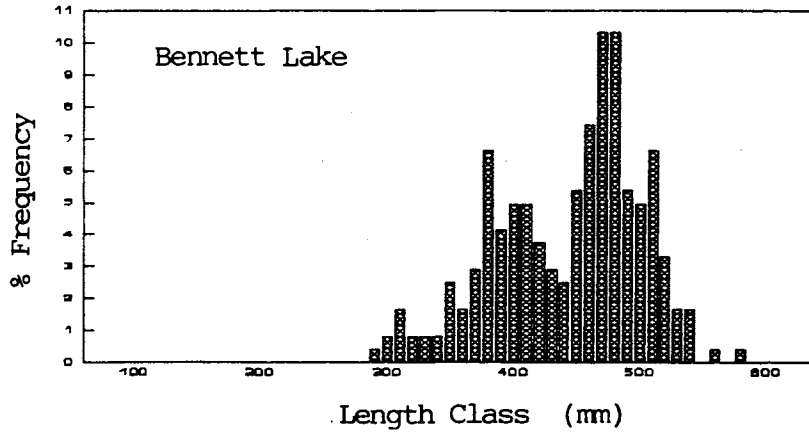


Figure 12 Length frequencies of lake whitefish caught in index nets on Bennett, Frances and Kluane Lakes, 1990.

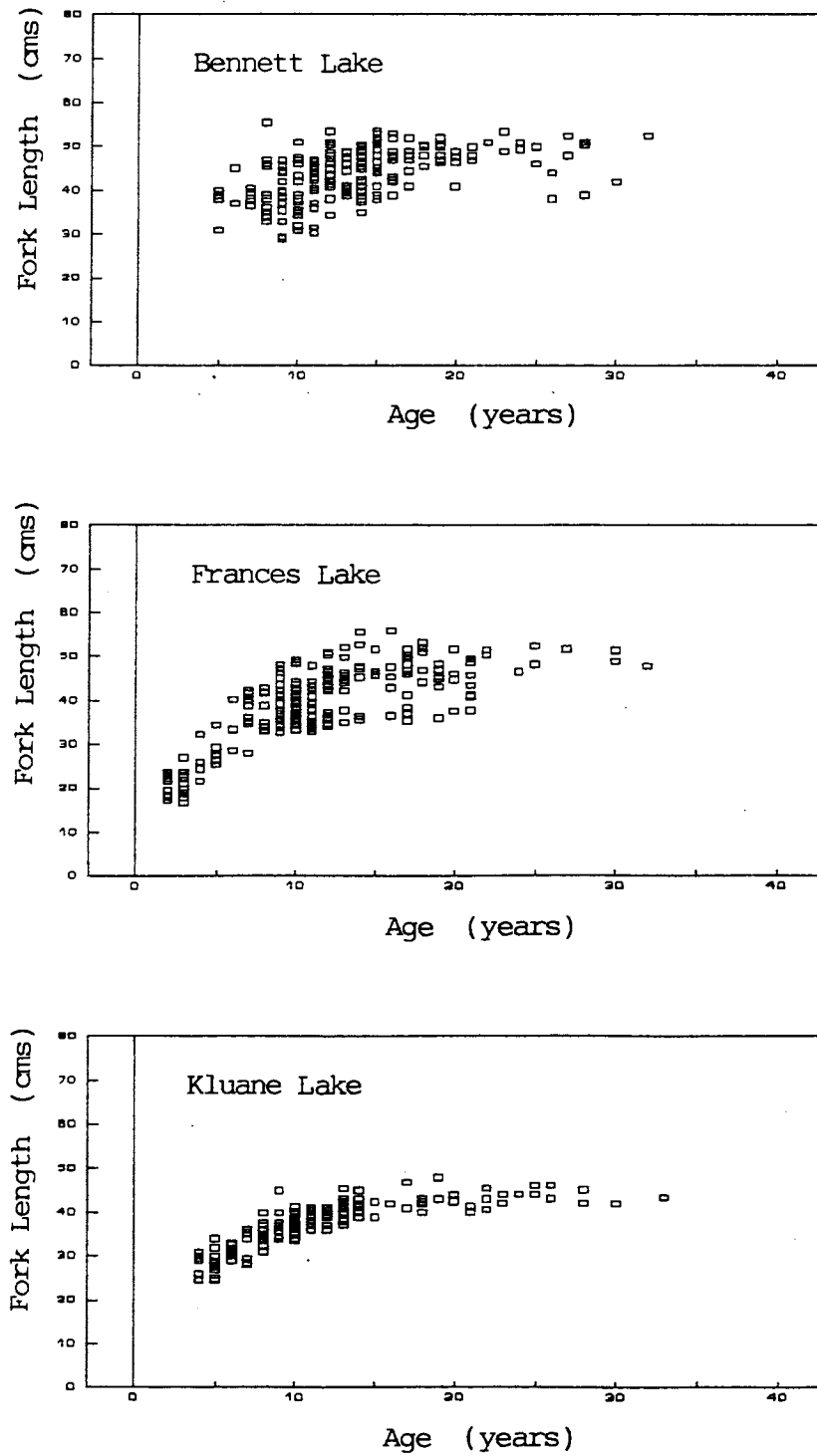


Figure 13 Age-length scatter plots of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Table XV Von Bertalanffy growth variables of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Lake	Sex	L_{∞} (mm)	K'	Age Range	r^2	N
Bennett	Male	526	.146	7-16	.6865	97
	Female	530	.147	8-11, 14-15,19	.4653	44
	Combined	539	.125	7-21	.5131	175
Frances	Male	522	.137	7,9-12, 17,18	.5497	79
	Female	525	.130	9-13,17	.9760	68
	Combined	535	.118	2-5,7-14, 16-19,21	.6750	215
Kluane	Male	492	.138	4-14,19	.6874	109
	Female	459	.148	6-12,14, 15,18,19, 24	.8263	86
	Combined	497	.117	4-16,18, 19,24	.5230	221

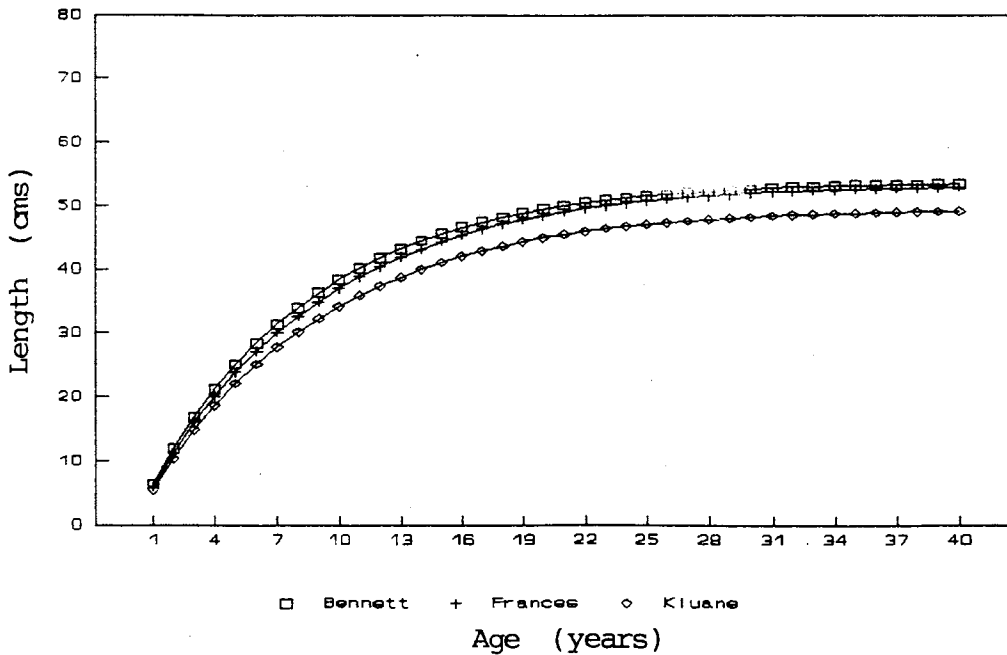
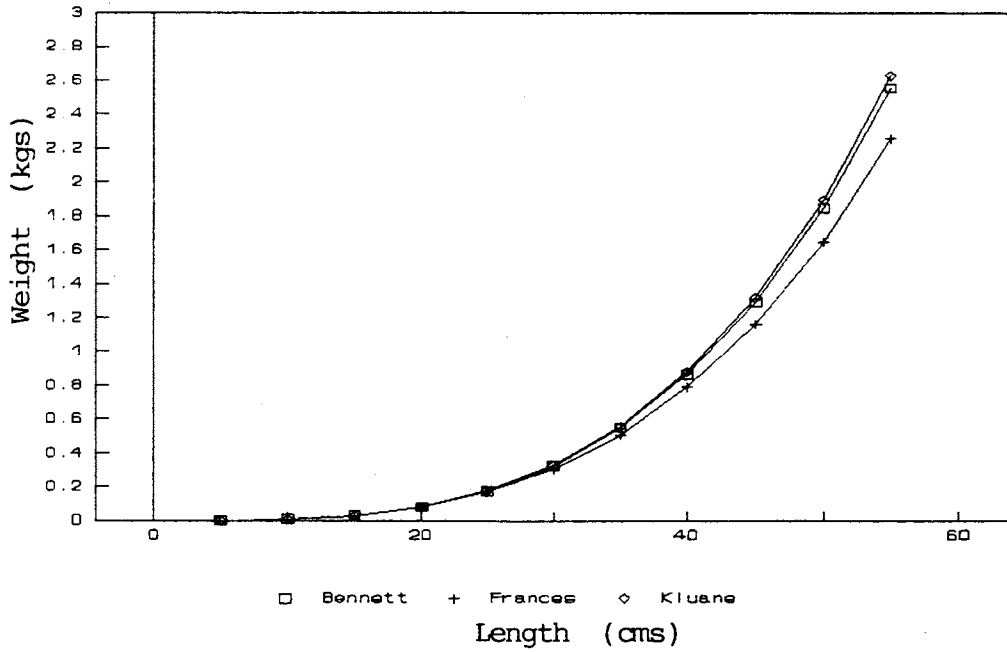


Figure 14 Length-weight relationships and Von Bertalanffy growth curves of lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Table XVI Robson - Chapman mortality and survival rates of lake trout and lake whitefish caught in index nets on Bennett, Frances and KLuane Lakes, 1990.

Species	Lake	Z	A	S
Lake Trout	Bennett	.201	.182	.818
	Frances	.264	.232	.768
	Kluane	.185	.169	.831
Lake Whitefish	Bennett	.347	.293	.707
	Frances	.286	.249	.751
	Kluane	.192	.175	.825

5.7 Maturity

Mean ages of maturation (MAM) for male lake trout were 2 to 3 years below those of females on Bennett and Frances Lakes (Table XVII). MAM's ranged from 9.53 years (Frances Lake-males) to 13.26 years (Kluane Lake-combined sexes). First onset of sexual maturation begins at age 5 with the bulk of maturation complete by age 15. Lake trout maturity at age tables for each lake are presented in Appendix II. All lake whitefish MAM's were comparable to those calculated for lake trout, ranging from 8.01 years (Frances Lake-combined sexes) to 15.68 (Bennett Lake-males). Within Bennett and Kluane Lakes, calculated lake whitefish male MAM's were greater than female. First onset of sexual maturation begins at age 6 with the bulk of maturation complete by age 15. Lake whitefish maturity at age tables for each lake are presented in Appendix II.

5.9 Mesh Size Effects

The effects of gillnet mesh size on lake trout and lake whitefish catches are summarized in Appendix III. Mean fork lengths, mean weights and percentages of mature fish generally increased with mesh size for both species. This relationship was more pronounced for lake whitefish.

The bulk of lake trout and lake whitefish catches within all three

Table XVII Mean ages of maturity of lake trout and lake whitefish from Bennett, Frances and Kluane Lakes, 1990.

Species	Lake	Male	Female	Combined
Lake Trout	Bennett	10.47	12.94	11.56
	Frances	9.53	12.42	10.81
	Kluane	13.20	13.23	13.26
Lake Whitefish	Bennett	15.68	12.74	14.81
	Frances	8.32	10.30	8.01
	Kluane	10.65	8.48	9.72

lakes were in mesh sizes ranging from 6.4 cm (2.5 inch) to 11.4 cm (4.5 inch). The relationship between catch and mesh size was less pronounced with respect to lake trout (Figure 15). A mesh size of 8.9 cm (3.5 inch) maximized catches of lake whitefish within Frances and Kluane Lakes. The 11.4 cm mesh (4.5 inch), while minimizing whitefish catches, is as efficient at catching lake trout as most of the smaller mesh sizes.

5.10 Lake Whitefish Cyst Infestation

Infestation rates of Triaenophorus crassus in lake whitefish ranged from a low of 38 cysts per 45.4 kg (100 lbs) within Bennett Lake to a high of 785 cysts per 45.4 kg (100 lbs) within Kluane Lake (Table XVIII). The occurrence of cysts (cysts per fish) were generally much less pronounced on Bennett Lake and an order of magnitude lower than those calculated for Frances and Kluane Lakes.

6.0 DISCUSSION

6.1 Lake Productivity

Calculated MEI values for each lake are relatively low compared to those calculated by Horler (1982) for 52 lakes within the Yukon Territory. The lower values in this study are directly the result

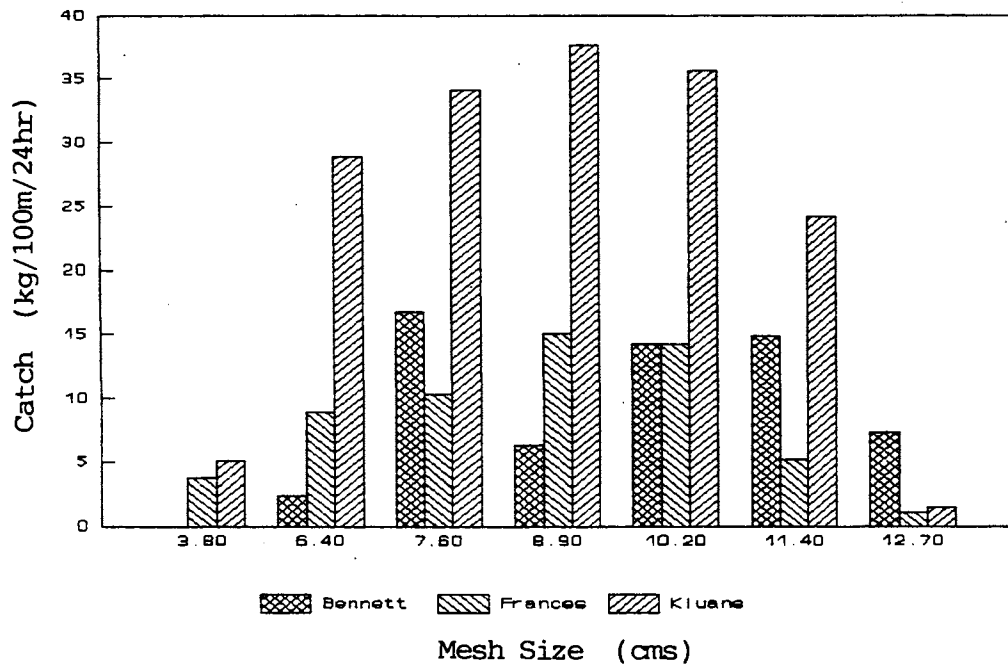
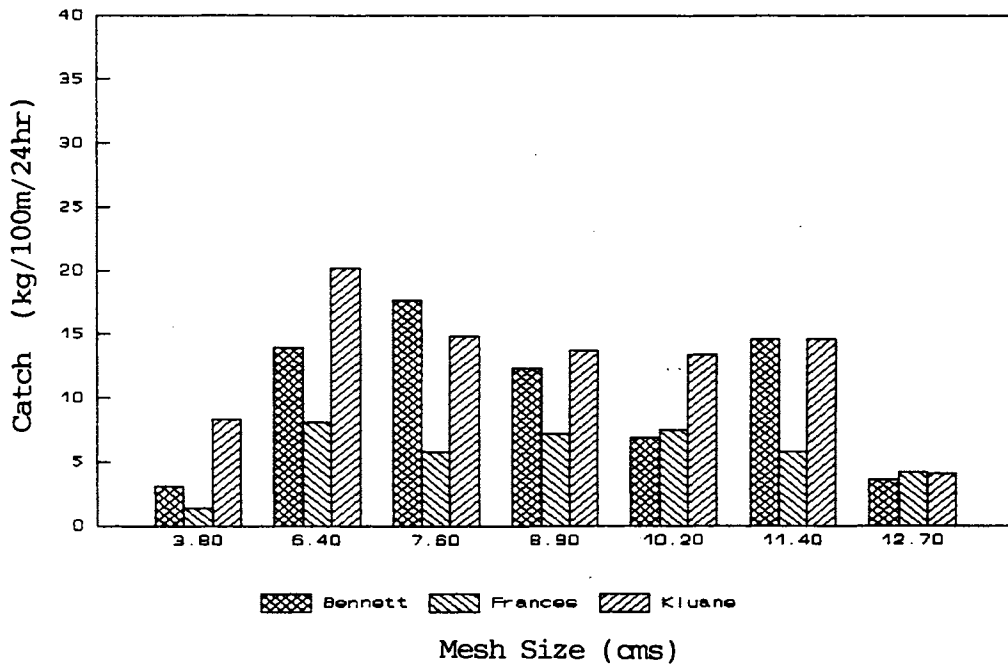


Figure 15 Mesh size effects of catches of lake trout and lake whitefish from index netting within Bennett, Frances and Kluane Lakes, summer 1990.

Table XVIII Lake whitefish infestation rates of Triaenophorus crassus cysts from Bennett, Frances and Kluane Lakes, 1990.

VARIABLE	LAKE		
	Bennett	Frances	Kluane
Sample Weight (kgs)	34.6	155.1	14.5
Cyst Count	29	1923	251
Mean cysts per fish	1.45	10.93	14.76
Infestation Rate (cysts\100lbs)	38	463	785
Sample Size	20	176	17

of the larger mean depths and lower dissolved solid values associated these large water bodies. The lakes are typically oligotrophic and generally isothermic. Their great volume, large fetch and incipient winds absorb and distribute the summer heat. The growing season is very short with water temperatures generally cold throughout most of the year. All three lakes have been glaciated with their respective basins and arms typically U-shaped. This is not a characteristic of the north-west basin of Kluane Lake, which consists of a shallow uniform substrate and speculated to be a glacial deposit. This feature contributes significantly to the overall higher productivity of this lake and greater MEI.

6.2 Lake Trout

The percentage of the catch as lake trout biomass was similar between lakes at approximately 30%. This figure is consistent with those found by Horler (1983) for 18 previously surveyed lakes within the territory. Relative catch per unit effort for lake trout was lowest on Frances Lake. This corresponded with low angling success of the sport fishery associated with this lake (Osborne, unpublished).

The mean ages of sexual maturity that were calculated in this study may be overestimated due to the difficulties in differentiating immature gonadal tissue with those of mature fish in a non spawning

condition. It is believed in some instances mature older aged (non spawning) fish were misidentified as immature. It has long been known that mature lake trout do not spawn every year (McPhail and Lindsey, 1970) It is not possible to determine the extent of this bias.

Asymptotic sizes of lake trout were generally greater than those found in Ontario study lakes (Payne 1990). Lake trout growth coefficients, calculated using age groups 4-7 as a standard, were lower than those determined by Payne (1990) for 47 lakes in Ontario. The slow growth of these stocks may be attributed to a number of variables that include latitude, lake morphology, low productivity and intensity of exploitation. MacLean (1990) found that invertebrate feeding populations of lake trout were slower growing than piscivorous populations. The poor relation of length at age, especially in the older age groups, infer different growth regimes as a function of diet within this present study. Lake trout diets were omnivorous with invertebrates being the primary forage base within Bennett and Kluane Lakes. Literature suggests this is not an artifact of the sampling season, as seasonal differences in lake trout diet are less distinct in arctic and subalpine lakes (Millar and Kennedy, 1948; Moshenko and Gillman, 1983; Donald and Alger 1986). Further, invertebrate foraging lake trout coexisting with ample forage species (coregonids) implies the existence of different feeding strategies within and between stocks. Length-weight relationships also varied between stocks,

with lake trout averaging the greatest weight for any given length within Kluane Lake. This may be an artifact of the relatively higher productive capacity of this particular lake.

All age compositions and associated mortality rates indicate light exploitation within all three lakes. There is some evidence that suggest that lake trout stocks do not exhibit the same compensatory mechanisms to exploitation as species that occupy lower trophic levels (O'Conner, pers comm). Managing this species, especially trophy fisheries, using traditional recruitment and yield approaches is difficult. Caution, therefore, must be made in the interpretation of these population statistics.

6.3 Lake Whitefish

The percentage of catch biomass and catch per unit effort statistics for lake whitefish varied considerably between lakes. Kluane Lake had the greatest catch effort for this species which dominated gillnet catches. The relatively high MEI of Kluane Lake suggests that it is a more productive water body for lake whitefish than either Bennett or Frances Lakes. Round whitefish and longnose sucker were as abundant as lake whitefish only within Bennett Lake. Both these species were caught throughout the lake and appear to be well established.

The earliest age of sexual maturation was age 6 (Kluane Lake) with the bulk of the fish from each lake mature by age 15. These estimates are higher than those reported by Healey (1977) for thirteen lakes throughout Canada and Horler (1983) for eighteen lakes within the Yukon Territory. The use of scales as the ageing structure in these previous studies, will underestimate ages and result in a maturation bias to earlier age groups. This bias is exemplified within unexploited stocks, where older age groups are more prevalent and scale ageing accuracy more unreliable. Conversely, the mean age of sexual maturation may be overestimated (similarly with lake trout) due to confusion between mature non-spawning and immature fish. It is believed that this bias is less significant than those associated with ageing as this problem is consistent throughout each survey.

Asymptotic sizes varied between lakes with Kluane Lake having the smallest. The largest fish caught were from Bennett Lake, but were only slightly larger than those from Frances Lake. Lake whitefish from Frances Lake weighed less at any given length than either of the other two lakes. The specific causes for these differences are unknown, however contributing factors may include relative abundance of the forage base, population density, lake productivity, genetic variation between stocks and parasite load.

Rates of growth were similar between lakes in this study but were generally lower than those found by other researchers for

unexploited populations (Kennedy, 1963; Kliever, 1970; Healey and Woodall, 1973). Data indicates it takes a minimum of ten years for a lake whitefish to achieve a fork length of 400 mm in each of the surveyed lakes. Lake whitefish data from fifteen unexploited lakes (Healey, 1975) having similar asymptotic sizes (450 to 550 mm), show a fork length of 400 mm is attained in all by age ten and in five of these lakes by age five. Although this suggests slower growth, in all cases scales were used in the analysis and may overestimate growth by underestimating the age of older fish.

All age compositions and associated mortality rates indicate stocks of lake whitefish within all three lakes to be virtually unexploited. Good representation of older age groups combined with the large number of year classes are indicative of light exploitation.

6.4 Management Implications

Lake trout is the target species in both the present commercial and sport fisheries. Although lake whitefish are caught, they have a lower marketable value. This is particularly true for Frances and Kluane Lakes which have high infestations of cysts (Trienophorus crassus) in the flesh and of little value for export. While lake whitefish have been successfully commercially fished throughout their range, commercial exploitation of lake trout is not as

extensive. Their slow growth characteristics, unique reproductive strategy (i.e. late age of maturity, intermittent spawning) and long life expectancy, factor in making this species vulnerable to excessive exploitation.

Historical quotas within these study lakes were high and an exaggeration of the lakes productive capability. In recent years, quotas were revised using Healey's (1978) recommended maximum harvest of .5 kg/ha per year. The imposition of a minimum mesh size of 10.2 cm (4 inch) enhanced lake trout catches over other species. Commercial records show that although lake quotas were never reached, lake trout contributed significantly to the landings that did occur (Appendix IV).

Quotas became species specific in an attempt to provide better protection to lake trout stocks. The higher quotas for lake whitefish have never been taken commercially, largely the result of the targeting of the smaller lake trout quotas. O'Conner (1982) suggested that a commercial allocation of 15 percent of the lake trout sustainable yield (MSY), a moderate level of sport angling quality could be maintained. This presumption was based on harvest statistics from northern Manitoba, in a lake that supported both a historic sport and commercial lake trout fishery. Although the lake differs in both morphology and species composition than the lakes studied in this report, their respective climatic conditions are similar.

The following table compares 1990 commercial quotas with those developed using 15 percent of the sustainable yields developed in this study:

Lake	1990 Lake	Harvest	Proposed Lake	Harvest
	Trout Quota	Rate	Trout Quota	Rate
	(kgs/yr)	(kgs/ha/yr)	(kgs/yr)	(kgs/ha/yr)
Bennett	1200	.12	545	.06
Frances	1620	.16	627	.06
Kluane	2300	.06	2783	.07

It is felt that these proposed harvest rates can maintain a small sustainable commercial fishery without drastically affecting the sport fisheries within these lakes. These values are well below those recommended by Healey (1978) of .2 kg/ha for moderate quality lakes in the N.W.T.

7.0 RECOMMENDATIONS

7.1 Bennett Lake

- (1) The commercial quota should be adjusted to a lake trout quota of 550 kilograms in round weight.

- (2) Allow the experimental use of smaller gillnet mesh sizes to increase catches of underutilized species.
- (3) Periodic surveys of the sport fishery for use as an index of lake trout abundance.

7.2

Frances Lake

- (1) The commercial quota should be adjusted to a lake trout quota of 625 kilograms in round weight.
- (2) Should the quota in (1) be unacceptable to the present commercial interests within this lake, the feasibility of retiring the quota should be pursued for the following rational:
 - (a) low relative abundance of lake trout
 - (b) low commercial value of the lake whitefish
 - (c) large distance from local markets
 - (d) high recreational potential
 - (e) high monitoring costs
- (3) Periodic surveys of the sport fishery for use as an index of lake trout abundance.

7.3 Kluane Lake

- (1) The commercial quota should be adjusted to a lake trout quota of 2775 kilograms in round weight.
- (2) Allow the experimental use of smaller gillnet mesh sizes to increase catches of underutilized species, especially lake whitefish.
- (3) Periodic surveys of the sport fishery for use as an index of lake trout abundance.

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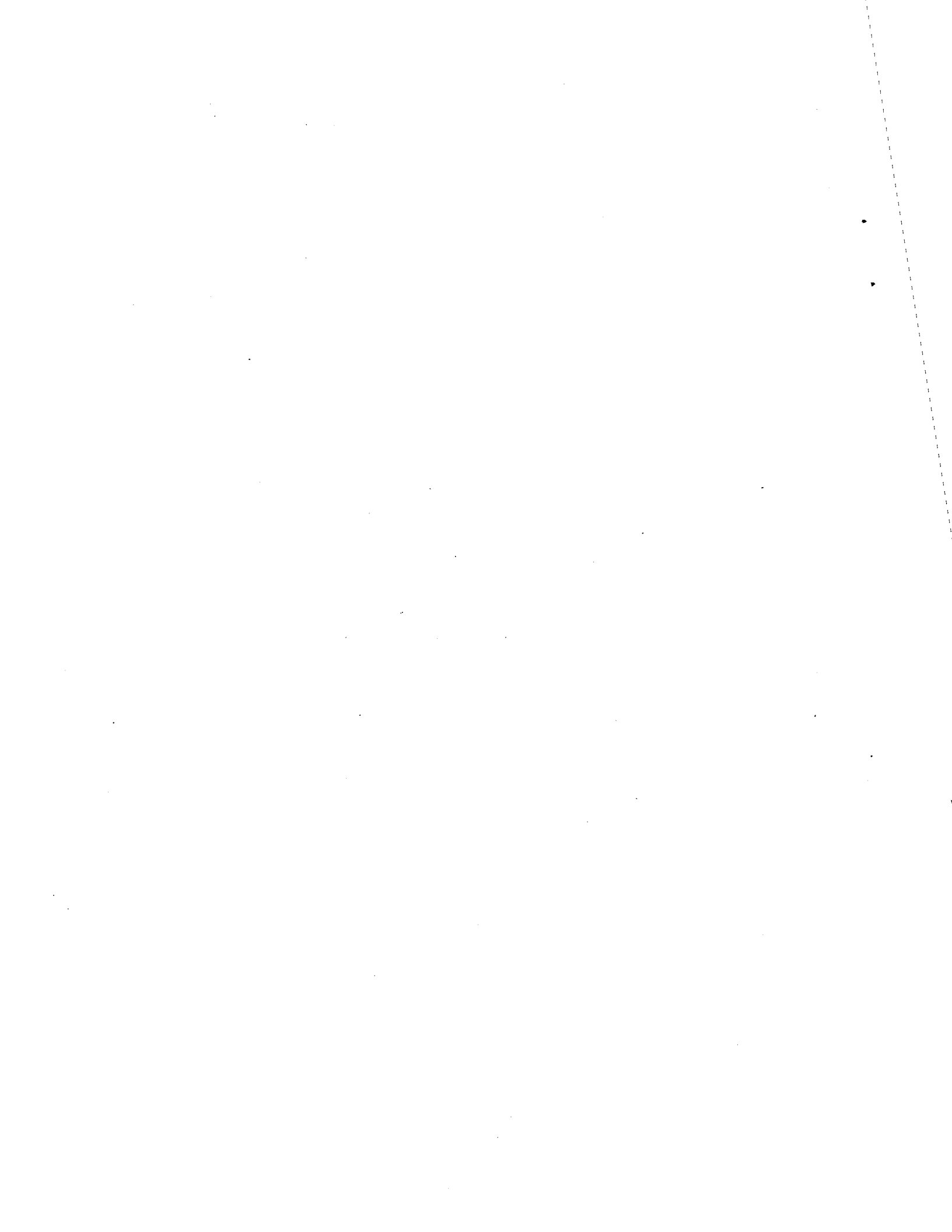
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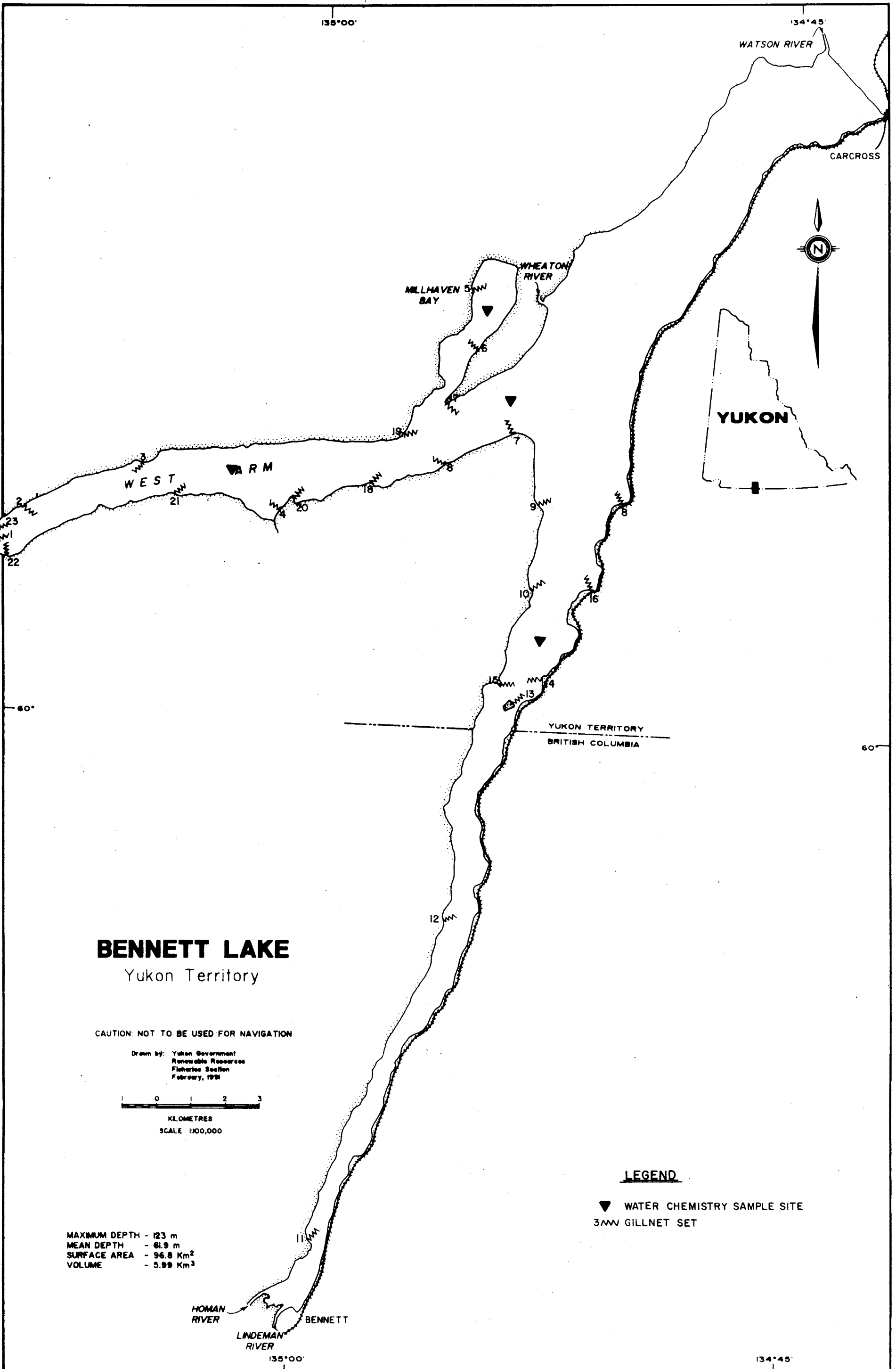
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A P P E N D I X I





BENNETT LAKE
Yukon Territory

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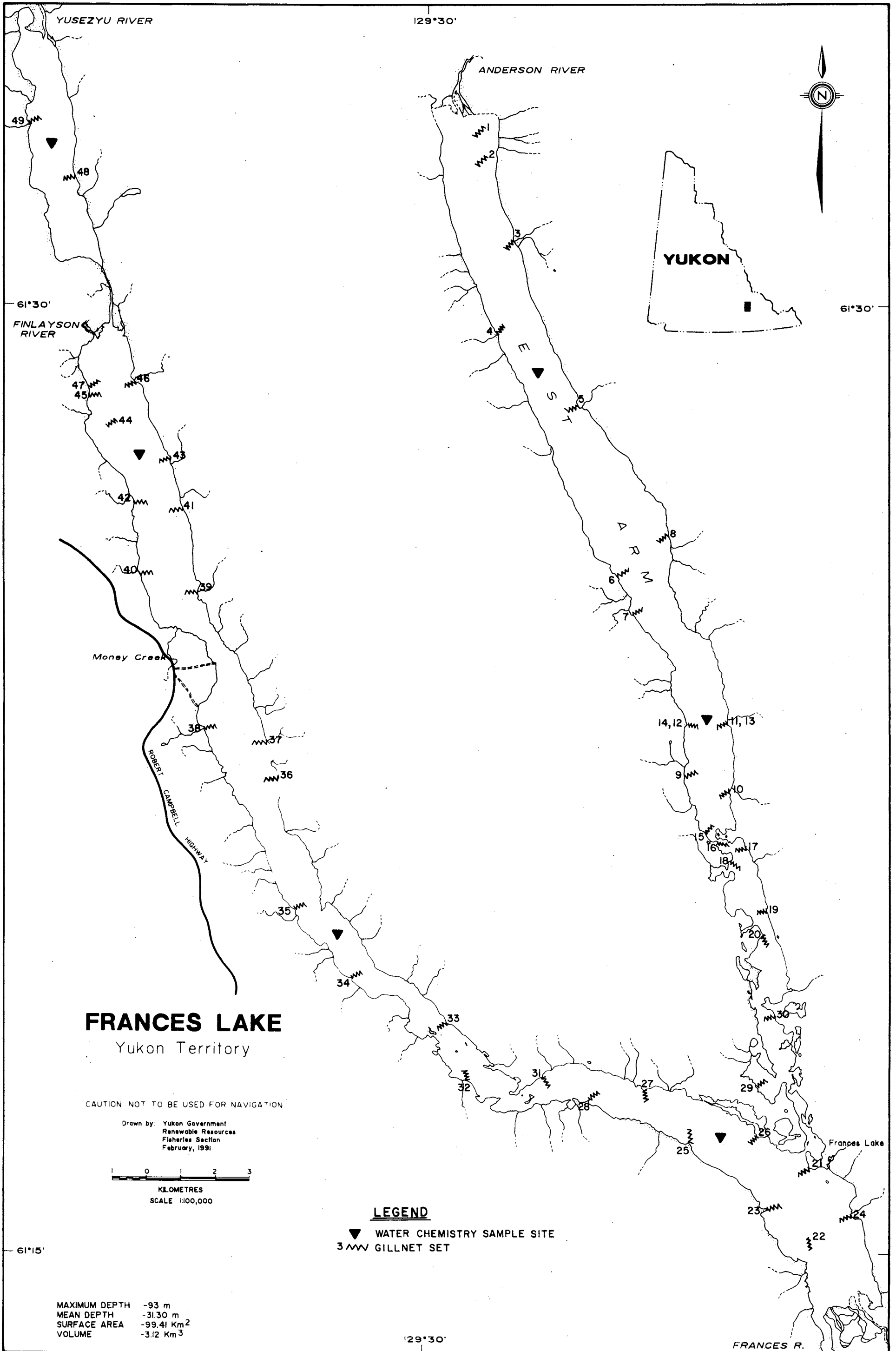
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Renewable Resources
Fisheries Section
February, 1991



MAXIMUM DEPTH - 123 m
MEAN DEPTH - 61.9 m
SURFACE AREA - 96.8 Km²
VOLUME - 5.99 Km³

LEGEND

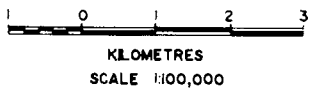
▼ WATER CHEMISTRY SAMPLE SITE
3W GILLNET SET



FRANCES LAKE
Yukon Territory

CAUTION NOT TO BE USED FOR NAVIGATION

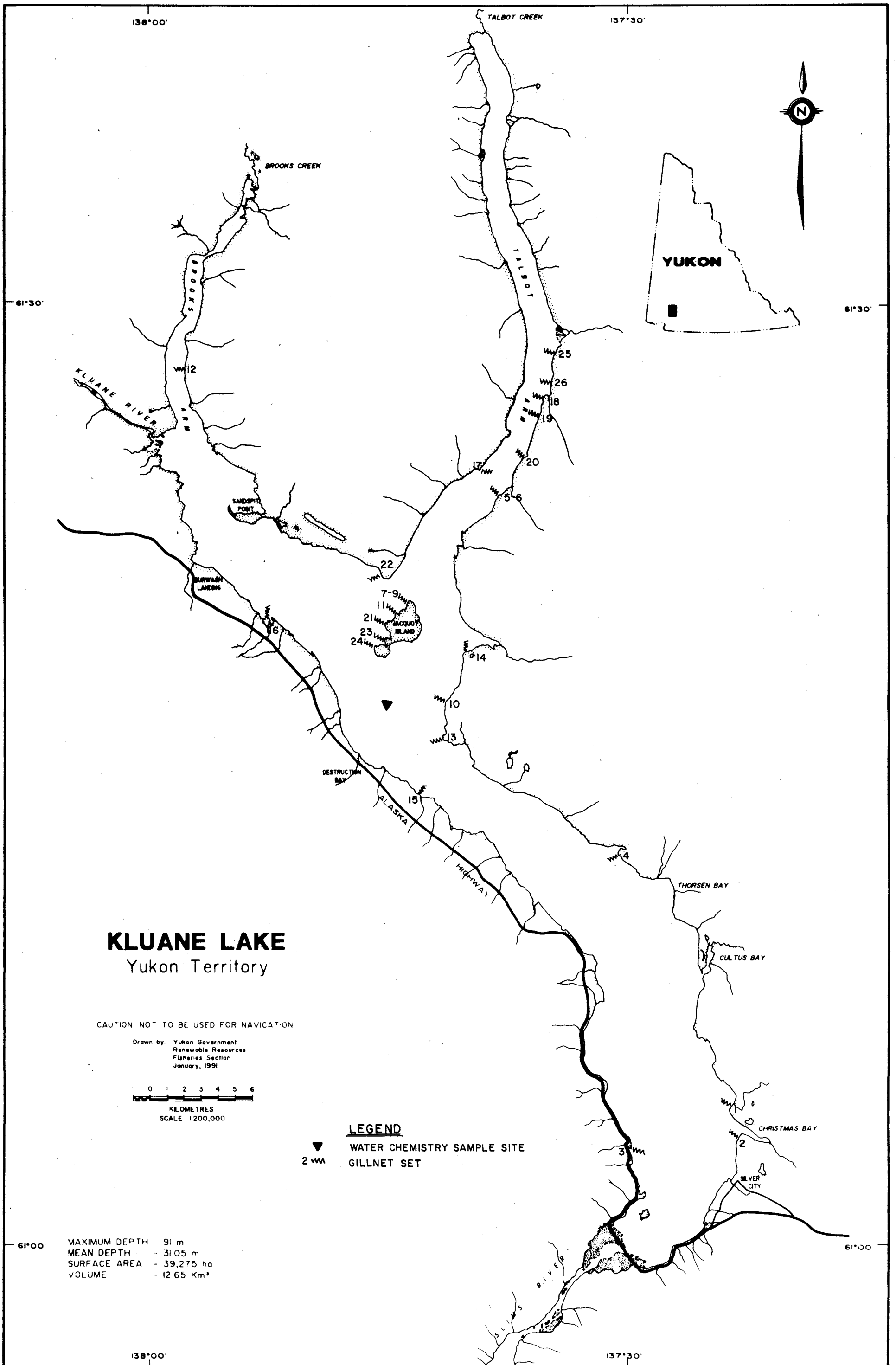
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Renewable Resources
Fisheries Section
February, 1991



LEGEND

- ▼ WATER CHEMISTRY SAMPLE SITE
- 3W GILLNET SET

MAXIMUM DEPTH	-93 m
MEAN DEPTH	-31.30 m
SURFACE AREA	-99.41 Km ²
VOLUME	-3.12 Km ³

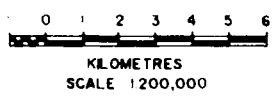


KLUANE LAKE

Yukon Territory

CAUTION: NOT TO BE USED FOR NAVIGATION

Drawn by: Yukon Government
Renewable Resources
Fisheries Section
January, 1991

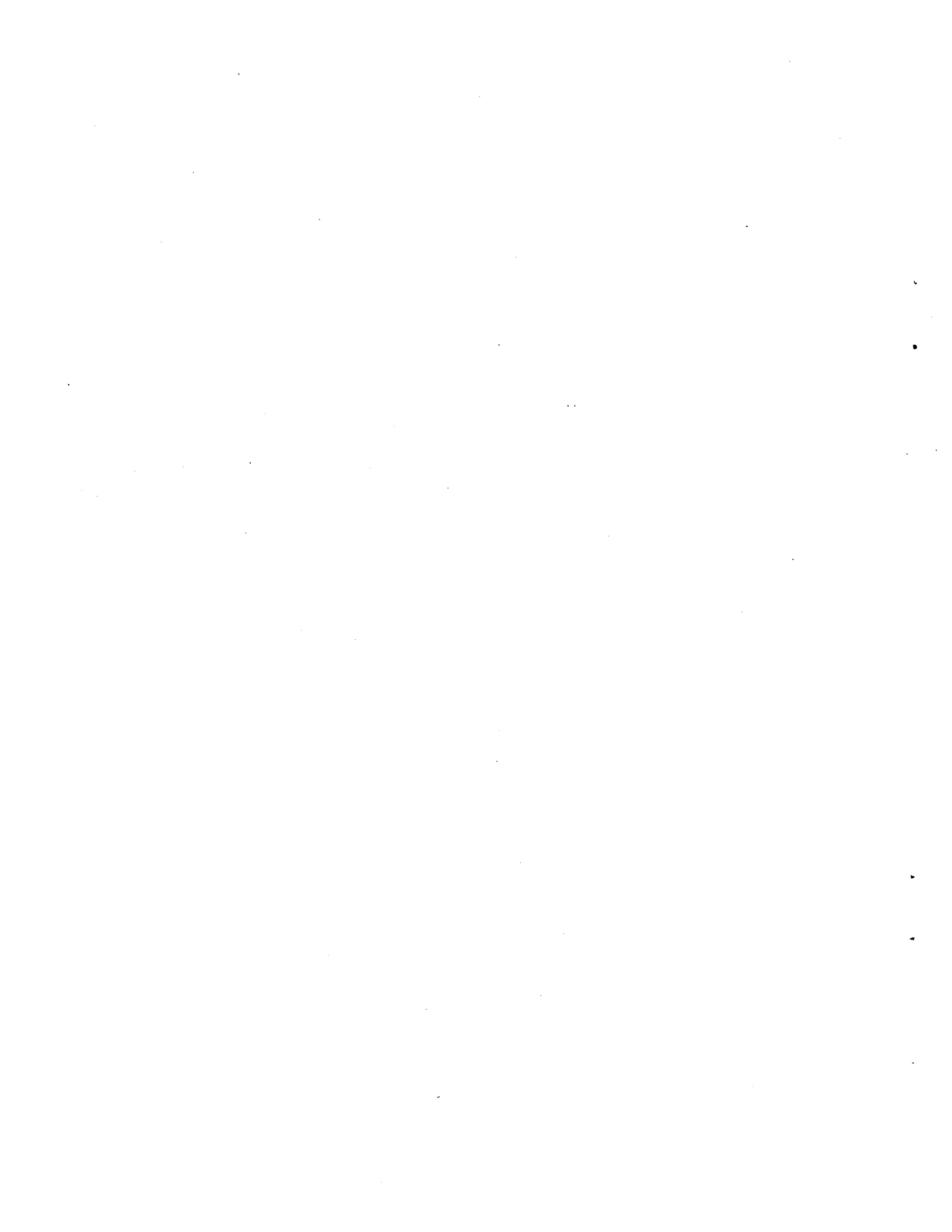


LEGEND

- WATER CHEMISTRY SAMPLE SITE
- GILLNET SET

MAXIMUM DEPTH - 91 m
 MEAN DEPTH - 31.05 m
 SURFACE AREA - 39,275 ha
 VOLUME - 12.65 km³

A P P E N D I X I I



AII-1 Maturity Schedule of Lake Trout from Bennett Lake, 1990

AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
3	1	0	1	0	0	0			
4	1	2	3	0	0	0			
5	2	5	7	0	1	1		16.67	12.50
6	3	6	9	1	0	1	25.00		10.00
7	8	9	17	0	0	0			
8	4	11	15	2	1	3	33.33	8.33	16.67
9	2	5	7	5	3	8	71.43	37.50	53.33
10	4	14	18	5	6	11	55.56	30.00	37.93
11	2	2	4	7	5	12	77.78	71.43	75.00
12	0	4	4	3	4	7	100.00	50.00	63.64
13	1	1	2	9	5	14	90.00	83.33	87.50
14	0	3	3	7	5	12	100.00	62.50	80.00
15	1	0	1	5	4	9	83.33	100.00	90.00
16	3	1	4	10	2	12	76.92	66.67	75.00
17	1	1	2	9	4	13	90.00	80.00	86.67
18	4	0	4	4	1	5	50.00	100.00	55.56
19	0	0	0	1	0	1	100.00		100.00
20	0	1	1	6	2	8	100.00	66.67	88.89
21	0	0	0	3	0	3	100.00		100.00
22	1	0	1	0	1	1		100.00	50.00
23	0	0	0	3	0	3	100.00		100.00
24	0	0	0	1	1	2	100.00	100.00	100.00
25	2	0	2	0	0	0			
26	0	1	1	0	0	0			
28	0	0	0	1	0	1	100.00		100.00
31	1	0	1	0	0	0			
32	0	0	0	0	2	2		100.00	100.00

AII-2 Maturity Schedules of Lake Trout from Frances Lake, 1990

AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
3	0	0	1	0	0	0			
4	2	1	4	0	0	0			
5	3	1	6	1	0	1	25.00		14.29
6	3	4	8	1	0	1	25.00		11.11
7	7	7	18	3	2	5	30.00	22.22	21.74
8	1	6	8	5	5	10	83.33	45.45	55.56
9	4	10	15	6	4	10	60.00	28.57	40.00
10	3	7	10	5	7	12	62.50	50.00	54.55
11	3	5	8	4	7	11	57.14	58.33	57.89
12	1	3	4	5	7	12	83.33	70.00	75.00
13	3	2	5	8	4	12	72.73	66.67	70.59
14	0	1	1	4	5	9	100.00	83.33	90.00
15	1	0	1	11	7	18	91.67	100.00	94.74
16	0	2	2	3	1	4	100.00	33.33	66.67
17	0	0	0	1	2	3	100.00	100.00	100.00
18	1	0	1	1	1	2	50.00	100.00	66.67
19	0	0	0	3	0	3	100.00		100.00
20	0	1	1	2	1	3	100.00	50.00	75.00
21	0	1	1	4	4	8	100.00	80.00	88.89
22	0	0	0	3	1	4	100.00	100.00	100.00
23	0	0	0	1	0	1	100.00		100.00
24	0	0	0	2	0	2	100.00		100.00
25	0	1	0	2	1	3	100.00	50.00	75.00
26	0	1	1	1	1	2	100.00	50.00	66.67
28	0	0	0	2	1	3	100.00	100.00	100.00
30	0	0	0	1	0	1	100.00		100.00
33	0	0	0	0	1	1		100.00	100.00
34	0	0	0	0	1	1			100.00
37	0	0	0	1	1	2	100.00	100.00	100.00

* Includes unknown sex data.

AII-3 Maturity Schedule of Lake Trout from Kluane Lake, 1990

AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
3	0	1	1	0	0	0			
5	3	8	11	0	0	0			
6	7	9	16	0	1	1		10.00	5.88
7	7	3	10	0	0	0			
8	4	5	9	0	0	0			
9	4	3	7	0	0	0			
10	3	6	9	4	3	7	57.14	33.33	43.75
11	3	5	8	2	2	4	40.00	28.57	33.33
12	1	5	6	2	2	4	66.67	28.57	40.00
13	7	3	10	3	10	13	30.00	76.92	56.52
14	2	2	4	4	2	6	66.67	50.00	60.00
15	3	2	5	2	2	4	40.00	50.00	44.44
16	0	0	0	5	14	19	100.00	100.00	100.00
17	1	0	1	4	5	9	80.00	100.00	90.00
18	0	0	0	3	1	4	100.00	100.00	100.00
19	0	0	0	2	3	5	100.00	100.00	100.00
20	0	1	1	1	3	4	100.00	75.00	80.00
21	0	1	1	2	0	2	100.00		66.67
22	0	0	0	2	3	5	100.00	100.00	100.00
23	3	0	3	4	1	5	57.14	100.00	62.50
24	0	0	0	1	2	3	100.00	100.00	100.00
25	1	0	1	3	1	4	75.00	100.00	80.00
26	0	1	1	5	1	6	100.00	50.00	85.71
27	0	0	0	2	2	4	100.00	100.00	100.00
28	2	1	3	1	1	2	33.33	50.00	40.00
29	0	0	0	1	2	3	100.00	100.00	100.00
30	0	0	0	1	1	2	100.00		100.00
31	0	0	0	1	0	1	100.00	50.00	100.00
32	0	1	1	0	1	1			50.00
35	0	0	0	1	0	1	100.00		100.00
39	0	0	0	1	0	1	100.00		100.00

AII-4 Maturity Schedule of Lake Whitefish from Bennett Lake, 1990

AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
5	3	1	4	0	0	0			
6	2	0	2	0	0	0			
7	5	2	7	0	0	0			
8	4	2	6	1	3	4	20.00	60.00	40.00
9	7	3	10	2	2	4	22.22	40.00	28.57
10	6	6	12	3	2	5	33.33	25.00	29.41
11	12	2	14	0	6	6		75.00	30.00
12	12	2	14	1	2	3	7.69	50.00	17.65
13	7	1	8	3	0	3	30.00		27.27
14	13	3	16	2	3	5	13.33	50.00	23.81
15	4	1	5	7	4	11	63.64	80.00	68.75
16	6	0	6	2	2	4	25.00	100.00	40.00
17	1	1	2	2	3	5	66.67	75.00	71.43
18	2	0	2	2	2	4	50.00	100.00	66.67
19	0	2	2	1	5	6	100.00	71.43	75.00
20	3	1	4	0	1	1		50.00	20.00
21	2	1	3	1	1	2	33.33	50.00	40.00
22	0	0	0	0	2	2		100.00	100.00
23	0	0	0	2	0	2	100.00		100.00
24	1	0	1	0	1	1		100.00	50.00
25	2	1	3	0	0	0			
26	1	0	1	0	1	1		100.00	50.00
27	1	0	1	0	1	1		100.00	50.00
28	2	0	2	1	0	1	33.33		33.33
30	0	1	1	0	0	0			
32	0	0	0	1	0	1	100.00		100.00

AII-5 Maturity Schedule of Lake Whitefish from Frances Lake, 1990

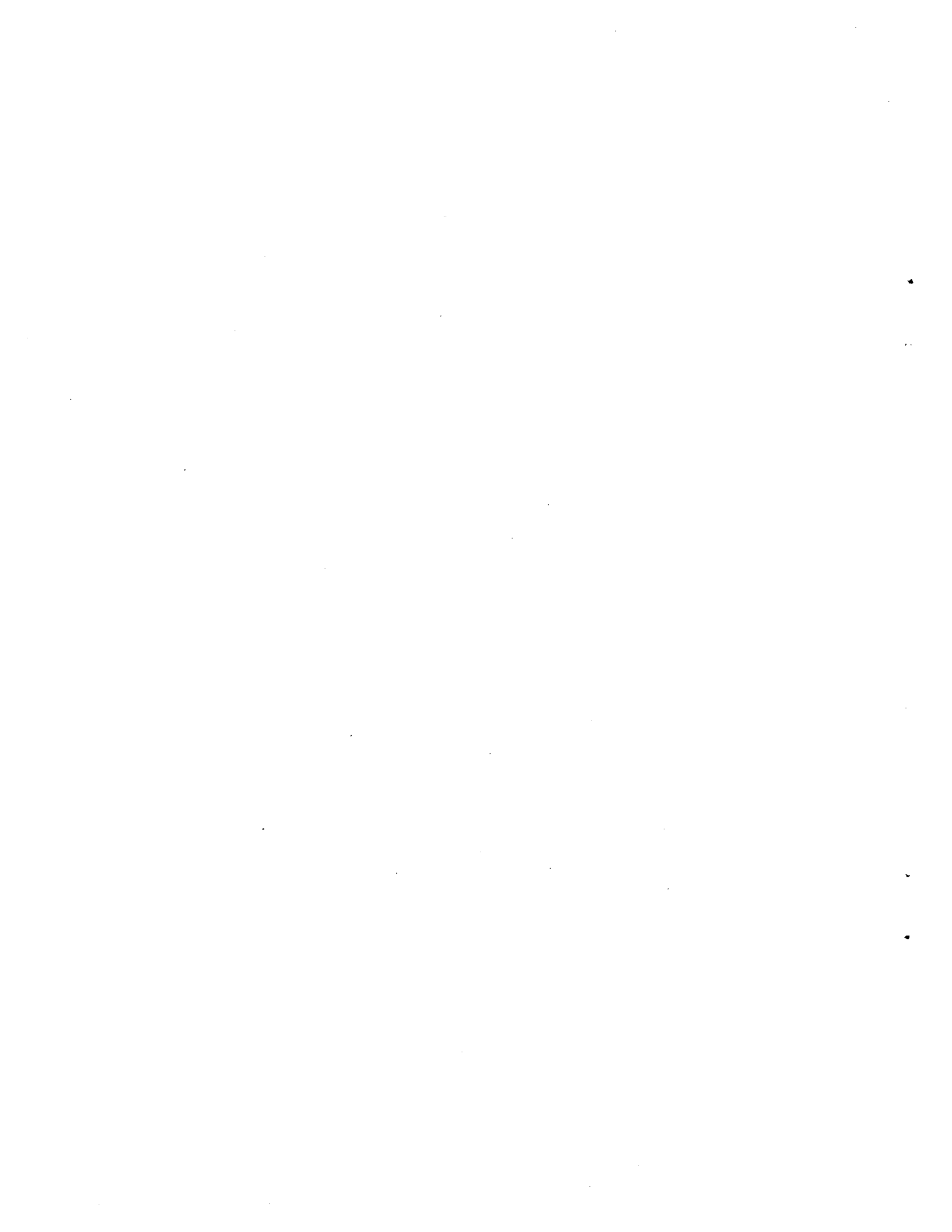
AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
2	1	1	4	0	0	0			
3	1	2	8	0	0	0			
4	1	2	3	0	0	0			
5	3	3	6	0	0	0			
6	1	0	1	1	0	1	50.00		50.00
7	3	2	5	4	2	6	57.14	50.00	54.55
8	0	1	1	4	3	7	100.00	75.00	87.50
9	3	3	6	10	2	12	76.92	40.00	66.67
10	0	9	9	15	12	27	100.00	57.14	75.00
11	3	2	5	16	11	27	84.21	84.62	84.38
12	0	2	2	12	10	22	100.00	83.33	91.67
13	0	1	1	4	4	8	100.00	80.00	88.89
14	0	0	0	3	3	6	100.00	100.00	100.00
15	0	0	0	0	3	3		100.00	100.00
16	0	0	0	3	3	6	100.00	100.00	100.00
17	0	0	0	6	7	13	100.00	100.00	100.00
18	0	0	0	6	0	6	100.00		100.00
19	0	0	0	4	2	6	100.00	100.00	100.00
20	0	0	0	4	0	4	100.00		100.00
21	1	0	1	2	4	6	66.67	100.00	85.71
22	0	0	0	1	1	2	100.00	100.00	100.00
24	0	0	0	1	0	1	100.00		100.00
25	0	0	0	1	1	2	100.00	100.00	100.00
27	0	0	0	0	1	1		100.00	100.00
30	0	0	0	1	1	2	100.00	100.00	100.00
32	0	0	0	1	0	1	100.00		100.00

* Includes unknown sex data.

AII-6 Maturity Schedules of Lake Whitefish from Kluane Lake, 1990

AGE	No. Immature			No. Mature			% Mature		
	Male	Female	Total*	Male	Female	Total	Male	Female	Total
4	6	1	7	0	0	0			
5	7	3	10	0	0	0			
6	9	4	13	1	1	2	10.00	20.00	
7	6	2	8	0	3	3		60.00	27.27
8	7	4	11	11	12	23	61.11	75.00	67.65
9	1	2	3	7	5	12	87.50	71.43	80.00
10	3	2	5	7	8	15	70.00	80.00	75.00
11	3	0	3	5	5	10	62.50	100.00	76.92
12	2	1	3	7	7	14	77.78	87.50	82.35
13	1	1	2	10	3	13	90.91	75.00	86.67
14	2	0	2	6	7	13	75.00	100.00	86.67
15	1	0	1	2	6	8	66.67	100.00	88.89
16	2	0	2	1	3	4	33.33	100.00	66.67
17	0	0	0	1	3	4	100.00	100.00	100.00
18	0	1	1	4	5	9	100.00	83.33	90.00
19	0	0	0	8	5	13	100.00	100.00	100.00
20	0	0	0	0	3	3		100.00	100.00
21	0	0	0	1	3	4	100.00	100.00	100.00
22	0	0	0	4	0	4	100.00		100.00
23	1	0	1	2	1	3	66.67	100.00	75.00
24	0	0	0	3	6	9	100.00	100.00	100.00
25	0	0	0	1	2	3	100.00	100.00	100.00
26	0	1	1	1	1	2	100.00	50.00	66.67
27	0	0	0	0	0	0			
28	0	1	1	0	2	2		66.67	66.67
29	0	0	0	2	0	2	100.00		100.00
30	0	0	0	1	0	1	100.00		100.00
33	0	0	0	0	1	1		100.00	100.00

A P P E N D I X I I I



AIII-1 Mesh Size Effects on Lake Trout Catches from Bennett Lake, 1990.

	Mesh Size (Cms)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# Caught	42	71	68	52	20	41	8
CUE(#/100m/day)	8.27	13.97	13.38	10.23	3.94	8.07	1.57
CUE(kg/100m/day)	3.07	13.92	17.69	12.29	6.89	14.64	3.62
Mean Length (mm)	279.05	402.01	471.99	449.71	505.50	513.66	560.63
Mean Weight (g)	371.43	996.06	1321.91	1200.77	1750.00	1814.39	2300.00
#mat. males	5	11	30	21	10	20	1
#imm. males	5	16	10	10	3	4	1
#mat. females	1	9	15	9	1	13	4
#imm. females	7	32	13	12	6	4	2
%mature	33.33	29.41	66.18	57.69	55.00	80.49	62.50
#unknown	24	3					
Mean age	6.80	10.32	13.37	12.59	14.06	15.09	17.86
Age(years)							
3	12.50						
4	25.00						
5	22.50	7.94		2.17			
6	15.00	4.76		6.52			
7	5.00	19.05	3.70	6.52			
8	2.50	17.46	7.41	4.35	5.56	6.06	
9		4.76	11.11	10.87	5.56	2.86	
10		11.11	18.52	13.04	16.67	9.09	
11		9.52	5.56	8.70	5.56	3.03	14.29
12		1.59	7.41	2.17	5.56	12.12	
13	2.50	1.59	7.41	8.70	5.56	15.15	
14	5.00	7.94	3.70	4.35	16.67	3.03	
15		1.59	7.41	4.35	5.56	3.03	14.29
16	5.00	1.59	5.56	8.70	5.56	15.15	
17			7.41	8.70	11.11	9.09	28.57
18	2.50	6.35		2.17	5.56	6.06	
19			1.85				
20		1.59	3.70	2.17		9.09	28.57
21			1.85		5.56	3.03	
22		1.59		2.17			
23	2.50		1.85			3.03	
24				2.17	5.56		
25			1.85				14.29
26			1.85				
27							
28						3.03	
29							
30							
31			1.85				
32		1.59		2.17			

AIII-2 Mesh Size Effects on Lake Trout Catches from Frances Lake, 1990.

	Mesh Size (Cms)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# Caught	15	83	38	49	46	27	16
CUE(#/100m/day)	1.37	7.56	3.46	4.46	4.19	2.46	1.46
CUE(kg/100m/day)	1.40	8.10	5.84	7.23	7.54	5.78	4.21
Mean Length (mm)	383.80	427.77	477.66	491.67	519.24	573.81	600.87
Mean Weight (g)	1026.67	1071.14	1688.16	1619.39	1799.46	2351.30	2891.56
#mat. males	5	20	11	18	9	12	6
#imm. males	2	13	5	6	4	0	2
#mat. females	1	12	8	12	13	12	7
#imm. females	2	22	12	4	12	1	0
%mature	34.78	47.76	52.78	75.00	57.89	96.00	86.67
#unknown	5	16	2	9	8	2	1
Mean age	8.5	10.76	12.79	13.60	13.00	14.89	14.81
Age(years)							
3	6.67						
4	13.33	1.20	2.63				
5	13.33	3.61		2.08	2.22		6.25
6	6.67	7.23	2.63	2.08	2.22		
7		15.66	10.53	8.33	2.22		6.25
8	13.33	6.02	13.16	8.33	6.67		6.25
9	6.67	13.25	15.79	8.33	15.56	11.11	
10	13.33	14.46	5.26	4.17	8.89	3.70	12.50
11	13.33	12.05	2.63	10.42	11.11		12.50
12	6.67	2.41	5.26	12.50	11.11	14.81	
13		4.82	10.53	6.25	8.89	14.81	6.25
14		3.61		6.25	4.44	7.41	6.25
15		6.02	7.89	10.42	4.44	11.11	6.25
16				2.08	6.67	11.11	6.25
17		1.20			2.22	3.70	
18		1.20	2.63	2.08			
19		2.41				3.70	6.25
20					2.22	3.70	12.50
21	6.67		7.89	6.25		7.41	6.25
22			5.26		2.22	3.70	
23			2.63				
24					2.22	3.70	
25		2.41		2.08	2.22		
26			2.63	2.08	2.22		
28		1.20	2.63	2.08			
30				2.08			
33					2.22		
34		1.20					
37				2.08			6.25

AIII-3 Mesh Size Effects on Lake Trout Catches from Kluane Lake, 1990.

	Mesh Size (Cms)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# Caught	36	58	53	42	40	45	11
CUE(#/100m/day)	6.27	10.09	9.22	7.31	6.96	7.83	1.91
CUE(kg/100m/day)	8.28	20.16	14.81	13.71	13.39	14.64	4.13
Mean Length (mm)	407.92	501.12	483.11	495.24	534.63	509.11	536.82
Mean Weight (g)	1322.22	1997.41	1605.09	1801.90	1923.75	1869.33	2159.09
#mat. males	3	6	10	11	14	13	6
#imm. males	8	11	13	11	5	12	1
#mat. females	5	22	13	11	13	11	4
#imm. females	12	16	16	7	8	9	
%mature	28.57	50.91	55.77	55.00	67.50	53.33	90.91
#unknown	8	3	1	2			
Mean age	7.33	11.81	13.36	10.21	16.13	11.60	17.36
Age(years)							
3	7.14						
4	7.14		2.00				
5	10.71	6.00	4.00	6.45		5.71	
6	17.86	14.00	6.00	3.23	2.94	2.86	
7	3.57	6.00	8.00	6.45		2.86	
8	10.71	8.00	2.00	3.23		2.86	
9		2.00	8.00		2.94	2.86	
10	10.71	8.00	8.00	3.23	2.94	8.57	
11	3.57	4.00	2.00	12.90	11.76	2.86	
12		2.00	4.00	9.68	2.94	8.57	
13	7.14	6.00	10.00	16.13	14.71	8.57	
14	3.57	2.00	2.00	3.23	2.94	8.57	
15	3.57	6.00	6.00		2.94	5.71	11.11
16	3.57	12.00	10.00	9.68	5.88	5.71	
17	3.57	2.00	4.00	6.45	2.94	5.71	11.11
18				3.23		5.71	11.11
19	3.57			3.23	2.94	2.86	11.11
20		2.00	4.00		2.94	2.86	
21			2.00		2.94	2.86	
22		2.00	2.00		2.94	2.86	11.11
23		6.00	4.00	3.23	2.94		11.11
24		2.00		3.23	2.94		
25		2.00			8.82		11.11
26	3.57		4.00	3.23		2.86	22.22
27			2.00		5.88	2.86	
28		2.00	4.00		2.94	2.86	
29		2.00	2.00			2.86	
30				3.23	2.94		
31					2.94		
32		4.00					
35					2.94		
39					2.94		

AIII-4 Mesh Size Effects on Whitefish Catches from Bennett Lake, 1990.

	Mesh Size (Cms)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# Caught		12	68	38	58	47	19
CUE(#/100m/day)		2.36	13.38	7.48	11.42	9.25	3.74
CUE(kg/100m/day)		2.41	16.75	6.33	14.23	14.83	7.27
Mean Length (mm)		409.17	439.78	386.71	439.74	479.57	495.26
Mean Weight (g)		1021.25	1251.62	846.00	1246.55	1603.19	1944.74
#mat. males		4	9	6	9	8	4
#imm. males		4	33	20	28	21	5
#mat. females		2	15	1	12	16	9
#imm. females		2	11	10	9	2	1
%mature		50.00	35.29	18.92	36.21	51.06	68.42
#unknown				1			
Mean age		14.11	13.34	12.03	13.04	16.68	16.93
Age(years)							
3							
4							
5			3.28	3.33	2.00		
6			1.64	3.33			
7			4.92	33.33	4.00	2.94	
8			4.92	10.00	8.00	2.94	
9		22.22	6.56	13.33	6.00	2.94	
10		11.11	9.84	13.33	12.00		
11		11.11	11.48	16.67	12.00	2.94	
12			4.92		12.00	11.76	13.33
13		11.11	9.84	10.00	6.00	2.94	
14			13.11	6.67	6.00	17.65	6.67
15		11.11	1.64	6.67	12.00	11.76	13.33
16		11.11			2.00	5.88	26.67
17			6.56		2.00	5.88	
18		11.11	4.92		2.00	2.94	
19			1.64		4.00	2.94	26.67
20			4.92		4.00		
21			4.92		2.00	2.94	
22			1.64				6.67
23						5.88	
24						2.94	6.67
25					2.00	5.88	
26		11.11	1.64				
27			1.64			2.94	
28				3.33		5.88	
29							
30					2.00		
31							
32				3.33			

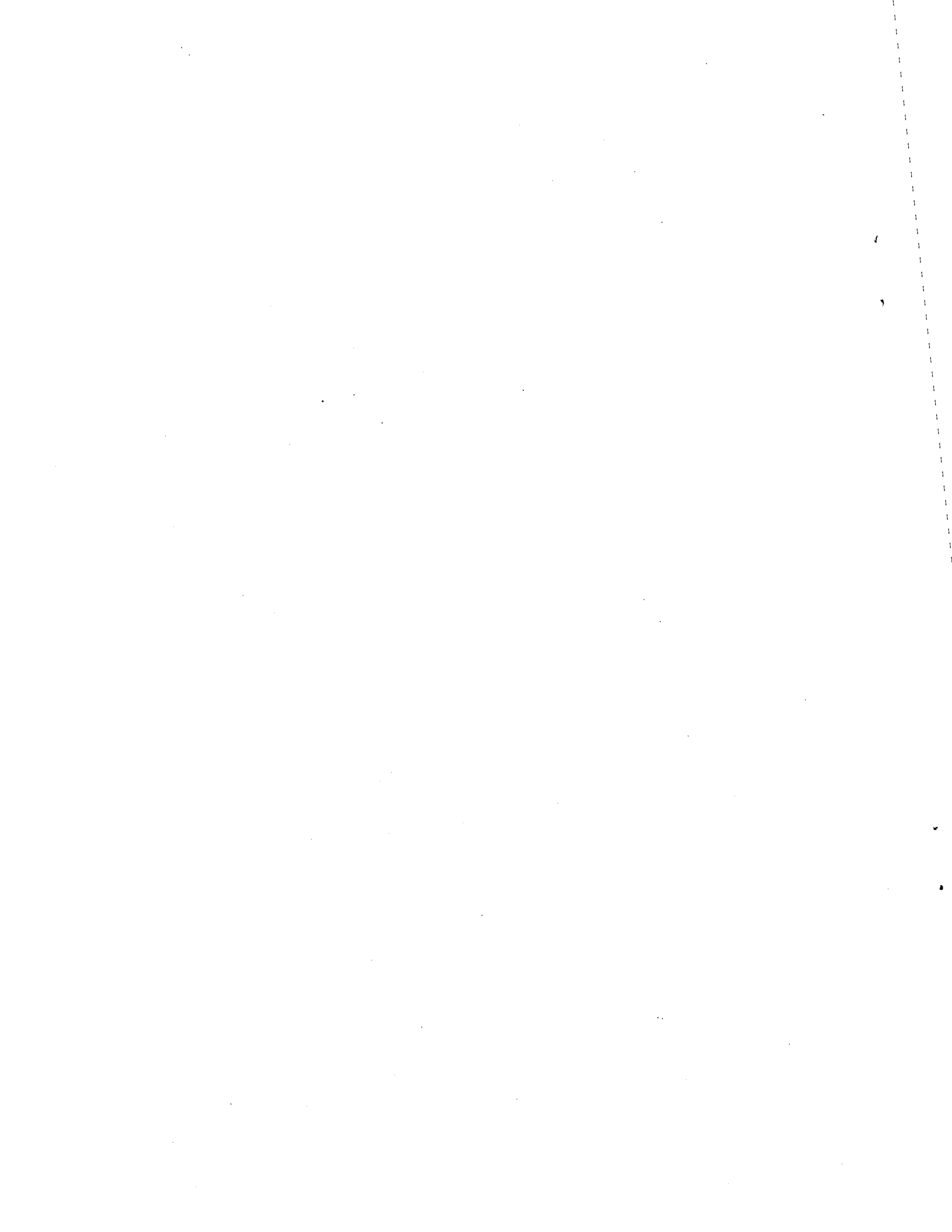
AIII-5 Mesh Size Effects on Lake Whitefish Catches from Frances Lake, 1990.

	Mesh Size (Inches)						
	1.5	2.5	3	3.5	4	4.5	5
# Caught	132	163	181	201	162	42	7
CUE(#/100yds/day)	12.02	14.85	16.49	18.31	14.76	3.83	.64
CUE(kg/100yds/day)	3.83	8.97	10.36	15.02	14.22	5.15	1.10
Mean Length (mm)	396.27	363.24	369.12	396.82	418.75	457.67	506.43
Mean Weight (g)	318.47	604.20	628.20	820.40	963.40	1345.24	1721.43
#mat. males	36	59	72	74	77	18	5
#imm. males	9	13	15	9	6		
#mat. females	24	37	46	82	70	23	2
#imm. females	23	43	30	21	5		
%mature	34.78	47.76	52.78	75.00	57.89	96.00	86.67
# unknown	40	11	18	15	4	1	
Mean Age	7.25	9.76	11.42	11.85	14.13	17.24	14.00
Age(years)							
2	11.60						
3	15.56	.34					
4	5.59	.93	.44	.23	.05	.05	
5	2.05	2.29	.44	.23	.05	.05	6.25
6	.88	1.12	.65	.90	1.06	.83	.31
7	3.87	5.43	5.62	7.02	7.83	4.85	1.86
8	3.02	4.58	4.55	4.54	4.33	2.58	.93
9	8.19	12.48	13.41	12.00	10.50	7.34	3.67
10	15.73	24.03	24.80	22.89	20.44	12.50	5.24
11	12.29	19.09	17.91	14.46	11.18	7.80	3.38
12	7.27	10.76	10.47	10.46	10.57	11.91	10.24
13	2.39	3.22	3.70	4.91	5.99	7.05	5.88
14	1.73	2.56	2.94	2.89	2.87	3.81	11.49
15	.23	.22	.24	.54	1.00	2.80	3.74
16	1.22	1.59	1.83	2.61	3.12	3.56	9.28
17	3.64	5.31	6.10	5.95	6.13	8.40	9.00
18	.29	.42	.45	1.04	2.14	5.61	11.00
19	1.33	1.68	1.94	2.61	3.21	4.47	2.74
20	.99	1.44	1.65	1.88	2.17	2.72	3.44
21	1.58	1.96	2.26	3.70	4.82	5.11	2.76
22		.07	.06	.06	.36	1.96	5.04
24	.11	.09	.11	.25	.41	.91	.61
25	.11	.13	.14	.28	.59	1.89	3.13
27		.04	.03	.03	.18	.98	2.52
30	.11	.13	.14	.28	.59	1.89	3.13
32	.11	.09	.11	.25	.41	.91	.61

AIII-6 Mesh Size Effects on Whitefish Catches from Kluane Lake, 1990.

	Mesh Size (Cms)						
	3.8	6.4	7.6	8.9	10.2	11.4	12.7
# Caught	89	273	281	275	224	139	7
CUE(#/100m/day)	15.49	47.51	48.90	47.86	38.98	24.19	1.22
CUE(kg/100m/day)	5.09	28.87	34.20	37.65	35.64	24.21	1.46
Mean Length (mm)	259.44	351.07	366.05	383.13	399.95	410.54	415.71
Mean Weight (g)	328.71	607.55	699.29	786.67	914.29	1000.83	1200.00
#mat. males	2	12	12	27	24	19	3
#imm. males		24	15	16	8	5	
#mat. females		9	9	47	27	23	2
#imm. females	2	17	5	4		2	
%mature	50.00	33.87	41.18	78.72	86.44	85.71	100.00
#unknown	6	1		1	1		
Mean age	7.88	8.88	10.59	11.77	15.23	17.19	21.00
Age(years)							
3	50.00						
4		8.00	3.45	2.67			
5	12.50	12.00	3.45	1.33		2.33	
6	12.50	12.00	13.79	6.67		2.33	
7		10.00	3.45	5.33	2.08		
8		20.00	20.69	14.67	8.33	6.98	
9		12.00	6.90	5.33	6.25		
10		4.00	10.34	16.00	6.25		
11		8.00	3.45	8.00	4.17		
12		2.00	3.45	8.00	12.50	6.98	
13		4.00	10.34	6.67	8.33	2.33	
14				5.33	12.50	11.63	
15			6.90	4.00	2.08	6.98	
16	12.50			2.67		6.98	
17				2.67	2.08	2.33	
18		2.00	6.90		6.25	9.30	
19				1.33	6.25	11.61	60.00
20					6.25	2.33	
21		2.00			2.08	4.65	
22				1.33	2.08	2.33	
23				1.33		6.98	
24	12.50		3.45	2.67		6.98	40.00
25				1.33	4.17		
26					4.17	2.33	
27							
28				1.33	2.08	2.33	
29					2.08	2.33	
30		2.00					
31							
32							
33				1.33			

A P P E N D I X I V



COMMERCIAL PRODUCTION STATISTICS (Kilograms)

Lake	Year	Lake Trout	Lake Whitefish	Other Species	Total
Bennett	1973	122.00	271.00	-	393.00
	1974	154.68	301.00	-	455.68
	1975	622.34	2061.00	-	2683.34
	1976	400.08	1998.00	-	2398.08
	1977	1137.18	1959.00	-	3096.18
	1978	108.86	485.00	-	593.86
	1979	129.50	794.00	2.10	925.60
	1980	231.00	57.80	3.60	292.40
	1981	1265.00	1127.00	68.00	2460.00
	1982	112.50	85.30	248.00	197.80
	1983	223.00	131.00	-	602.00
	1984	410.00	73.00	-	483.00
	1985	41.00	18.00	-	59.00
	1986	91.40	52.30	-	143.70
	1987	773.40	1211.10	-	1984.50
	1988	616.00	535.00	-	1151.00
1991	364.80	439.40	5.44	809.64	
Frances	1974	106.14	1242.00	-	1348.14
	1979	33.10	36.60	-	69.70
	1980	20.40	90.70	40.80	151.90
	1981	122.50	58.50	106.30	287.30
	1983	57.60	130.00	36.30	223.90
	1984	123.00	107.00	15.90	245.90
	1985	22.00	20.40	4.50	46.90
	1986	68.50	61.20	62.40	192.10
	1987	121.60	17.00	-	138.60
	1988	1348.00	788.00	1091.50	3227.50
1989	225.90	155.00	177.30	558.20	
Kluane	1973	610.55	507.00	-	1117.55
	1974	830.09	1205.00	-	2035.09
	1975	967.98	2444.00	-	3411.98
	1976	340.20	383.00	-	723.20
	1977	251.75	538.00	-	789.75
	1978	208.20	132.00	-	340.20
	1979	342.90	85.10	10.00	438.00
	1980	590.00	477.90	9.10	1077.00
	1981	579.00	255.00	103.70	937.70
	1982	344.00	15.40	-	359.40
	1983	939.00	315.00	43.40	1297.40
	1984	364.00	4.00	-	368.00
	1987	20.40	58.00	-	78.40
	1988	984.10	178.20	6.80	1169.10
	1989	1918.60	476.80	11.20	2406.60
	1990	1477.10	206.60	4.60	1688.30
1991	1847.00	633.10	196.60	2676.70	
1992	1596.80	598.10	65.70	2260.60	

source: 1973 - 1978 data from Seigel and McEwen, 1984.
 1979 - 1989 data from Dept. Fisheries and Oceans (Canada).
 1990 - 1992 data from Yukon Territorial Government.

