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Lake Trout Studies in the AYK Region, 1995

by

Thomas T. Taube

September 1996

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd
Spell out acre and ton.	

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s
Spell out year, month, and week.	

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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LAKE TROUT STUDIES IN THE AYK REGION, 1995

by

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ABSTRACT

Standardized gillnet sampling (Index fishing) was used in July 1995 as a method to capture lake trout *Salvelinus namaycush* in Irgnyivik and Nanushuk lakes to estimate abundance, length composition, and CPUE. Due to warm water temperatures and lack of mixing between events, abundance for 1995 was not determined. An abundance of 492 lake trout ≥ 368 mm for July 1994 was calculated for Irgnyivik Lake using the Petersen estimate for a two season mark-recapture experiment. The largest proportion (0.29, SE = 0.027) of lake trout captured in Irgnyivik Lake was in the 400-425 mm length category. In Irgnyivik Lake, lake trout ranged in length from 191 - 743 mm; ages of 21 lake trout examined ranged from 6 to 22 years. The largest proportion (0.46, SE = 0.025) of lake trout captured in Nanushuk Lake was in the 375-400 mm length category. In Nanushuk Lake, lake trout captured ranged in length from 169 - 590 mm; ages of 25 lake trout examined ranged from 5 to 30 years. CPUE of Index fishing was 2.15 fish/net h at Irgnyivik Lake and 5.86 fish/net h at Nanushuk Lake.

During July and August 1995, fyke nets were used to collect 64 juvenile lake trout (age 0 and age 1) from Sevenmile Lake for length-at-age and weight-at-age data. In September 1995, 63,100 fertilized eggs were taken from the Sevenmile Lake stock for rearing at Clear Hatchery and Donnelly Lake. Lake trout of known age were collected from six stocked lakes for an ongoing age validation study.

Key words: lake trout, *Salvelinus namaycush*, Index fishing, CPUE, abundance, length composition, age validation, Irgnyivik Lake, Nanushuk Lake, Sevenmile Lake.

INTRODUCTION

Concerns over increased fishing effort in lakes north of the Brooks Range, due to the opening of the Dalton Highway (Haul Road) to the general public, initiated population studies of four lake trout lakes in 1994. Results of these studies by the Department of Fish and Game, Sport Fish Division, provided the basis to close the Trans-Alaska Pipeline corridor lakes to the harvest of lake trout (Burr 1995). The need for further baseline population data from north slope lakes prompted the investigation of a method suitable to provide an index of abundance or stock status. In Ontario, a combination of sport fish harvest surveys and Index fishing with gillnets are used to monitor lake trout stocks (Lester et al. 1991). Lake trout harvests within the Pipeline corridor averaged 95 fish between 1986 and 1993 (Mills 1987-1994). Harvests of this size would make collecting biological harvest data difficult, whereas an index would provide a indicator whether a mark-recapture study was necessary. Research conducted in 1994 initiated examination of catch per unit effort (CPUE) with standardized gillnet sampling (Index fishing) as a method for assessing lake trout populations north of the Brooks Range and the Arctic-Yukon-Kuskokwim (AYK) region.

During 1994 sampling was conducted at Galbraith, Irgnyivik, Nanushuk, and Itkillik lakes (Figure 1). Lake trout in each lake were sampled to estimate length distribution and median CPUE. In addition, Galbraith Lake was sampled to estimate lake trout and burbot abundance. The estimate of abundance for lake trout ≥ 500 mm in Galbraith Lake (412 ha) was 236 fish (SE = 41), which was lower than expected, and was reflected in low estimates of CPUE (0.21 lake trout per gillnet hour). In comparison, Irgnyivik and Nanushuk lakes (87 and 81 ha, respectively) had substantially higher estimates of CPUE (2.9 and 7.4 fish per gillnet hour, respectively) than Galbraith Lake and would be expected to have a greater abundance of lake trout. Mark-recapture experiments conducted on

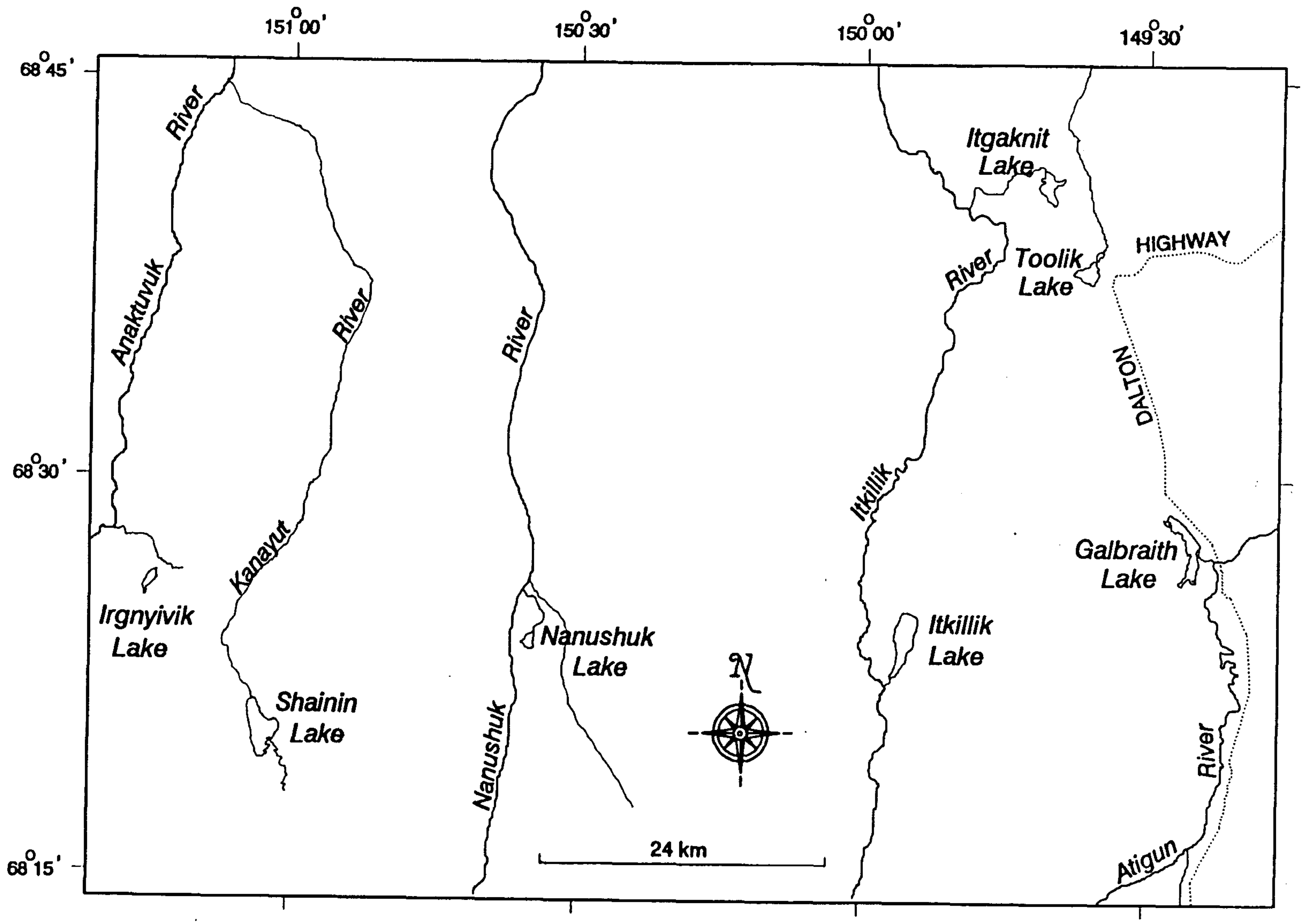

Figure 1.-Location of Haul Road lakes sampled in 1995.

these small lakes would provide abundance estimates as a basis to determine if Index fishing can be used as an index of abundance in Alaskan waters.

Lake trout density and production has been related to various physical characteristics of the lakes in which the species is found. To better understand the relationships between physical habitat and lake trout populations in Alaska, data from a large number of lakes of diverse size and type will be required. Accumulation of these physical data should be combined with collection of biological population data.

Burr (1994) estimated that at least 20% of the potential annual egg production was removed from the lake trout population in Sevenmile Lake during the 1993 egg take. It is not clear whether replacing this lost recruitment by stocking yearlings would result in a net loss or gain to the population. To assess the potential impact of replacing the lost recruitment to age-1 with hatchery fish, the growth to age-1 for fish in the population prior to (or after) 1993 should be compared with growth of the 1993 age group. If it is found that the 1993 fish grew faster, this may be evidence that growth compensation and presumably increased survival occurred. If there is not a change in growth rates for yearling fish, no compensatory growth and/or survival is indicated and modest supplemental stocking may be recommended.

The project objectives for 1995 were to estimate:

1. the abundance of lake trout in Nanushuk and Irgnyivik lakes such that the estimate is within 25% of the actual value 90% of the time;
2. the length composition of lake trout in Nanushuk and Irgnyivik lakes such that the estimate is within 10 percentage points 95% of the time;
3. the catch per effort (CPUE) with standardized gillnet sampling (Index fishing) for lake trout in Nanushuk and Irgnyivik lakes; and,
4. the mean length and weight of yearling lake trout in Sevenmile Lake in September 1995 such that the estimate is within 5 mm of the actual length 95% of the time.

In addition, project tasks for 1995 were to:

1. collect depth information on Nanushuk and Irgnyivik lakes such that bathymetric maps of those lakes can be generated;
2. conduct an egg take at Sevenmile Lake; and,
3. validate that ages of lake trout stocked in 1991 as determined from otoliths, opercular bones and scales are true ages.

METHODS

Irgnyivik and Nanushuk lakes are located north of the Brooks Mountain range west of the Alyeska oil pipeline haul road (Figure 1). These lakes were sampled for abundance, length and age composition, and CPUE from July 7 to July 22, 1995. Sevenmile Lake (Figure 2) is located in the upper Tanana River drainage of central Alaska. Sampling for age validation at stocked lakes and young of the year lake trout at Sevenmile Lake occurred

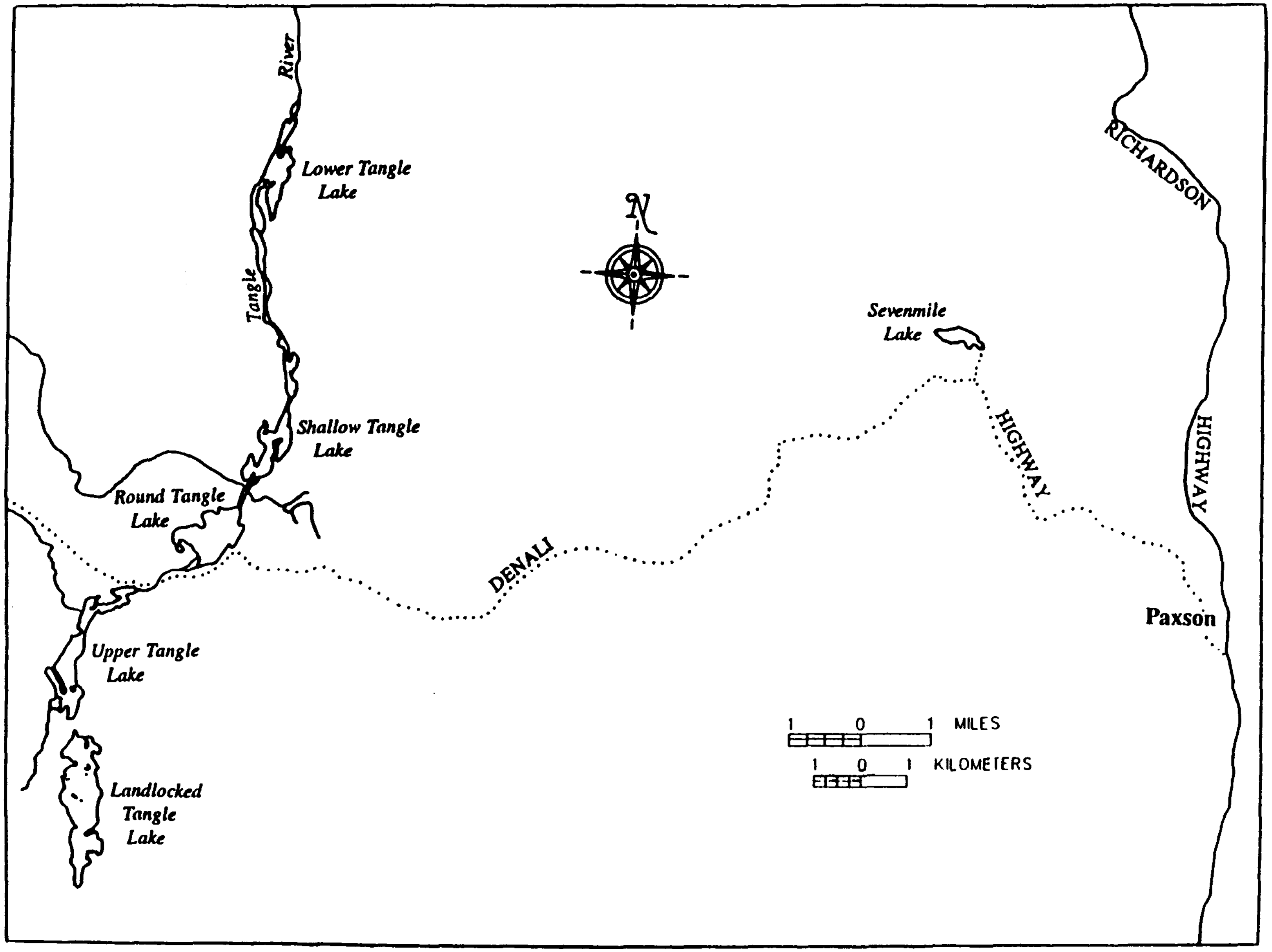

Figure 2.-Location of Sevenmile Lake.

between July 25 - August 30. The egg take at Sevenmile Lake was conducted September 11 - 14, 1995. At Nanushuk and Irgnyivik lakes, a two member crew sampled lake trout (and round whitefish *Prosopium cylindraceum* in Irgnyivik Lake) captured in gillnets, minnow traps (hoop traps), and by hook and line. Lake trout were individually marked with a numbered Floy anchor tag and upper caudal fin punch. The gillnets were deployed and fished according to the sampling protocol of Lester et al. 1991 (Appendix A1). Minnow traps were fished during the first event at both lakes. The minnow traps were 1.8 m in length with five steel hoops, diameters tapered from 0.6 m at the entrance to 0.5 m at the cod end. Each trap was double throated (tied to the first and third hoop), net material was knotted nylon with 12 mm bar mesh and treated with an asphaltic compound. Each trap was stretched with two sections of 25.4 mm PVC pipe attached by snap clips to the end hoops of the trap. A buoy was attached to the cod end of the trap with a polypropylene rope.

At Sevenmile Lake fyke nets were set throughout the lake to capture young of the year lake trout. Each fyke net was 6.1 m long composed of a double square 1.2 m aluminum frame and four steel hoops measuring 0.9 m in diameter. The traps had three throats; one attached to the square frame, the others attached to the first and third hoops. Attached to outer sides of the square frame are 7.6 m long by 1.2 m deep seines which funnel fish toward the trap. All mesh was 9.5 mm nylon webbing. The fyke nets were set facing the shoreline with 15.2 m to 30.5 m seines attached to shore and to the center of the square frame.

ABUNDANCE ESTIMATION

Abundance of lake trout in Nanushuk and Irgnyivik lakes was to be estimated in 1995 with a Petersen mark-recapture experiment (Seber 1982). Sampling to mark lake trout was conducted July 7 - 10 and July 11 - 14 at Irgnyivik and Nanushuk lakes, respectively. The recapture events occurred July 15 - 18 at Irgnyivik Lake and July 19 - 22 at Nanushuk Lake. Lake trout were marked with Floy tags and a lower caudal punch in Irgnyivik Lake, but were only marked by a lower caudal punch in Nanushuk Lake during sampling in 1994. This allowed an estimate of abundance to be calculated for Irgnyivik Lake for 1994 at the time of marking.

The marking event occurred during July 12 - 15, 1994. All lake trout captured and judged to be in good condition were doubly marked with individually numbered Floy tags and a lower caudal punch. The recapture event was the combination of the two sampling events conducted in July 1995. The number of lake trout in Irgnyivik Lake was estimated using a modification of the Petersen mark-recapture population estimator (Seber 1982). Population abundance and the approximate variance of the estimates were calculated with the following formulas (Seber 1982):

$$\hat{N} = \frac{(C+1)(M+1)}{R+1} - 1 \qquad (1)$$

$$V[\hat{N}] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \qquad (2)$$

where:

N = the population size;

M = the number marked during the first sampling event;

C = the number examined during the second sampling event; and,

R = the number captured during the second sampling event with marks from the first sampling event.

The Chapman estimator is appropriate if the following assumptions are met:

1. catching and handling the fish does not affect the probability of recapture;
2. fish do not lose marks between events;
3. recruitment and mortality do not occur between sampling events (recruitment or mortality can occur, but not both); and,
4. every fish must have an equal probability of being marked and released alive during the first sampling event; or every fish must have an equal probability of being captured during the second sampling event; or marked fish mix completely with unmarked fish between sampling events (Seber 1982).

The lake trout population in Irgnyivik Lake is considered closed. No significant outlets exist in the lake. Condition 1 was thought to have been met because only lake trout that were judged to be in good condition after capture were marked prior to being released. Condition 2 was met by double marking each fish (Floy tag and finclip) in order to determine if marks were lost between events. In regards to condition 3, growth recruitment likely occurred between the 1994 and 1995 sampling events. To evaluate growth recruitment, the lengths of lake trout marked in 1994 and recaptured in 1995 were examined at the time of recapture and the time of marking. Lake trout that were less than the length of the smallest marked lake trout captured during the second event were culled from the second event sample. Lake trout that were less than the length of the smallest recaptured lake trout at the time of marking were culled from the first event sample. The estimate therefore pertains to the abundance of lake trout in Irgnyivik Lake greater than or equal to the length of the smallest lake trout recaptured during the second event at the time of marking. There is virtually no harvest of lake trout in Irgnyivik Lake and mortality was considered negligible.

To evaluate condition 4, the hypothesis of equal probability of capture for fish of all sizes during the marking and recapture sampling events was tested using the two-sample Kolmogorov-Smirnov test. The first test involves the frequency of tagged fish recaptured versus the length frequency of those not recaptured. The second test compares the length frequencies of fish captured during the marking event with fish captured during the recapture event. The procedure to be followed given each possible outcome of these tests is mapped in Appendix B1.

To test the hypothesis of equal probability of capture by lake area, the lake was divided into two areas of approximately equal size. The marked-to-unmarked ratio by lake area during the second event was examined using the chi-square statistic and a 2 by 2 contingency table. If the marked-to-unmarked ratios were significantly different ($P < 0.05$), the estimate would need to be stratified by area.

LENGTH COMPOSITION

Length composition of lake trout in Nanushuk and Irgnyivik lakes was estimated as multinomial proportions. Lake trout were collected during Index fishing and hook and line sampling conducted during both sampling events in July. The Kolmogorov-Smirnov test was used to determine if the length distribution of lake trout sampled during the first event was the same as the length distribution of lake trout sampled during the second. Lengths and scale samples were also collected from round whitefish captured by Index fishing during the first event at Irgnyivik Lake.

The proportion of fish in the length (25 mm FL) and age categories were calculated as described by Cochran (1977) where:

$$\hat{p}_j = \frac{n_j}{n} \qquad (3)$$

$$\hat{V}[\hat{p}_j] = \frac{\hat{p}_j(1-\hat{p}_j)}{n-1} \qquad (4)$$

where:

n_j = the number in the sample from group j;

n = the sample size; and,

$\hat{p}_j$ = the estimated fraction of the population that is made up of group j.

For lake trout ≥ 368 mm in Irgnyivik Lake the estimated abundance of each group j in the population is:

$$\hat{N}_j = \hat{p}_j \hat{N} \qquad (5)$$

where:

$\hat{N}_j$ = the estimated number of fish in the population in group j; and

$\hat{N}$ = the estimated population.

The variance of $\hat{N}_j$ is approximated by the delta method (Seber 1982):

$$\hat{V}[\hat{N}_j] = \hat{V}[\hat{p}_j]\hat{N}^2 + \hat{V}[\hat{N}]\hat{p}_j^2. \qquad (6)$$

Size selectivity of the three gill net mesh sizes during the July sampling was investigated by examination of plots of the cumulative distribution of lengths for each mesh size. The hypothesis of equal probability of capture for fish of all sizes with each mesh size was tested by using a K-Sample Andersen-Darling Test (Scholz and Stephens 1987).

CPUE INDEX NETTING

The CPUE was calculated for lake trout captured in Nanushuk and Irgnyivik lakes. The length of time each gillnet was fished was recorded and totaled in hours. The total number of lake trout caught was then divided by the total amount of time gillnets were fished. The catch per unit effort is then the number of lake trout caught per net hour.

LENGTH AT AGE

Unbaited fyke traps were set in Sevenmile Lake to capture yearling lake trout during July and August of 1995. Two distinct size distributions of juvenile fish were captured and age 0 was assigned to the smaller of the two groups and age 1 to the larger.

Scales and lengths of round whitefish collected at Irgnyivik Lake by Index fishing during the first sampling event were used to calculate mean length-at-age.

Estimates of mean length-at-age and mean weight-at-age were generated with standard normal procedures. Simple averages and average squared deviations from the means were used to calculate means and variances of the means:

$$\bar{x}_k = \frac{\sum_{i=1}^{n_k} x_{ik}}{n_k} \tag{7}$$

$$V[\bar{x}_k] = \frac{\sum_{i=1}^{n_k} (x_{ik} - \bar{x}_k)^2}{(n_k - 1)} \tag{8}$$

where:

x_{ik} = length of the i^{th} fish of age k;

$\bar{x}_k$ = the estimated mean length of fish in age k; and,

n_k = the sample size of age k.

AGE VALIDATION

Lake trout of known age will be used to determine if ages estimated from otoliths, opercular bones, and scales represent the true ages of these fish. During June of 1991, a total of 52,900 young of the year lake trout were released into 10 lakes in the Tanana River drainage. These lake trout came from eggs taken in September 1990 from Paxson Lake and reared in Clear Hatchery. Lake trout stocked in the four lakes which were previously stocked were marked with an adipose fin clip to identify them as members of the 1991 group. Ages will be determined at the end of the five year sampling program.

RESULTS

ABUNDANCE ESTIMATION

Low numbers of fish marked in 1995 were recaptured in 1995, likely due to high water temperatures during the second event. Thus, no estimates of abundance pertaining to 1995 were obtained for Irgnyivik and Nanushuk lakes. A sufficient number of fish marked in 1994 at Irgnyivik Lake were recaptured in 1995, and an abundance estimate, as described below, was generated. The length of the smallest lake trout recaptured in 1995 was 370 mm. This fish was 368 mm at the time of marking in 1994. Lake trout < 368 mm captured during the marking event were culled from the sample, as were lake trout < 370 mm captured during the recapture event. The estimate therefore pertains to the abundance of lake trout (≥ 368 mm) in Irgnyivik Lake at the time of marking in 1994.

For fish ≥ 368 mm, there was no significant difference between the lengths of lake trout marked during the first event and lake trout examined during the second event (D = 0.16, P = 0.32). There was no significant difference between length of lake trout marked during the first event and marked lake trout recaptured during the second event (D = 0.38, P = 0.18). According to the criteria followed to detect bias due to unequal catchability by length, stratification by length was not necessary for the abundance estimate (Appendix B1). There was no significant difference in marked-to-unmarked ratios between the two lake areas ($\chi^2 = 0.44$, P = 0.51), therefore, stratification by area was not necessary for the abundance estimate.

Fifty-eight lake trout (≥ 368 mm) were marked in 1994. Of these, ten were recaptured during 1995 of 91 lake trout (≥ 370 mm) examined. The abundance of lake trout (≥ 368 mm) in Irgnyivik Lake in July 1994 was estimated at 492 (SE = 121). Estimated density was 5.7 fish per ha (2.3 fish/acre).

LENGTH AND AGE COMPOSITION

Length composition samples were taken from all unique lake trout captured during both events in 1995 for Irgnyivik and Nanushuk lakes. There was no significant difference between lengths of lake trout captured during the first event and lake trout captured during the second event in Irgnyivik Lake (D = 0.10, P = 0.95) and Nanushuk Lake (D = 0.14, P = 0.13). This indicates that size selectivity did not occur during either sampling event and lengths from both events were pooled to estimate length composition of the 1995 sample.

Irgnyivik Lake

The largest proportion of lake trout captured was in the 400 - 425 mm length category (P = 0.29, SE = 0.027) (Figure 3, Appendix C1). Lake trout ranged in length from 191 - 743 mm. Seventy-one percent of the lake trout captured were between 351 - 425 mm. Ages of 21 lake trout mortalities were determined from examination of otoliths. Ages ranged from 6 - 22 years. Length-at-age of lake trout mortalities from Irgnyivik Lake are graphically portrayed in Appendix C2. Length and age composition of round whitefish captured by Index fishing is reported in Appendices C3 and C4.

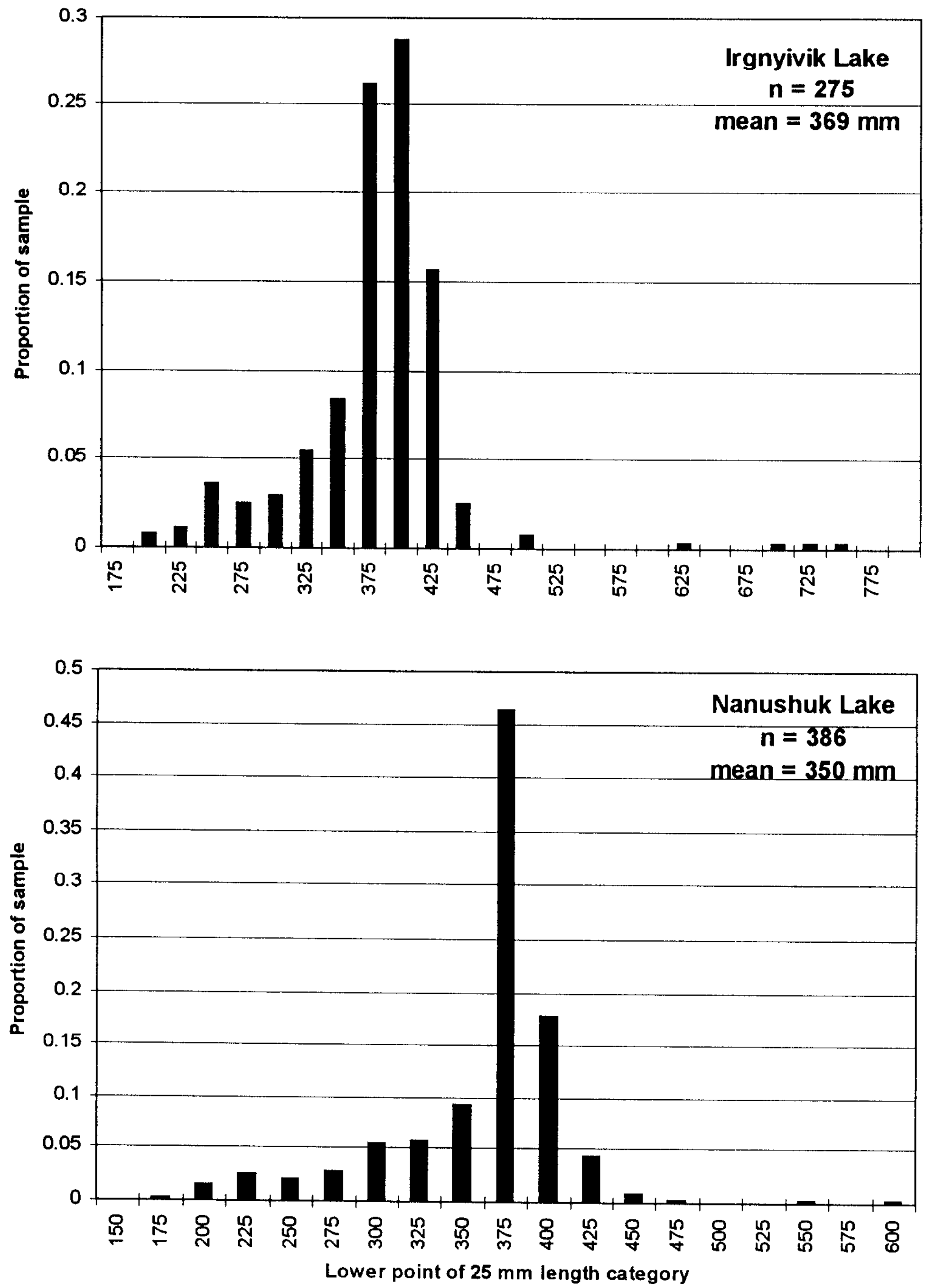

Figure 3.-Length composition of lake trout examined from Irgnyivik Lake during sampling in 1994-95 and Nanushuk Lake during sampling in 1995.

Population length composition was estimated for lake trout ≥ 368 mm in 25 mm length categories (Figure 4, Appendix C5). The largest proportion of lake trout captured was in the 400 - 425 mm length category (P = 0.46, SE = 0.038). Size selectivity was not found in examination of the length distribution between events and lengths from lake trout captured during both events (1994 and 1995) were used to calculate length composition of lake trout ≥ 368 mm.

Nanushuk Lake

The largest proportion of lake trout captured was in the 375 - 400 mm length category (P = 0.46, SE = 0.025) (Figure 3, Appendix C6). Lake trout ranged in length from 169 - 590 mm. Ages of 25 lake trout mortalities were determined from examination of otoliths. Ages ranged from 5 to 30 years. Length-at-age of lake trout mortalities from Nanushuk Lake are graphically portrayed in Appendix C2.

Temperature profiles of Irgnyivik and Nanushuk lakes are found in Appendix D1.

CPUE Index Netting

Irgnyivik Lake

Index fishing was conducted between July 7 - 9 and July 15 - 18 during which 111 net sets were made, averaging 0.48 h in length (Table 1). A total of 114 lake trout were caught by Index fishing for a CPUE of 2.15 fish/net h. The CPUE of round whitefish caught by Index fishing was 8.25 fish/net h.

Nanushuk Lake

Index fishing was conducted between July 11 - 14 and July 19 - 22 during which 123 net sets were made, averaging 0.42 h in length (Table 1). A total of 301 lake trout were caught by Index fishing for a CPUE of 5.86 fish/net h.

Size selectivity of gillnets

Length distributions of lake trout captured by three different mesh sizes were examined by lake and both lakes combined. A total of 118 lake trout were caught by all gillnets at Irgnyivik Lake, 28 by 19 mm (0.75 in), 44 by 25 mm (1.0 in), and 46 by 32 mm (1.25 in). There was a significant difference in length distributions of lake trout by mesh size (D = 9.88, P < 0.01). By pairwise comparison, there was no difference in length distributions of lake trout caught in the 25 mm and 32 mm nets (D = 0.12, P = 0.91). Length distributions from 19 mm and 25 mm nets were different (D = 0.48, P < 0.01), as were length distributions from 19 mm and 32 mm nets (D = 0.51, P < 0.01).

A total of 300 lake trout were caught by all gillnets at Nanushuk Lake, 59 by 19 mm, 103 by 25 mm, and 138 by 32 mm. There was a significant difference in length distributions of lake trout by mesh size (D = 17.55, P < 0.01). By pairwise comparison, length distributions from 19 mm and 25 mm nets were different (D = 0.33, P < 0.01), as were length distributions from 19 mm and 32 mm nets (D = 0.39, P < 0.01) and from 25 mm and 32 mm nets (D = 0.23, P < 0.01). Length distributions by gear type for Irgnyivik and Nanushuk lakes are found in Appendices E1 and E2.

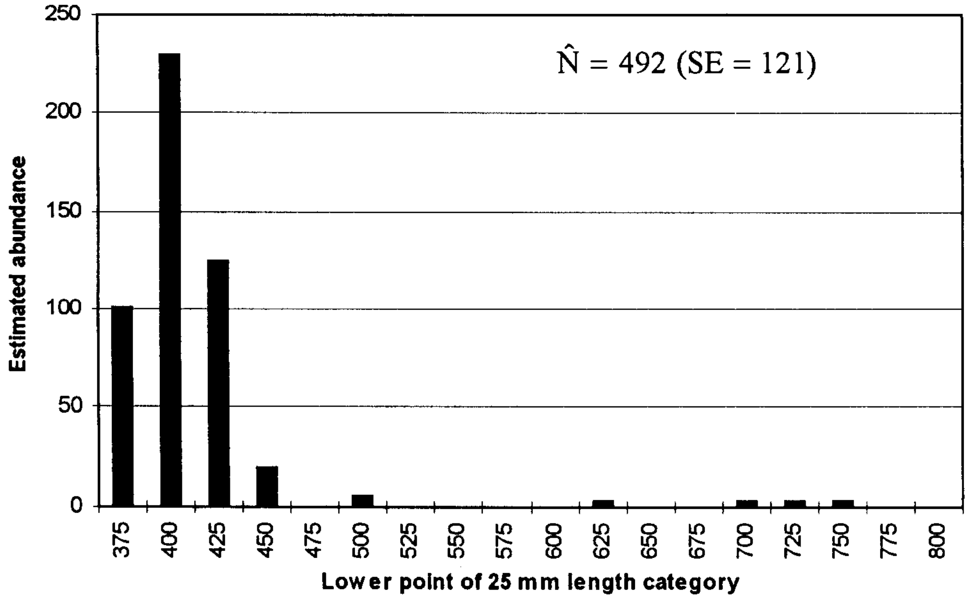

Figure 4.-Estimated length composition of population ≥ 368 mm from Irgnyivik Lake in 1994.

Table 1.-Catch per unit effort from Index fishing in Nanushuk and Irgnyivik lakes in 1995.

Lake		Catch by Species		Sets	Effort (net hour)	
		Lake Trout	Round Whitefish			
Nanushuk Lake						
Event 1						
	CPUE	6.14			Mean	0.45
	Total	166	0	60	Total	27.02
Event 2						
	CPUE	5.55			Mean	0.39
	Total	135	0	63	Total	24.33
Both events						
	CPUE	5.86			Mean	0.42
	Total	301	0	123	Total	51.35
Irgnyivik Lake						
Event 1						
	CPUE	2.24	7.20		Mean	0.59
	Total	67	215	51	Total	29.85
Event 2						
	CPUE	2.03	9.61		Mean	0.39
	Total	47	222	60	Total	23.10
Both events						
	CPUE	2.15	8.25		Mean	0.48
	Total	114	437	111	Total	52.95

When data from both lakes were pooled, a total of 418 lake trout were caught by all nets, 87 by 19 mm bar mesh, 147 by 25 mm, and 184 by 32 mm (Figure 5). There was a significant difference in length distributions of lake trout by mesh size ($D = 24.27$, $P < 0.01$). By pairwise comparison, length distributions from 19 mm and 25 mm nets were different ($D = 0.37$, $P < 0.01$), as were length distributions from 19 mm and 32 mm nets ($D = 0.43$, $P < 0.01$) and from 25 mm and 32 mm nets ($D = 0.17$, $P = 0.02$).

LENGTH AT AGE

Sixty-four juvenile lake trout were collected from Sevenmile Lake during July and August. Examination of the length distribution indicated 50 lake trout of age 0 and 14 lake trout of age 1. Mean length of age 0 fish was 64 mm and age 1 was 147 mm (Table 2). Mean weight of age 0 and age 1 lake trout was 2.7 g and 25.0 g, respectively.

Mean length at age was calculated for round whitefish captured during Index fishing at Irgnyivik Lake (Appendix C4).

AGE VALIDATION

A sample of 62 lake trout were captured from six of the 11 stocked lakes during July and August. The number and location of lake trout collected from 1992-95 is reported in Appendix F1. All age structure samples and data files (see Appendix G1) are currently archived in the Fairbanks office and the final archive location will be at RTS in Anchorage.

SEVENMILE LAKE EGG TAKE

The egg take at Sevenmile Lake was conducted September 11-14, 1995. A total of 322 lake trout were captured by gillnet. Sex composition was 199 males and 123 female. An estimated 46,600 eggs were sent to Clear Hatchery and an additional 16,500 eggs were planted in Donnely Lake.

Collecting depth information such that bathymetric maps of Nanushuk and Irgnyivik lakes could be produced was deferred to 1996.

DISCUSSION

ABUNDANCE ESTIMATION

The abundance estimate of 492 lake trout ≥ 368 mm in Irgnyivik Lake was the best estimate for the data available. Due to unusually warm water temperatures, lake trout movements were likely reduced during sampling in 1995. This prevented an inseason estimate of abundance from being calculated. Two fish marked in 1995 were recaptured at Irgnyivik Lake, but only one third of the desired sample size was marked and examined. Burr (1995) report catches of 118 lake trout in 32 net sets (3.7 fish/net) during July 12 - 15, 1994. In comparison, 114 lake trout were captured in 111 net sets (1.0 fish/net) during July 7 - 9 and July 15 - 18, 1995. Surface water temperatures in 1995 were already 14°C on July 8 and peaked at 18°C on July 14, whereas surface water temperatures did not exceed 13.5°C during sampling in 1994. At least one third of Irgnyivik Lake is less than 5 m in depth and the water temperature was 15°C or higher down to 6 m in depth on July 15 (see Appendix D1). Index fishing protocol (Lester et al. 1991) states that sampling should occur before water temperature exceeds 13.0°C, unfortunately, the

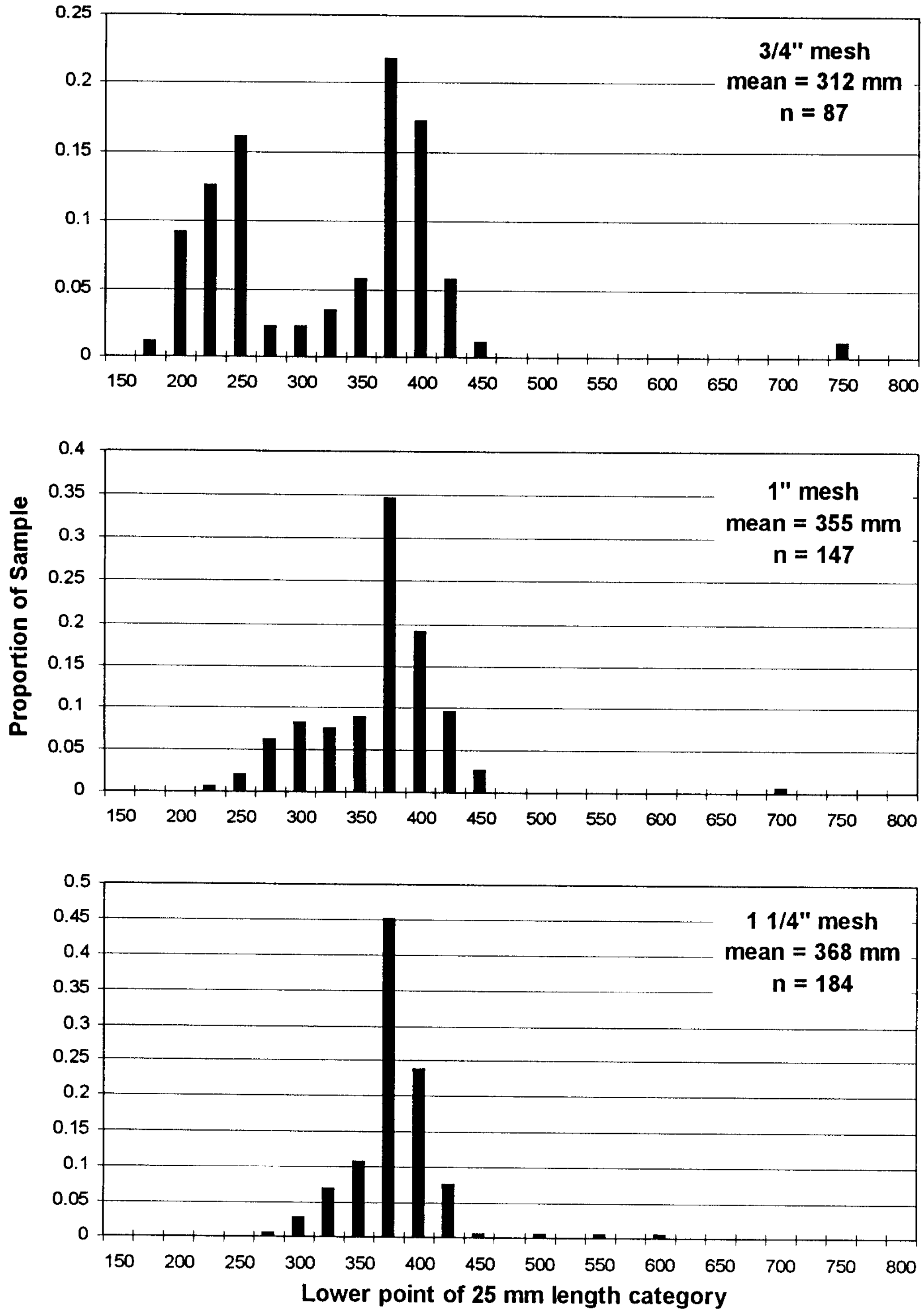

Figure 5.-Length frequencies of lake trout captured by gill nets of three mesh sizes during Index fishing in 1995 at Irgnyivik and Nanushuk lakes.

Table 2.-Mean length and weight of lake trout from Sevenmile Lake collected during July and August, 1995.

Age	Mean Length (mm)	Variance	n
0	63.4	52.4	50
1	147.1	121.6	14

Age	Mean Weight (g)	Variance	n
0	2.68	0.49	46
1	24.98	45.97	11

logistics involved with sampling remote lakes can not always adjust for unusual climate conditions.

Another possible factor reducing the success of estimating in season abundance of Irgnyivik and Nanushuk lakes may have been the short hiatus between sampling events. Burr (1994) conducted an inseason abundance estimate of lake trout at Sevenmile Lake with only three days hiatus between mark and recapture events. In that experiment, 358 lake trout were marked in three days, but it took 10 days to examine 107 lake trout (marking took place when fish were congregated for spawning and recapture after fish had dispersed post-spawning). In Nanushuk Lake, the target numbers of lake trout marked and examined were dictated prior to sampling, but only one marked fish was recaptured. This could indicate mortality due to marking, that marked fish need a longer hiatus to mix with the unmarked fish, or that the population is extremely abundant. The latter possibility can be discounted based on lake size, angler reports, and prior sampling. The fact that 10 lake trout marked in 1994 in Irgnyivik Lake were recaptured in 1995 would suggest that a larger mixing time is required.

Future sampling at Irgnyivik and Nanushuk lakes should allow a longer hiatus between sampling events. At Irgnyivik Lake an inseason estimate may be difficult due to unacceptably high sampling mortalities, induced by high surface water temperatures in summer. It may be necessary to conduct sampling over two consecutive years. Nanushuk Lake is at a higher elevation, has greater average depth, and does not seem to have the temperature problem that occurs in Irgnyivik Lake.

INDEX FISHING

The CPUE of Index fishing in 1995 was similar to results at Irgnyivik and Nanushuk lakes in 1994. Burr (1995) reported CPUE of 2.90 and 7.38 fish per gillnet hour for Irgnyivik and Nanushuk lakes, respectively. In comparison, CPUE was 2.24 and 2.15 at Irgnyivik Lake and 6.14 and 5.86 at Nanushuk Lake for the marking event and both events combined, respectively. Since harvest is virtually non-existent in these lakes, one would expect CPUE to remain the same if it is indicative of lake trout density or abundance.

Lake trout abundance in Galbraith Lake in June 1994 was estimated at 236 lake trout > 499 mm. Estimated density was 0.6 fish/ha (0.2 fish/acre) and CPUE of 0.21(Burr 1995). In contrast, Irgnyivik Lake had a density of 5.7 fish/ha and CPUE of 2.90 in 1994. Currently, these are the only corresponding data sets of abundance, CPUE and density. The abundance and density of lake trout in Nanushuk Lake would be expected to be greater than Irgnyivik Lake based upon the 1994 and 1995 estimates of CPUE. Burr (1992) summarized abundance and density estimates for seven interior Alaska lakes, the majority of which were sampled using gillnets in combination with other gear types. Six of these lakes ranged in size from 33 ha to 318 ha, the other was 1,575 ha. Densities of these lakes ranged from 1.4 to 50.5 fish/ha and abundance from 211 to 5,066 lake trout. CPUE in these lakes would be expected to be higher in the lakes with greater lake trout density and abundance, although Index fishing may not be representative of density and abundance in large lakes or lakes with large amounts of structure (i.e. islands and reefs). Further examination of lakes of varying size, structure, and abundance/density is necessary to determine whether Index fishing can be used in Alaska.

Due to the time constraints of conducting two mark-recapture experiments using Index fishing before water temperatures exceed 13°C, sampling two lakes north of the Brooks Range may not be feasible. Four days for each event in 1995 was not adequate to achieve the desired samples necessary for an abundance estimate. In addition, a longer hiatus between events would likely increase the number of marks recaptured. A better approach would be to conduct a marking event at a lake that is ice free earlier than lakes north of the Brooks Range, and the recapture event during the hiatus between events at the north slope lake. Since the majority of lake trout lakes south of the Brooks Range have previous abundance estimates, selection would be based upon known abundance and the hypothesis of greater or less CPUE and/or greater or less abundance/density could be tested.

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LITERATURE CITED

Bernard, D. R., and P. A. Hansen. 1992. Mark-recapture experiments to estimate abundance of fish. Alaska Department of Fish and Game, Special Publication No. 92-4, Anchorage.

Burr, J. M. 1992. A summary of abundance and density estimates for selected lake trout populations in the Alaska Range, and an examination of trends in yield. Alaska Department of Fish and Game, Fisheries Data Series No. 92-1, Anchorage.

Burr, J. M. 1994. Evaluation of introduced lake trout in the Tanana drainage and population abundance of lake trout in Sevenmile Lake. Alaska Department of Fish and Game, Fisheries Data Series No. 94-18, Anchorage.

Burr, J. M. 1995. Lake trout studies in the AYK region, and burbot index of abundance in Galbraith Lake, 1994. Alaska Department of Fish and Game, Fisheries Data Series No. 95-30, Anchorage.

Cochran, W.C. 1977. Sampling techniques, third edition. John Wiley and Sons, New York.

Lester, N. P., M. M. Petzold, W. I. Dunlop, B. P. Monroe, S. D. Orsatti, T. Schaner, and D. R. Wood. 1991. Sampling Ontario lakes: issues and standards. Lake trout Synthesis, Ontario Ministry Natural Resources, Toronto. 117 p.

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report (1986). Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report (1987). Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report (1988). Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

LITERATURE CITED (Continued)

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series Number 91-58, Anchorage.

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. 2nd ed. Charles Griffin & Co, Ltd. London.

Zar, J. H. 1984. Biostatistical Analysis. 2nd edition. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

APPENDIX A.

Appendix A1.-Index fishing

Fishing Gear

Gear used was a 46 m (150 ft) gillnet gang, comprised of three 15.2 m (50 ft) panels. All three panels were of the same mesh size, either 38 mm (1.5 in), 51 mm (2 in), or 64 mm (2.5 in) stretched mesh. The panels were 2.4 m (8 ft) tall. The mesh was made of monofilament and dyed green.

Sampling Methods

The sampling occurred during daylight hours after ice melt and before surface temperature reached 13° C at Nanushuk Lake. Surface water temperature was above 13° C during sampling at Irgnyivik Lake and sampling effort was conducted prior to 1200 and after 1800 to reduce mortality. Sampling began at Irgnyivik Lake for four days and then Nanushuk Lake was sampled for four days (marking event). After the first sampling period at Nanushuk Lake, sampling was repeated at Irgnyivik Lake for four days and then Nanushuk Lake for four days (recapture event). Randomly selected sites were sampled for approximately 30 min each day, depending on number of fish captured and water temperature (set time: 16 - 50 min (Irgnyivik); 15 - 40 min (Nanushuk). Eighteen sites per day were sampled and the following procedure was used for selecting sample sites:

1. the shoreline was partitioned into 120 equal length sections;
2. for each sample day, 18 sections were randomly selected without replacement;
3. the optimum survey path (least distance) for visiting the 18 sections (sampled on one day) was determined and one gillnet gang was set in each section;
4. gangs of different mesh were set in sequence (i.e. 38 mm at site 1, 51 mm at site 2, 64 mm at site 3, 38 mm at site 4, 51 mm at site 5, etc.) so that different mesh sizes were distributed throughout the lake and six sites were sampled by each mesh per day.

Gangs were set perpendicular to the shoreline starting at a depth of 2 m and extending no deeper than 17 m. The starting location was random within the section sampled, with the exception that river mouths, debris strewn areas (likely to damage nets) and very steep gradients (> 45 degrees) were avoided.

The nets were left to fish for approximately 30 min and the following data were obtained from each set:

1. total number and weight of fish captured (by species);
2. fork length and round weight from each fish;
3. otolith and sex from dead lake trout; and,
4. record of fin clips and tag numbers.

APPENDIX B

Appendix B1.-Methodologies for alleviating bias due to gear selectivity by means of statistical inference (Bernard and Hansen 1992).

Results of Hypothesis Tests (K-S and χ^2) on Lengths of Fish Marked during First Event and Recaptured during Second Event	Results of Hypothesis Tests (K-S) on Lengths of fish Captured during First Event and during Second Event
Case I:	
"Accept" H_o	"Accept" H_o
There is no size-selectivity during either sampling event.	
Case II:	
"Accept" H_o	Reject H_o
There is no size-selectivity during the second sampling event but there is during the first.	
Case III:	
Reject H_o	"Accept" H_o
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_o	Reject H_o
There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from the second sampling event to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data.

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Also, calculate a single estimate of abundance without stratification.

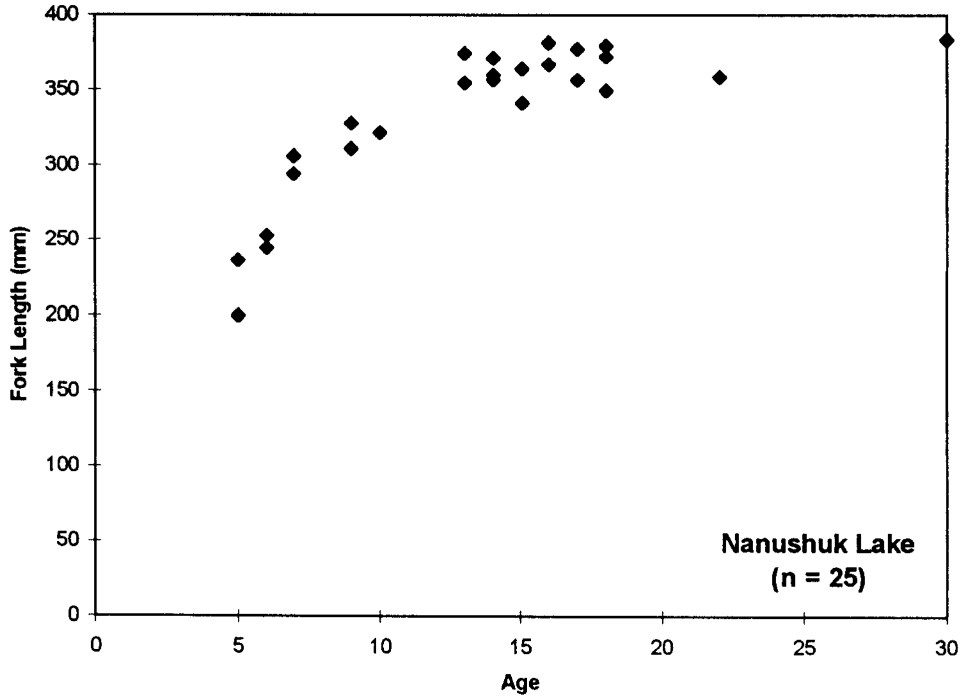
Case IVa: If the stratified and unstratified abundance estimates for the entire population are dissimilar, discard the unstratified estimate. Only use the lengths, ages, and sexes from the second sampling event to estimate proportions in composition, and apply formulae to correct for size bias to data from the second event.

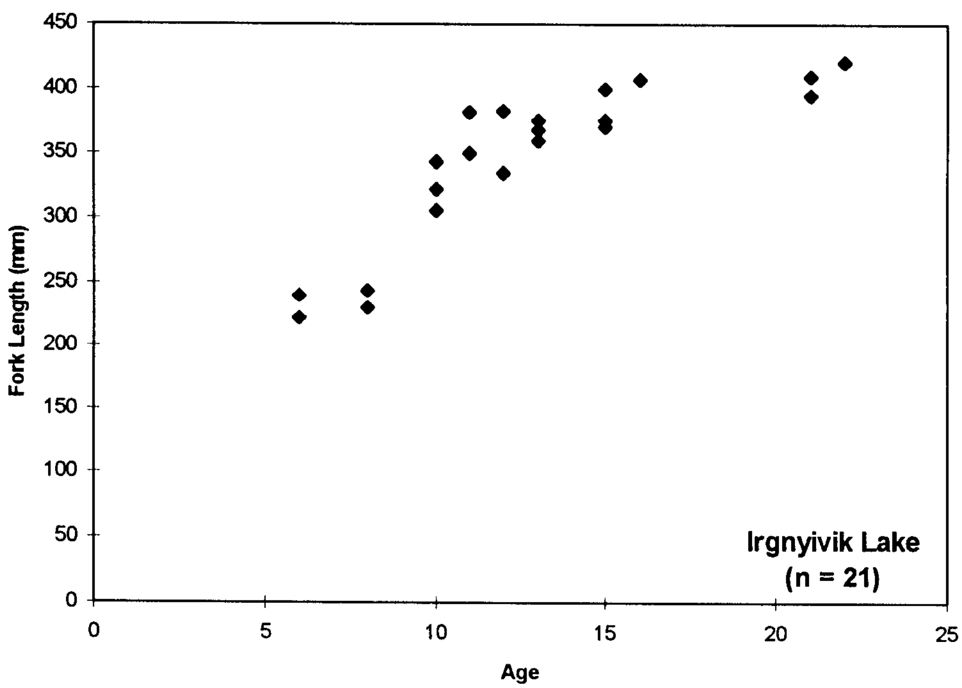
Case IVb: If the stratified and unstratified abundance estimates for the entire population are similar, discard the estimate with the larger variance. Only use the lengths, ages, and sexes from the first sampling event to estimate proportions in compositions, and do not apply formulae to correct for size bias.

APPENDIX C

Appendix C1.-Length composition of lake trout examined during 1994-95 sampling events at Irgnyivik Lake.

Lower of 25 mm Length Group	Frequency	$\hat{p}$	$V(\hat{p})$	SE
175	0	0	0	0
200	2	0.01	2.63E-05	0.005
225	3	0.01	3.94E-05	0.006
250	10	0.04	1.28E-04	0.011
275	7	0.03	9.05E-05	0.010
300	8	0.03	1.03E-04	0.010
325	15	0.05	1.88E-04	0.014
350	23	0.08	2.80E-04	0.017
375	72	0.26	7.05E-04	0.027
400	79	0.29	7.47E-04	0.027
425	43	0.16	4.81E-04	0.022
450	7	0.03	9.05E-05	0.010
475	0	0	0	0
500	2	0.01	2.63E-05	0.005
525	0	0	0	0
550	0	0	0	0
575	0	0	0	0
600	0	0	0	0
625	1	0.00	1.32E-05	0.004
650	0	0	0	0
675	0	0	0	0
700	1	0.00	1.32E-05	0.004
725	1	0.00	1.32E-05	0.004
750	1	0.00	1.32E-05	0.004
775	0	0	0	0
800	0	0	0	0
Total	275			





Appendix C2.-Length-at-age of lake trout mortalities during sampling in 1995 from Irgnyivik and Nanushuk lakes.

Appendix C3.-Length composition of round whitefish examined in July 1995 from Irgnyivik Lake.

Lower of 25 mm Length Group	Frequency	$\hat{p}$	$V(\hat{p})$	SE
200	0	0	0	0
225	3	0.01	6.49E-05	0.008
250	20	0.09	3.98E-04	0.020
275	26	0.12	5.01E-04	0.022
300	85	0.40	1.12E-03	0.034
325	58	0.27	9.28E-04	0.030
350	20	0.09	3.98E-04	0.020
375	2	0.01	4.35E-05	0.007
400	0	0	0	0
	214			

Appendix C4.-Age composition of round whitefish examined in 1995 from Irgnyivik Lake.

Age	Frequency	$\hat{p}$	$V(\hat{p})$	SE	Mean Length (mm)
4	1	0.01	2.77E-05	0.005	212
5	9	0.05	2.39E-04	0.015	232
6	12	0.06	3.13E-04	0.018	251
7	35	0.18	7.95E-04	0.028	280
8	72	0.38	1.25E-03	0.035	300
9	51	0.27	1.04E-03	0.032	303
10	9	0.05	2.39E-04	0.015	321
11	1	0.01	2.77E-05	0.005	337
	190				

Appendix C5.-Proportion and abundance of lake trout ≥ 368 mm by length category in Irgnyivik Lake, 1994 and 1995.

Lower of 25 mm Length Group	Frequency	$\hat{p}$	$V(\hat{p})$	SE	$\hat{N}$	$V(\hat{N})$	SE
375	35	0.21	0.0010	0.0311	101	851	29
400	79	0.46	0.0015	0.0384	229	3,496	59
425	43	0.25	0.0011	0.0334	125	1,201	35
450	7	0.04	0.0002	0.0153	20	81	9
475	0	0.00	0.0000	0.0000	0	0	0
500	2	0.01	0.0001	0.0083	6	19	4
525	0	0.00	0.0000	0.0000	0	0	0
550	0	0.00	0.0000	0.0000	0	0	0
575	0	0.00	0.0000	0.0000	0	0	0
600	0	0.00	0.0000	0.0000	0	0	0
625	1	0.01	0.0000	0.0059	3	9	3
650	0	0.00	0.0000	0.0000	0	0	0
675	0	0.00	0.0000	0.0000	0	0	0
700	1	0.01	0.0000	0.0059	3	9	3
725	1	0.01	0.0000	0.0059	3	9	3
750	1	0.01	0.0000	0.0059	3	9	3
775	0	0.00	0.0000	0.0000	0	0	0
800	0	0.00	0.0000	0.0000	0	0	0
	170				492		

Appendix C6.-Length composition of lake trout examined during sampling events in July 1995 at Nanushuk Lake.

Lower of 25 mm Length Group	Frequency	$\hat{p}$	$V(\hat{p})$	SE
150	0	0	0	0
175	1	0.00	6.71E-06	0.003
200	6	0.02	3.97E-05	0.006
225	10	0.03	6.55E-05	0.008
250	8	0.02	5.27E-05	0.007
275	11	0.03	7.19E-05	0.008
300	21	0.05	1.34E-04	0.012
325	22	0.06	1.40E-04	0.012
350	36	0.09	2.20E-04	0.015
375	179	0.46	6.46E-04	0.025
400	69	0.18	3.81E-04	0.020
425	17	0.04	1.09E-04	0.010
450	3	0.01	2.00E-05	0.004
475	1	0.00	6.71E-06	0.003
500	0	0	0	0
525	0	0	0	0
550	1	0.00	6.71E-06	0.003
575	0	0	0	0
600	1	0.00	6.71E-06	0.003
Total	386			

APPENDIX D

Appendix D1.-Water temperature (°C) from Nanushuk and Irgnyivik lakes, July 14 - 15, 1995.

Depth (m)	Nanushuk Lake (17.8 m depth)	Irgnyivik Lake (17 m depth)
0	13.0	17.5
1.5	13.0	17.5
3	12.5	17.5
4.5	11.0	16.5
6	7.5	15
7.5	7.0	11.5
9	6.5	8.0
10.5	6.5	6.5
12	-[a]	6.0
13.5	-	5.5
15	-	5.0
16.5	-	5.0

[a] temperatures below 10.5 m for Nanushuk Lake were not taken due to equipment malfunction.

APPENDIX E

Appendix E1.-Lengths of lake trout captured by gear type from Irgnyivik Lake, 1995.

Upper of 25 mm Length Group	3/4" Gillnet		1" Gillnet		1 1/4" Gillnet		All Gillnets		Sport Gear		Hoop Trap		All Gear	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
200	2	7	0	0	0	0	2	2	0	0	0	0	2	1
225	3	11	0	0	0	0	3	3	0	0	0	0	3	2
250	9	32	1	2	0	0	10	8	0	0	0	0	10	7
275	0	0	2	5	1	2	3	3	0	0	0	0	3	2
300	1	4	0	0	2	4	3	3	1	3	0	0	4	3
325	0	0	4	9	2	4	6	5	1	3	0	0	7	5
350	1	4	2	5	7	15	10	8	2	6	0	0	12	8
375	2	7	9	20	8	17	19	16	10	31	0	0	29	19
400	6	21	12	27	15	33	33	28	14	44	0	0	47	31
425	3	11	10	23	9	20	22	19	3	9	1	100	26	17
450	0	0	3	7	1	2	4	3	0	0	0	0	4	3
475	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	1	2	1	1	1	3	0	0	2	1
525 - 675	0	0	0	0	0	0	0	0	0	0	0	0	0	0
700	0	0	1	2	0	0	1	1	0	0	0	0	1	1
725	0	0	0	0	0	0	0	0	0	0	0	0	0	0
750	1	4	0	0	0	0	1	1	0	0	0	0	1	1
Total	28		44		46		118		32		1		151	
Mean	316		381		375		363		377		406		323	
SE	116		67		42		78		31				62	
Min	191		240		265		191		300		406		191	
Max	743		700		500		743		485		406		743	

Appendix E2.-Lengths of lake trout captured by gear type from Nanushuk Lake, 1995.

Upper of 25 mm Length Group	3/4" Gillnet		1" Gillnet		1 1/4" Gillnet		All Gillnets		Sport Gear		All Gear	
	n	%	n	%	n	%	n	%	n	%	n	%
150	0	0	0	0	0	0	0	0	0	0	0	0
175	1	2	0	0	0	0	1	0	0	0	1	0
200	6	10	0	0	0	0	6	2	0	0	6	2
225	8	14	1	1	0	0	9	3	1	1	10	3
250	5	8	2	2	0	0	7	2	1	1	8	2
275	2	3	7	7	0	0	9	3	2	2	11	3
300	1	2	12	12	3	2	16	5	5	6	21	5
325	3	5	7	7	11	8	21	7	1	1	22	6
350	4	7	11	11	13	9	28	9	8	9	36	9
375	17	29	42	41	75	54	134	45	46	53	180	47
400	9	15	16	16	29	21	54	18	15	17	69	18
425	2	3	4	4	5	4	11	4	6	7	17	4
450	1	2	1	1	0	0	2	1	1	1	3	1
475	0	0	0	0	0	0	0	0	1	1	1	0
500	0	0	0	0	0	0	0	0	0	0	0	0
525	0	0	0	0	0	0	0	0	0	0	0	0
550	0	0	0	0	1	1	1	0	0	0	1	0
575	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	1	1	1	0	0	0	1	0
Total	59		103		138		300		87		387	
Mean	310		344		366		347		361		350	
SE	77		45		34		53		38		50	
Min	169		215		293		169		221		169	
Max	445		448		590		590		460		590	

APPENDIX F

Appendix F1.-Lake Trout Age Validation Study

Stocked lake trout have provided fish of known age from which validation of age determination is being investigated. Lakes which contain lake trout of known age are listed in the following table. The age of these fish is known because either the water body was stocked only once or finclips were used to differentiate between stocking cohorts. Starting in 1992, lake trout were sampled and the age structures archived from the 1991 stocking cohort. It is estimated that less than 100 samples will be needed annually from this cohort. These data will be collected for at least five consecutive years after which analysis and evaluation of these data will be conducted.

			Number Sampled			
Lake	Date Stocked	Fin Clip	1992	1993	1994	1995
Bullwinkle	1989	None	1	0	0	0
Chet	1991	Adipose	0	0	9	1
Coal Mine #5	1991	Adipose	10	0	9	7
Craig	1991	None	5	0	0	1
Fourmile	1991	None	0	0	0	0
Fourteenmile	1991	None	25	14	0	36
Nickel	1991	Adipose	10	1	8	9
North Twin	1991	None	18	6	0	0
Paul's Pond	1991	Adipose	4	0	0	0
Rapids	1991	None	7	16	10	8
Summit	1989	None	2	0	0	0
Total			82	37	36	62

To determine if the ages obtained from otoliths, opercular bones, and scales are true ages, the proportion (and variance) of lake trout whose estimated age reflects the true age will be calculated for each structure as:

$$\hat{p} = \frac{a}{n}$$

$$V[\hat{p}] = \frac{\hat{p}(1-\hat{p})}{n-1}$$

-continued-

where:

a = the number of fish whose assigned ages agree with the true age; and,

n = total number of known age structures in the sample.

A one-tailed Z test (Zar 1984) will be performed to determine if the accuracy rate for any one structure is significantly less than 0.90.

H_o: P = 0.90

H_a: P < 0.90.

The test will have the ability to detect a 10% difference with the probabilities of an experimentwise type I error being 0.05 and the probability of a type II error being 0.20.

Contingency table analysis will be used to determine if all structures are equally accurate by testing the hypothesis:

H_o: accuracy is independent of structure

H_a: accuracy is dependent on structure.

To determine if the estimated ages for any of the structures is different, the mean ages determined for each structure will be compared using analysis of variance with structures as fixed effects. Multiple comparisons will be made using Fisher's Least Significant Difference test. The hypothesis tested is:

H_o: μ scales = μ otoliths = μ opercular

H_a: at least one is not equal.

Logistic regression is used to determine if the accuracy in determining the age of lake trout decreases as the true age increases:

H_o: $\beta = 0$

H_a: $\beta < 0$.

APPENDIX G

Appendix G1.-Data files used in the preparation of this report.

Data File	Description	Status
IRGNLT94.XLS	Lake trout biological data, Irgnyivik Lake 1994	Previously submitted
Z0830LA5.XLS	Lake trout biological data, Irgnyivik Lake 1995	Included
95IRGCPU.XLS	Irgnyivik Lake set data; CPUE estimate 1995	Included
Z0880LA5.XLS	Lake trout biological data, Nanushuk Lake 1995	Included
95NANCPU.XLS	Nanushuk Lake set data; CPUE estimate 1995	Included
LTEGG95.XLS	Sevenmile Lake eggtake data, 1995	Included
U9990LA5.DTA	Sevenmile Lake yearling lake trout data; age validation data 1995	Included