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Abundance and Composition of Lake Trout Populations in Fielding (1999) and Island (2000) Lakes, Alaska

by

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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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ABSTRACT

The Sport Fish Division of the Alaska Department of Fish and Game conducted experiments to evaluate the status of populations of lake trout *Salvelinus namaycush* in Fielding Lake (1998-2000) and Island Lake (2000), Alaska. In Fielding Lake, investigators conducted three sampling events to estimate abundance of adult lake trout in Fielding Lake. Originally, the experiment was designed to use a beach seine to capture fish during the fall event in 1998 and 1999, and use hook-and-line in June 1999, providing the three events needed to use a Jolly-Seber model to estimate abundance and survival. The design was modified when differences in size selectivity was detected from exploratory sampling in the fall of 1998, between hook-and-line sampling and beach seining ($D=0.72$; $P<0.01$). As a result, lake trout were captured with a beach seine in September of 1998, 1999, and 2000 to generate a Jolly-Seber estimate of abundance germane to the fall of 1999. The estimate of abundance of adult-male lake trout was 193 fish (SE = 35). The estimate of abundance of lake trout ≥ 550 mm FL, or =22 in (current minimum length limit for harvest in Fielding Lake) was 132 fish (SE = 68) or 69% or the adult population. A length-weight relationship was also developed (weight = $0.0859\ e^{length*0.0057}$) based upon 109 lake trout (18 females and 91 males) sampled during the experiment. From 3 March to 9 September 2000, water temperature was recorded hourly using data loggers at four depths in Fielding Lake. Water temperatures at 1 m averaged 5.9°C, 2.5 m 5.4°C, 5.5 m 4.8°C, and 10 m 4.8°C.

In 2000, an experiment was conducted to estimate the abundance and length composition of lake trout in Island Lake, a small lake near the Dalton Highway. Only fourteen unique fish were handled during this experiment. Based upon a low number of recaptures, estimated abundance is believed to be between 14 and 45 lake trout ≥ 430 mm FL.

Key words: lake trout, *Salvelinus namaycush*, Fielding Lake, Island Lake, abundance, length composition, length/weight relationship, temperature.

INTRODUCTION

FIELDING LAKE

Populations of lake trout in interior Alaska lakes may be susceptible to over harvest because of the low productivity of lakes and slow growth of fish (Burr 1992). In the Tanana River drainage, there are few places to fish for lake trout. Fielding Lake provides anglers an opportunity to catch large lake trout at a location that is accessible by the road system. The sport fishery for lake trout in Fielding Lake is currently managed based on a lake-area model that indicates a guideline harvest of 0.5 kg of lake trout per lake surface hectare per year. This model is commonly used to manage lake trout populations (Burr 1992). Recently, regulations have become increasingly restrictive for the purpose of limiting harvests to help ensure future opportunity.

The sport fishery for lake trout in Fielding Lake occurs mostly during the ice-free season (usually the third week of June through the middle of October), although some effort does occur during the winter months. In 1999, an estimated 279 lake trout were caught by sport anglers in Fielding Lake, of which an estimated 43 were harvested (Table 1). From 1996 through 2000, the average yearly estimated catch of lake trout in Fielding Lake was 262 and the estimated harvest was 35. The estimated average catch from 1981 through 1995 was 399 fish and an estimated average harvest of 174 fish (Table 1). This recent reduction in harvest levels from previous years suggests that the current regulation have been probably effective in reducing harvest of large lake trout, the ethics of anglers has probably changed, and catch-and-release has become more popular. In order to evaluate the effectiveness of the sport fishing regulation for lake trout in Fielding Lake (one fish per day ≥ 22 in), an experiment was designed to estimate abundance and length composition.

Table 1.-Estimates of effort for Fielding Lake and estimates of harvest and catch of lake trout in Fielding Lake, 1981-2000.

Year	Effort	Harvest	Catch
1981 [ab]	1,369	295	-
1982 [ab]	2,764	364	-
1983 [ab]	1,737	294	-
1984 [ab]	871	169	-
1985 [b]	1,023	347	-
1986 [b]	1,682	136	-
1987 [b]	1,023	127	-
1988 [c]	1,728	364	-
1989 [c]	1,664	195	-
1990 [c]	1,255	186	321
1991 [c]	1,572	295	870
1992 [c]	1,910	170	247
1993 [c]	1,827	276	939
1994 [d]	2,129	52	213
1995 [d]	3,735	44	486
1996 [d]	960	42	222
1997 [d]	1,259	55	245
1998 [d]	1,602	19	341
1999 [d]	1,154	43	279
2000 [d]	827	18	221
	Average		
1981-2000	1,597	174	399
1996-2000	1,160	35	262

[a] Set lining or "jug fishing" was permitted.

[b] Data From Mills 1982-1994; Howe et al. 1995, 1996, 2001a, b, c, d; Walker et al. *In prep.*

[c] Ten fish per day, two of which may be greater than 20 in.

[d] Two fish per day with a minimum size limit of 18 in.

[e] One fish per day with a minimum size limit of 22 in.

Lake trout gather in large aggregations during spawning (Burr 1991). Once these aggregations are located, lake trout are easy to capture and sample. In 1990, Burr (1991) implanted ten mature lake trout with radio transmitters which were tracked to identify one spawning site in Fielding Lake. The location was a steep shoal, where the water was shallow enough to visually see groups of 4-20 large fish using spotlights at night (Burr 1991).

Sport fishing for burbot in Fielding Lake has been closed since 1994 to allow the burbot population to recover from overfishing (Parker 2001) but will begin again in April 2001. As a result of the burbot fishery, additional pressure may be directed towards lake trout. Anglers fishing for burbot often use gear similar to what is used for catching lake trout. This renewed opportunity will likely attract additional anglers to Fielding Lake during the winter months.

Use of lake surface area as a predictor for sustainable lake trout yield is currently used to manage lake trout in several Tanana River drainage lakes. According to this model sustainable yield of lake trout is = 0.5 kg per hectare per year (Healy 1978). Fielding Lake has a surface area of 538 hectares. The sustainable yield for Fielding Lake would be 269 kg annually. This method works well for smaller lakes, but may not work as well for lakes of increased size, depth, and availability of desired habitat. To better predict sustainable yield of lake trout, a measure of available habitat, or thermal habitat volume (THV), may be used to predict biomass and production of fish (Marshall 1996). The THV model, developed by Christie and Regier (1988), relates fish harvest to lake thermal provisions. THV is defined for lake trout as the volume of water in a lake that averages between 8^{o} and 12^{o} C over the summer period. Furthermore, THV calculated over a restricted midsummer period can increase the precision of the model and requires less field data (Payne et al. 1990).

ISLAND LAKE

Concerns over increased fishing effort in lakes north of the Brooks Range, due in part to the opening of the Dalton Highway to the general public, led ADF&G to initiate population studies of four lake trout lakes in 1994. Results of these studies prompted the Alaska Department of Fish and Game (ADF&G) to close all lakes along the corridor to harvest of lake trout. No specific information exists on the nature of the lake trout fishery at Island Lake, but visitors to the North Slope via the Dalton Highway have increased 47% since 1994 (P. Tacquard, Bureau of Land Management, Fairbanks, personal communication). This, coupled with increases in harvest of Arctic char and Arctic grayling (*Thymallus arcticus*) within the Dalton Highway corridor in recent years (Mills et. al 1979 – 1994; Howe et. al 1995, 1996, 2001a, b, c, d) suggests that the angling pressure on these road-accessible lakes has increased. The Dalton Highway corridor is described in regulation as a corridor five miles wild on each side of the Dalton Highway (AAC 2001).

In 2000, a mark-recapture experiment was conducted in Island Lake to estimate abundance and length composition of lake trout to examine the effectiveness of current regulations.

OBJECTIVES

FIELDING LAKE

The 1998-2000 Fielding Lake study was designed to estimate the abundance (germane to 1999) and survival (between 1998 and 1999) of mature male lake trout in Fielding Lake through the use of a multi-year mark-recapture experiment.

The objectives for the lake trout project were to:

1. estimate the adult male spawner abundance in 1999 and survival rate from 1998 to 1999 for lake trout in Fielding Lake, such that each estimate is within 50% of the actual value 95% of the time; and,
2. estimate the length composition of mature male lake trout in Fielding Lake such that all proportions are within 10% of the actual value 90% of the time.

In addition, project tasks were to:

1. capture lake trout in the spring of 1998 with hook and line techniques and estimate CPUE;
2. visually enumerate fish on the spawning site at Fielding Lake using high intensity spotlights;
3. weigh lake trout caught in 2000 with a calibrated digital scale; and,
4. measure the temperature profile of the lake in three locations during July and August to determine thermal habitat volume between 8^{o}C and 12^{o}C.

ISLAND LAKE

The research objectives for the Island Lake mark-recapture experiment in 2000 were to:

1. estimate the population abundance of lake trout ≥ 200 mm FL in Island Lake such that the estimate is within 25% of the actual value 90% of the time; and,
2. estimate the length composition of the lake trout population ≥ 200 mm FL in Island Lake such that the estimates of proportions are within 10% of the actual value 95% of the time.

STUDY AREAS

Fielding Lake (63^{o}10' N, 145^{o} 42' W) is geographically isolated from other lakes in the upper drainage of the Delta River. Fielding Lake is accessible to fishermen by a 2 mi graveled road from the Richardson Highway at MP 200.5 (Figure 1). Elevation at Fielding Lake is 906 m and the lake surface area is 538 ha with a maximum depth of 23 m (Figure 2). Several small inlets drain the hillsides around the lake and a single outlet drains northward for approximately 3.5 km into glacially fed Phelan Creek. The lake begins to freeze by the middle of October and breakup of ice usually occurs from 15 June to 1 July.

Fielding Lake has a public campground, boat launch, and several private cabins located along the east shore. In addition to lake trout, Fielding Lake contains Arctic grayling, burbot (*Lota lota*), and round whitefish (*Prosopium cylindraceum*).

Island Lake is located in the Dalton Highway corridor on the North Slope (Figure 3) approximately 475 km north of Fairbanks and 150 km north of Coldfoot. The estimated surface area of the lake is 62 ha and the maximum recorded depth is 14.5 m. The lake is within walking distance of the road (50 m) and is probably oligotrophic. Island Lake has a small, intermittent stream that drains into the much larger Galbraith Lake, but passage of fish is unlikely. The ice typically does not go off Island Lake until the middle of June and ice forms again in the middle of September, allowing a short open-water fishing season. Arctic char, Arctic grayling, round whitefish, and slimy sculpin (*Cottus cognatus*) are other fish species known in Island Lake.

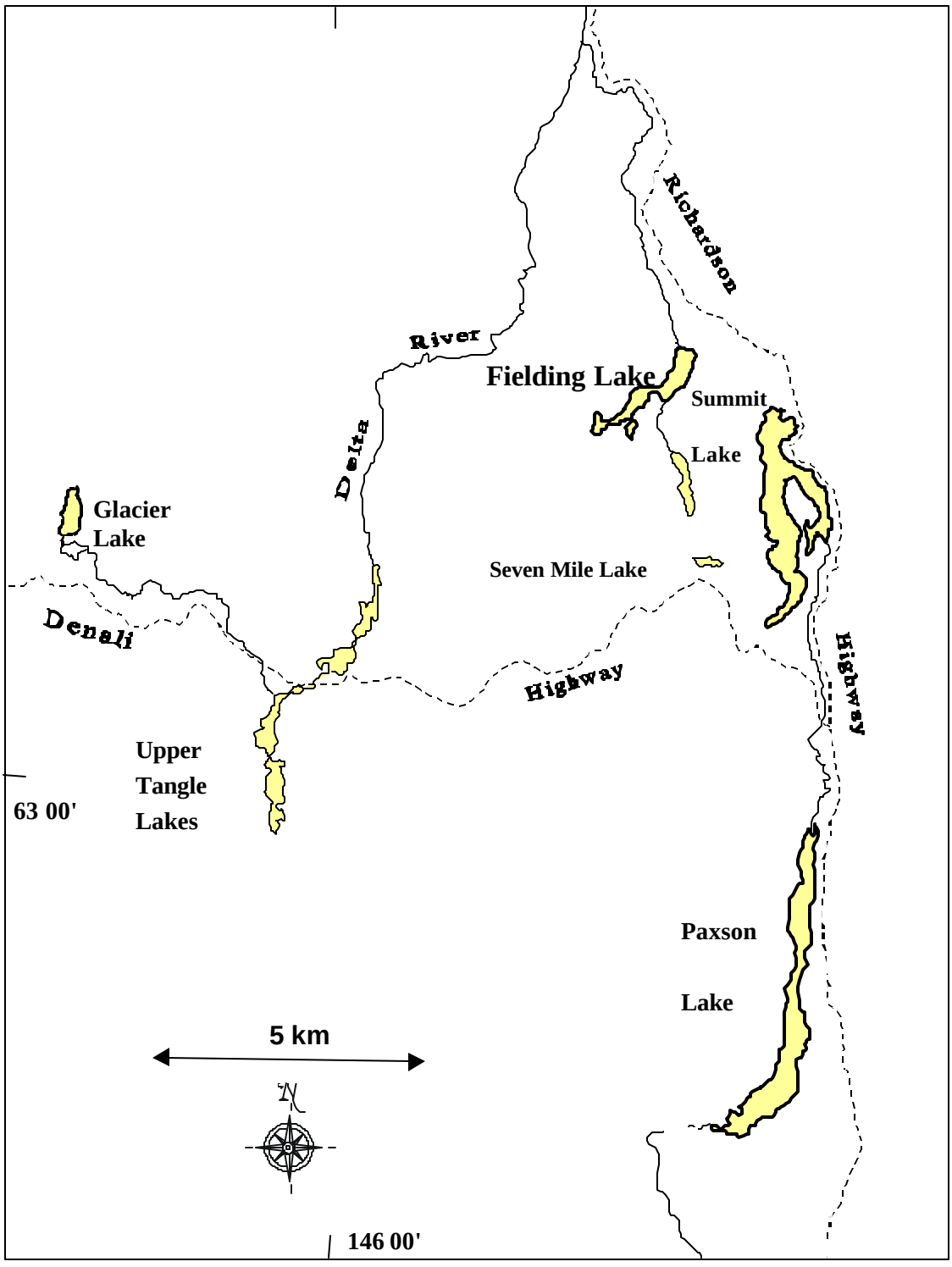

Figure 1.-Location of Fielding Lake.

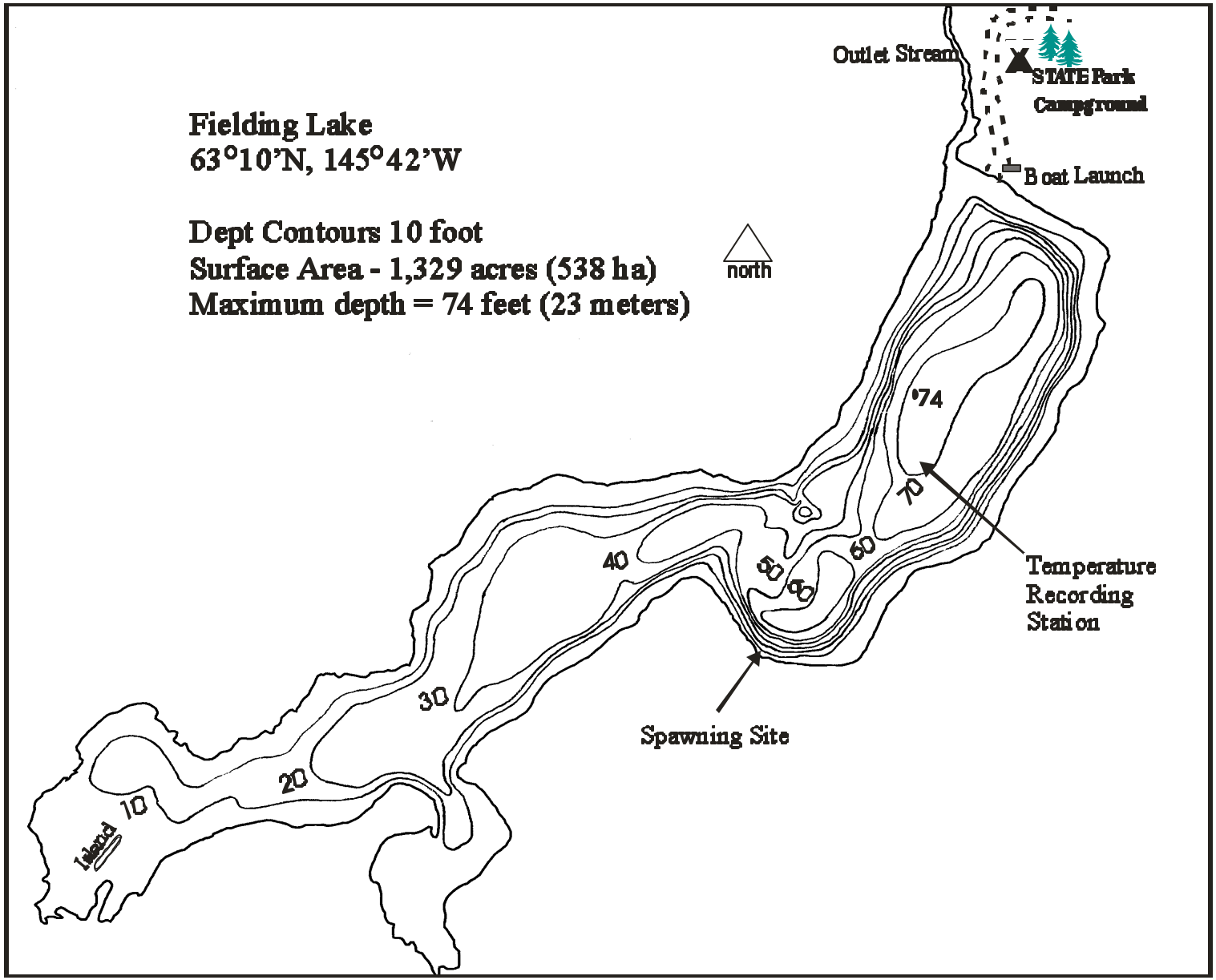

Figure 2.-Bathymetric map of Fielding Lake.

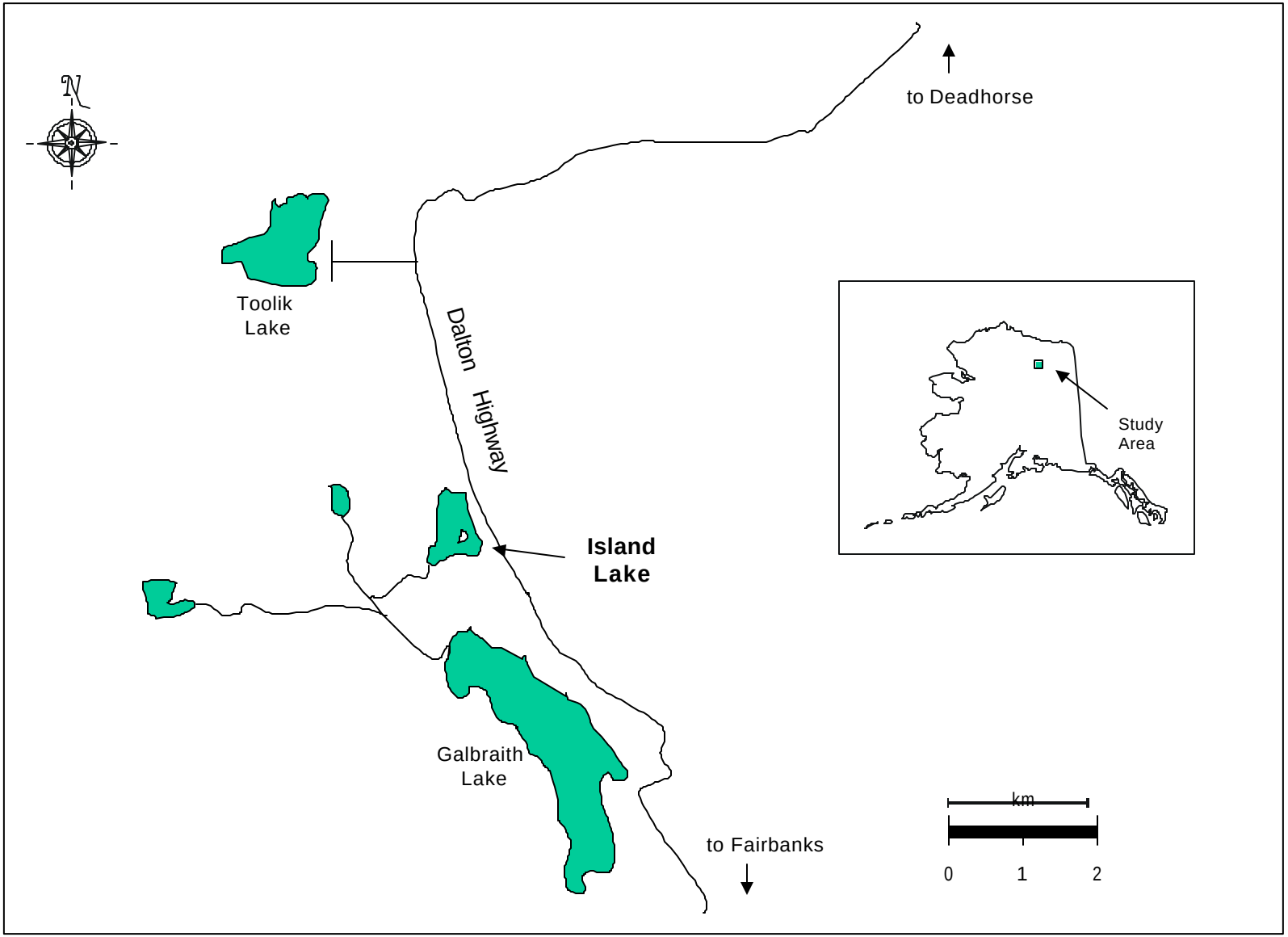

Figure 3.-Island Lake study area.

In 1988, Burr (1989) attempted to get an estimate of abundance for lake trout using mark-recapture techniques in Island Lake, but due to low catch rates and high handling mortality during the marking event, the recapture event was cancelled. No known lake trout abundance data exists for Island Lake, it was thought that about 300 fish ≥ 200 mm FL were in this lake (J. Burr, Alaska Department of Fish and Game, Fairbanks, personal communication).

METHODS

FIELDING LAKE

Abundance of male lake trout is used as an index of abundance for mature lake trout in Fielding Lake. Males stay longer on the spawning site longer than females, spawn every year, and demonstrate fidelity to spawning site (Burr 1992; Martin and Oliver 1980; Szarzi 1992, 1993; Szarzi and Bernard 1994) making them easier to estimate than females. When estimates of abundance for mature male lake trout are doubled to obtain an estimate of total adult abundance there is unknown bias (Martin and Oliver 1980; Szarzi 1992, 1993).

To estimate the abundance and survival of adult male lake trout in Fielding Lake, lake trout were sampled on three separate occasions. Originally, three sampling events were proposed: beach seining on spawning lake trout in the fall of 1998 and 1999 for the first and third events, and hook-and-line sampling in June 1999 for the second event. However, exploratory hook-and-line sampling in June 1998 suggested that insufficient numbers of fish would be caught and also that hook-and-line sampling may have a different size selectivity when compared to seining on the spawning grounds ($D = 0.72$; $P < 0.01$; Wuttig and Parker 1999). Therefore, in place of the hook-and-line event a third seining event was used. The three sampling events consisted of seining lake trout on the spawning grounds in the fall of 1998, 1999, and 2000. The Jolly-Seber model for a geographically closed population was applied to all three sampling events and provided estimates of abundance for lake trout in 1999 and survival from 1998-1999.

Surveys for spawning lake trout were conducted beginning the second week of September 1998 and 1999 to locate spawning congregations. In a boat, two crew members standing on a 2 m elevated platform visually searched for lake trout using 750,000 candle power spotlights. During 9 through 15 September 1998 and 9 through 16 September 1999, all potential spawning locations (shoreline and shallow areas) were identified and repeatedly searched throughout the night (2000 – 0400). To help locate spawning fish that may not be seen during visual surveys, gill nets (consisting of 19 mm to 25 mm stretch variable mesh) were periodically deployed perpendicular to the shoreline in areas with suitable spawning habitat and allowed to soak for 30 minutes. Catch data for each net set (location, time, depth, and number of fish caught) were recorded.

Once the spawning site was identified (only a single area was located; Figure 2) the spawning area was demarcated by reflective markers at 7.5 m intervals along the adjacent shoreline. This was to pinpoint the spawning area and to see if the same area was used consistently. The spawning congregation was monitored hourly throughout the night and lake trout were visually counted. When the number of lake trout appeared to peak, collection of lake trout commenced. Fish were collected using a beach seine (120 m long and 2.5 m deep) with a large bag in the center (3.7 m wide). One end of the seine was anchored to the shore and the rest was deployed from a boat around the aggregation of lake trout and then brought back to the shore in a semi-circle. This was repeated each night approximately every two hours until no more lake trout were seen on the spawning ground. Upon capture, lake trout were placed in floating net pens

until sampling was completed to avoid capturing a fish more than once. Lake trout were captured on 16 and 17 September in 1998, from 9 through 12 September in 1999, and from 13 through 15 September in 2000. Sex, length (mm FL), presence of old marks, Floy tag numbers, and spawning condition (defined as green, ripe, partially spent, and spent) were recorded. All lake trout judged to be in good condition and not already tagged were individually marked with numbered Floy tags and received a secondary mark (an upper caudal punch in 1998 and lower caudal punch in 1999). All lake trout were examined upon completion of sampling and released in good condition. No known mortalities occurred during the three sampling periods.

In 1998, lake trout were first observed on the spawning grounds on 9 September (water temperature was 7.0°C). In 1999, lake trout were first observed on 9 September (water temperature was 8.0°C), and in 2000, first observed on 12 September (water temperature was 6.8°C). In 1999 and 2000, a 110 m variable mesh (19 mm to 25 mm stretch mesh) gillnet net was used in combination with the beach seine. The gillnet was deployed around the perimeter of the spawning area on the outside of the seine to capture fish that escaped or were missed while beach seining.

Estimation of Abundance

Abundance, survival rate, and recruitment of adult male lake trout were estimated using the mark-recapture histories of fish according to the models of Jolly (1965) and Seber (1965; 1982). The computer program Jolly (model A) as described in Pollock et al. (1985; 1990) was used to generate the estimate. In years 1998-2000, single-event samples were used for the Jolly-Seber model. After sampling in 2000, the data set contained observations from three consecutive events and were used to obtain estimates of abundance for spawning lake trout for 1999. In addition to the estimate of abundance in 1999, this analysis provided an estimate of survival between 1998-1999. The assumptions necessary for reliable estimation of abundance, survival, and recruitment were as follows (from Seber 1982):

1. all fish in the population had the same probability of capture in the ith sample;
2. all fish in the population had the same probability of surviving from the ith to the (i+1)th sample;
3. all fish caught in the ith sample had the same probability of being released alive into the population;
4. all marked fish did not lose their marks and all marked fish were reported on recovery; and,
5. all samples were instantaneous (sampling time is negligible) and each release is made immediately after the sample.

Assumptions 1 and 2 are central to reliable parameter estimation. However, changes in survival rate cannot be separated from changes in capture probability. These assumptions will be tested for marked fish (1998-2000 database) with a goodness-of-fit test comprising two sets of chi-square contingency tables devised by Pollock et al. (1985) and implemented in a modified form in program Jolly (Pollock et al. 1990). A nonsignificant test statistic will imply that there have been no gross violation of assumptions 1 and 2. A significant test will imply violation of assumption 1 or 2. The specific assumption violated may be determined by which of the two component chi-square test are significant. Male lake trout in Fielding Lake display behavioral characteristics that differ from females and immature fish. Males tend to stay longer on the

spawning grounds whereas females and immature fish are much more mobile. When unequal capture by sex occurs assumption 1 will be compromised. For that reason only adult male lake trout were estimated.

Assumption 3 is assumed to be negligible because only fish deemed to be in good condition were released after sampling. Testing assumption 4 was enabled by double-marking of fish during all sampling events. Sampling time was negligible relative to the time between events.

Abundance for 1999 and survival rate between 1998 and 1999 were estimated for the adult male lake trout population in Fielding Lake by first estimating the number of marked fish in the population immediately prior to these sampling events:

$$\hat{M}_i = \frac{R_i z_i}{r_i} + m_i, (i = 2,3,..., s-1); \quad (3)$$

where:

$\hat{M}_i$ = estimated number of marked fish in the population immediately prior to the *i*th sampling event;

R_i = number of marked fish released after the *i*th sampling event;

z_i = number of different fish caught prior to the ith sample which are not observed during the *i*th sampling event, but are subsequently recaptured during later sampling events;

r_i = number of fish recaptured from the *i*th sampling event (recaptures from R_i);

m_i = number of marked fish caught during the *i*th sample (recaptures); and

s = number of sampling events.

With estimates of M_i, survival rate ($\hat{\phi}_i$) can be calculated from the relationship of those surviving to those initially marked and released:

$$\hat{\phi}_i = \frac{\hat{M}_{i+1}}{\hat{M}_i - m_i + R_i}, =1.2,3,..., s-2) \quad (4)$$

Abundance (N_i) is then estimated by substituting estimated marks alive for marks released in a standard Petersen estimator:

$$\hat{N}_i = \frac{\hat{M}_i n_i}{m_i}, (i =2,3,...,s-1); \quad (5)$$

where: n_i = the number of lake trout caught during the *i*th sample.

If assumption 2 does apply to unmarked fish, then the estimated number of recruits added to the population between the *i*th sample and (*i*+1)th sample that survive to the (*i*+1)th sample (B_i) becomes:

$$\hat{B}_i = \hat{N}_{i+1} - \hat{\phi}_i\left(\hat{N}_i - n_i + R_i\right), (i = 2, 3, ..., s-2) \quad (6)$$

Length Composition

Length composition of lake trout in Fielding Lake was estimated from fish samples for fish greater than and less than 558 mm FL (~22 in TL). Also, multinomial proportions in 50 mm FL categories were generated for fish sampled in 1998, 1999, and 2000. The proportion of lake trout in each length category was estimated with the following formulae (Cochran 1977):

$$\hat{p}_j = \frac{n_j}{n} \quad (7)$$

$$V\left[\hat{p}_j\right] = \frac{\hat{p}_j(1-\hat{p}_j)}{n-1} \quad (8)$$

where:

$\hat{p}_j$ = the estimated proportion of the sample that was made up of group *j;*

n_j = the number in the sample from group *j*; and

n = total sample size.

For lake trout ≥ 558 mm FL and lake trout < 558 mm FL, the estimated abundance of fish in each length category was:

$$\hat{N}_j = \hat{p}_j \hat{N} \quad (9)$$

where:

$\hat{N}_j$ = the estimated number of mature males in the population ≥ or < 558 mm; and

$\hat{N}$ = the estimated abundance of mature males.

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

$$\hat{V}\left[\hat{N}_j\right] = \hat{V}\left[\hat{p}_j\right]\hat{N}^2 + \hat{V}\left[\hat{N}\right]\hat{p}_j^2 \quad (10)$$

Thermal Habitat Volume

Water temperature profiles at four depths were recorded using data loggers. The data loggers were placed in deep water between the boat launch and the spawning location and temperature data was recorded from March through September (Figure 2).

Length-Weight Relationship

Length of captured lake trout were measured to the nearest millimeter and weights were taken in 1999 and 2000 with a CCI TLE-70 x 0.05 pound digital platform-style scale. Weights and lengths were plotted and a least squares regression was used the estimate parameters:

$$\text{weight} = a\, e^{\text{length}*b}\, e \tag{11}$$

by using the natural log transformation (Neter and Wasserman, 1974) where a and b are parameters to be estimated and e is the error term.

ISLAND LAKE

The Island Lake lake trout study was designed to estimate abundance and length composition of lake trout using a two-event mark-recapture experiment. The assumptions (from Seber 1982) were that:

1. the population was closed (no change in the number or composition of lake tout during the experiment);
2. all lake trout ≥ 200 mm FL had the same probability of capture during the marking event or the same probability of capture during the recapture event or marked and unmarked lake trout mix completely between the marking and recapture events;
3. marking of lake trout did not affect their probability of capture in the recapture event;
4. lake trout did not lose their mark between events; and,
5. all marked lake trout were reported when recovered in the recapture event.

The sampling design allowed the validity of these assumptions to be insured or tested.

Sampling took place in late July and early August and consisted of a systematic sampling design. The lake was divided into four areas of equal size, and sampling was conducted by one crew of four individuals. Each area was systematically sampled such that sampling was not concentrated in a small portion of the lake but evenly distributed throughout. The crew sampled the lake for four days during the mark event and four days during the recapture event, with a two-week hiatus between events. Given the small size of Island Lake and the two-week hiatus, complete mixing of marked fish should have occurred.

There is no historical lake trout abundance data on Island Lake. However, based upon the prediction that there were 300 lake trout ≥ 200 mm FL in Island Lake at least 84 lake trout were needed for marking marked during the marking event and 84 lake trout were needed to examine during the recapture event to estimate abundance within 25% of true abundance 90% of the time (Robson and Regier 1964). Considering predicted abundance, the required sample size to estimate the length composition of lake trout ≥ 200 mm FL in Island Lake was 89 using the method described by Thompson (1987) and corrected for a finite population (Cochran 1977).

A variety of gear types were utilized in the 2000 Island Lake lake trout mark-recapture experiment. Gill nets, baited hoop traps, fyke traps, and baited lines suspended under floats (also known as jug lines) were used. Multifilament gill nets 150 ft long and 8 ft deep that consisted of a 75 ft panel of 1 in stretch mesh and a 75 ft panel of 1.5 in stretch mesh were used. Each net checked a minimum of every 30 minutes. Hoop traps (baited with whitefish or herring) were set, without wings, in deeper water. Fyke traps with attached wings were set in water ≤ 1.5 m in

depth parallel to the shoreline. The lake was divided into four areas, and each area was sampled for one day with equal effort across days. The evening before an area was to be sampled, the fyke traps and hoop traps were deployed. Rod and reel was used as sampling gear between trap and net examinations. At the end of the sampling day, the fyke traps and hoop traps were moved and set in areas to be sampled the following day. Extreme care was given to minimize mortality. Holding tubs were filled with fresh water before fish were removed from each net. All mortalities were recorded and removed from the lake for disposal. The marking event occurred 18 July through 20 July and the recapture event occurred 8 August through 10 August.

All data from lake trout captured during the Island Lake mark-recapture experiment was recorded on ADF&G Tagging Length Mark-Sense Form, Version 1.0. A new form was used for each area and the date, area, and set number were recorded on the description line. The importance of thoroughly examining all lake trout for Floy tags, recent tagging wounds, and recent fin clips and accurately recording data was stressed to all members of the crew.

During the marking event, all lake trout ≥ 200 mm FL that were captured were measured for length, tagged with a uniquely numbered Floy tag, the left pectoral fin slightly clipped, and sex determined if possible. Fork length was measured and recorded to the nearest millimeter. Both the left and right side of the dorsal fin was examined for the presence of a Floy tag; and if present, the color and number of the tag recorded; or if not present, a new Floy FD-68 internal anchor tag was inserted at the left base of the dorsal fin and the number recorded. Lake trout killed during the sampling procedure were not tagged but all other data was recorded and the fate (K) was clearly noted in the blank space after the length on the mark-sense form. The sex of each lake trout was determined when possible by the presence of milt or eggs and recorded.

During the recapture event, the same data collection procedures was used for all lake trout ≥ 200 mm FL as during the marking event. In addition, both the left and right sides of the dorsal fin were examined closely for recent tag wounds and the left and right pectoral fin examined closely for recent clips, and then the right pectoral fin, instead of the left, slightly clipped. Tag loss (TL) was clearly noted in the blank space after the tag number on the mark-sense forms for lake trout without a Floy tag but with a recent tag wound or recent left pectoral fin clip. Recaptures (R) were clearly noted on the mark-sense form for known recaptures from the marking event. A lake trout was not sampled more than once during the recapture event. Lake trout with recent right pectoral fin clips were not sampled and no data was recorded.

Estimated abundance of lake trout in Island Lake was calculated from the number of lake trout marked, examined for marks, and recaptured. The Chapman estimator (Seber 1982) was used:

$$\hat{N} = \frac{(M+1)(C+1)}{R+1} - 1 \qquad (12)$$

where: M = the number of lake trout marked and released alive during the marking event;

C = the number of trout examined for marks during the recapture event;

R = the number of lake trout recaptured during the recapture event; and,

$\hat{N}$ = estimated abundance of lake trout at the time of marking.

Variance of the abundance estimate (Seber 1982) was estimated as:

$$\hat{V}\left[\hat{N}\right] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \quad (13)$$

The assumptions for the Chapman estimator are identical to those described earlier for the Jolly-Seber abundance estimator.

RESULTS

FIELDING LAKE

From 1998 through 2000, 292 lake trout were sampled in Fielding Lake during September. Of these, 242 fish (83%) were male, 49 (17%) were female, and the sex of one fish could not be determined. In 1998, 97 fish (82 males, 14 females, 1 unknown) were captured on the spawning ground, marked, and released (Table 2). In 1999, 91 fish (74 males and 17 females) were captured on the spawning ground, 34 of which were recaptures (33 males and 1 female) from fall 1998 sampling (Table 2). In 2000, 104 fish (86 males and 18 females) were captured on the spawning ground, of which 29 (27 males and 3 females) were recaptures from 1999, and 19 (16 males and 3 females) were recaptures from the 1998 fall sampling (Table 2). Seventeen lake trout (all males) captured in 2000 were captured both in 1998 and 1999 (Table 2).

In 1998, lake trout were first observed on the spawning ground on 14 September at 2315 hours, when 23 lake trout were counted (Table 3). In 1999, lake trout were first observed the evening of 9 September (Table 4). Lake trout were observed congregating within a 75 ft section of shoreline at a depth of approximately 1-2 m. The maximum number of lake trout counted (95) was on 16 September 1998 (Tables 4 and 5). In 1998 and 1999, visual surveys of the entire shoreline of Fielding Lake were conducted. Lake trout were only observed at the one location.

Estimation of Abundance

Jolly-Seber estimator was used to estimate abundance of adult male lake trout in 1999. Estimated abundance of adult male lake trout was 193 (SE = 35; Table 5) with a confidence interval (CI) of 18.3% (Table 5). Estimated density of adult male lake trout in 1999 was 0.36 per hectare (SE = 0.07; Table 5). Annual survival rate from 1998-1999 for adult male lake trout was $\geq$ 90.4% (Table 5). In 2000, two cases of tag loss were observed and (one each was from 1998 and 1999 and were included as recaptures). There was no observed overwinter tag loss from 1998-1999. A total of 32 male lake trout captured in 1999 were from the marking event in 1998 and 45 in 2000 from events both in 1998 and 1999 (Table 6). No mortality incurred while handling lake trout during the three year period at Fielding Lake. The smallest male lake trout caught in the spawning area from 1998-2000 was 455 mm FL in 2000. Similar sized fish were caught in 1998 (471 mm FL) as in 1999 (460 mm FL). Mean annual growth of 91 male lake trout captured more than once between 1998-2000 was 14.2 mm per year (SE = 1.22). For spawning male lake trout $\geq$ 518 mm FL, there was no significant difference between the lengths of fish marked during the first event (1998) and those lake trout examined during the second event (1999, D = 0.14, P = 0.47; Parker and Wuttig 2000). No significant difference was found between the lengths of the spawning males marked during the first event (1998) and recaptured fish during the second event (1999, D = 0.19, P = 0.38; Parker and Wuttig 2000). All mature male lake trout captured on the spawning grounds qualify by length for the Jolly-Seber estimate. One lake trout captured in 1999 could not be sexed and was removed from the analysis. Length distributions of sampled lake trout from 1998-2000 do not appear to be significantly different between years (Figure 4).

Table 2.-Catch and length statistics by sex for lake trout captured in Fielding Lake from 1998 to 2000.

Statistics	Sex		
	Females	Males	Total
1998			
Total number of fish captured	14	82	97
Average length	657.5	602.1	609.7
Standard Error of length	23.5	8.7	8.4
Minimum length	509	471	471
Maximum length	778	781	781
Sex Ratio	0.13	0.83	1.0
Standard Error of Sex Ratio	0.034	0.034	
1999			
Total number of fish captured	17	74	91
Average length	637.4	610.1	615.2
Standard Error of length	18.3	9.0	8.1
Minimum length	538	460	460
Maximum length	767	815	815
Sex Ratio	0.19	0.81	1.0
Standard Error of Sex Ratio	0.041	0.041	--
Number of 1998 tagged fish	2	32	34
2000			
Total number of fish captured	18	86	104
Average length	624.2	611.7	613.9
Standard Error of length	16.3	9.6	8.4
Minimum length	530	455	455
Maximum length	752	815	815
Sex Ratio	0.17	0.83	1.0
Standard Error of Sex Ratio	0.037	0.041	--
Number of 1998 tagged fish	3	17	20
Number of 1999 tagged fish	3	28	31

Table 3.-Time observed, numbers of lake trout observed by date on the spawning ground from an elevated boat platform, number seined, and water temperature (C^o), in Fielding Lake, 1998.

Date	Time	Number Counted	Number Seined	Water temperature (C^o)
9-Sept	2200	1	--	9.0
10-Sept	2200	0	--	8.2
11-Sept	0030	0	--	8.0
11-Sept	0200	0	--	8.0
14-Sept	2100	0	--	7.0
14-Sept	2215	23	--	7.0
14-Sept	2330	40	--	7.0
15-Sept	0015	62	--	7.0
15-Sept	0115	24	--	7.0
15-Sept	0200	50	--	7.0
15-Sept	0230	0	--	7.0
15-Sept	2200	30	--	7.0
16-Sept	0040	78	--	7.0
16-Sept	0130	94	--	7.0
16-Sept	2245	60	43	7.1
17-Sept	0145	15	16	--
17-Sept	0300	20	5	--
17-Sept	2230	7	--	5.5
17-Sept	1330	--	27	--
18-Sept	0130	0	--	--

Table 4.-Time observed, numbers of lake trout observed by date on the spawning ground from an elevated boat platform, number seined, and water temperature (C^o), in Fielding Lake, 1999.

Date	Time	Lake trout counted	Number of lake trout seined	Water temperature (C^o)
9-Sept	1015	12	--	8.0
9-Sept	1130	20	4	8.0
10-Sept	0100	30	3	8.0
10-Sept	0200	12	--	8.0
10-Sept	2230	30	14	8.5
10-Sept	2400	0	--	..
11-Sept	2230	18	13	..
11-Sept	2400	0	--	8.5
12-Sept	2245	21	23	8.0
13-Sept	0130	0	--	..
13-Sept	2230*	2	--	9.5
14-Sept	0030**	25	21	9.6
14-Sept	0130	0 (finished)	--	..

* Wind blowing 10-20 mph lake trout absent while windy.

** Soon after wind ceased, lake trout appeared on spawning ground.

Table 5.-Estimates of abundance (N) for adult male lake trout calculated using the Jolly-Seber (all captured adult males) estimator. Also presented is estimate of Survival (S) using the Jolly-Seber model, proportion of abundance above and below the lake trout minimum size limit (22 in or 558 mm FL), and number of lake trout per hectare (density) in Fielding Lake.

Estimate Type	N	SE (N)	CV% (N)	±	%	-95	+95	% lengths ± 558 mm	Density LT/ha	SE/ha 95%	Accuracy
1998									0.36	0.07	36%
1999 Jolly-Seber	193	35	18.3%	69	36	124	262				
lake trout <558 mm FL	60	64						0.31			
lake trout >558 mm FL	133	68						0.69			

Table 6.-Numbers of mature male lake trout captured, marked, and recaptured in Fielding Lake at sampled spawning grounds, 1998-2000.

Year of Release	Year of Recapture		
	1998	1999	2000
1998	0	32	19
1999		0	26
2000			0
Captured with tags	0	32	45
Captured without tags	83	42	41
Total Captured	83	74	86
Total Released	83	74	86

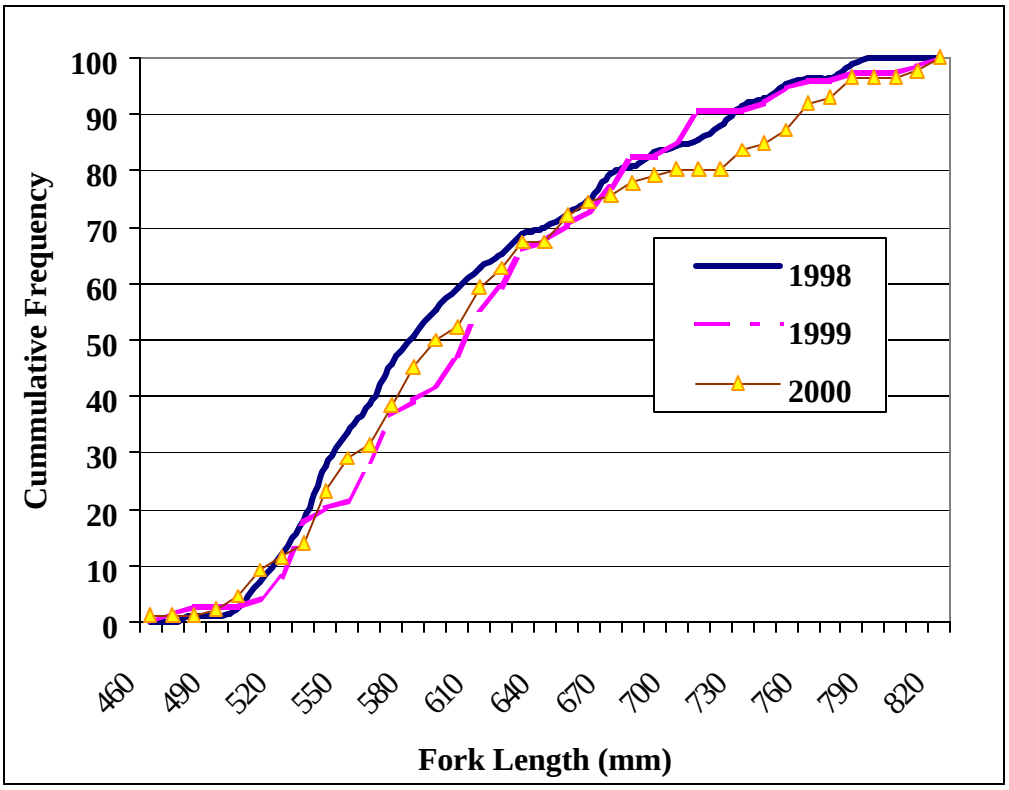

Figure 4.-Cumulative frequency distributions of lake trout lengths from fall beach seining in Fielding Lake, 1998 - 2000.

Length and Sex Composition of the Samples

The proportion of male lake trout captured on the spawning area was 0.83 in 1998, 0.81 in 1999, and 0.83 in 2000 (Table 2). Mean length of male lake trout from 1998 through 2000 was 602, 610, and 612 mm FL (Table 2). Mean length for female lake trout was 657, 637, and 624 from 1998 through 2000 (Table 2). The smallest male lake trout sampled on the spawning bed during the three year period was 455 mm FL, and the largest sampled lake trout was a male that was 815 mm FL (Table 2). The number of smaller fish (451-550 mm FL) sampled increased over the three sampling events (Figure 5). Of the spawning males captured from 1998 to 2000, 31% were smaller than the minimum size limit (22 in or 558 mm) and 69% were larger (Table 5; Figure 6). Of the females captured only about 12% were smaller than the minimum size limit (22 in or 558 mm; Figure 7). The 1999 Jolly-Seber estimate of abundance by 50 mm length categories for male lake trout can be found in Table 6. Male fish in the 551-600 mm FL category were most prevalent (24%) in the sampled population in 1999 (Table 7). The number of male fish captured in 1998 and 2000 by size category is very similar to that of 1999 (Table 7). Length composition data for both males and female lake trout in Fielding Lake from 1998 to 2000 is presented in Appendix A3.

Thermal Habitat Volume

Data on volume of water is not presented in this report but will be reported in a future report. Temperature Data was collected from 23 March to 12 September 2000 at four depth stations (1 m, 2.5 m, 5.5 m, and 10 m). The temperature profiles at each depth indicate that thermal habitat exists (8-12^{o}C) for lake trout is available (Appendix B1) but does not delineate at which depth the preferred temperature changes.

Length-Weight Relationship

The estimated length-weight model for the lake trout sampled in Fielding Lake is $\text{weight} = 0.0859 e^{\text{length}*0.0057}$, (Figure 7).

Experimental Hook-and Line-Sampling

In June of 1998, lake trout were sampled with hook and line in as an initial marking event. Twenty-three hours of sampling effort from 18 June to 25 June 1998 were required to capture 25 lake trout (CPUE = 1.1). The lengths ranged from 302 to 608 mm FL and the average length of fish was 454 mm FL (SE = 16.4). Sex could not be determined. Probabilities of capture by length were significantly different between hook-and-line sampling in the lake and beach seine-sampling on the spawning ground in 1998 ($D = 0.72$, $P < 0.01$; Figure 4). Two lake trout marked in June 1998 (male = 592 mm FL; female = 608 mm FL) were recaptured in the 1998, 1999, and 2000 fall sampling events. One fish (male = 592 mm FL) that was caught in June 1998 was also captured in the fall of 1998 (length = 594 mm FL) and fall of 2000 (length = 652 mm FL). There was also a lower proportion of recaptured fish from the hook-and-line sampling (4%) compared to fish sampled during spawning events with a beach seine (37%; Parker and Wuttig 2000). Lengths of lake trout captured from the spawning grounds in 1998 ranged from 471 to 781 mm FL, whereas only 44% of the lake trout caught by hook-and-line were in this range.

Given the difference in vulnerability by length between the two types of gear, hook-and-line techniques was not used for the third recovery event. The 25 lake trout caught by hook-and-line were not included in the tagging history unless they were captured and marked during the first two events. Data collected from lake trout captured using hook-and-line can be found in Appendix A1.

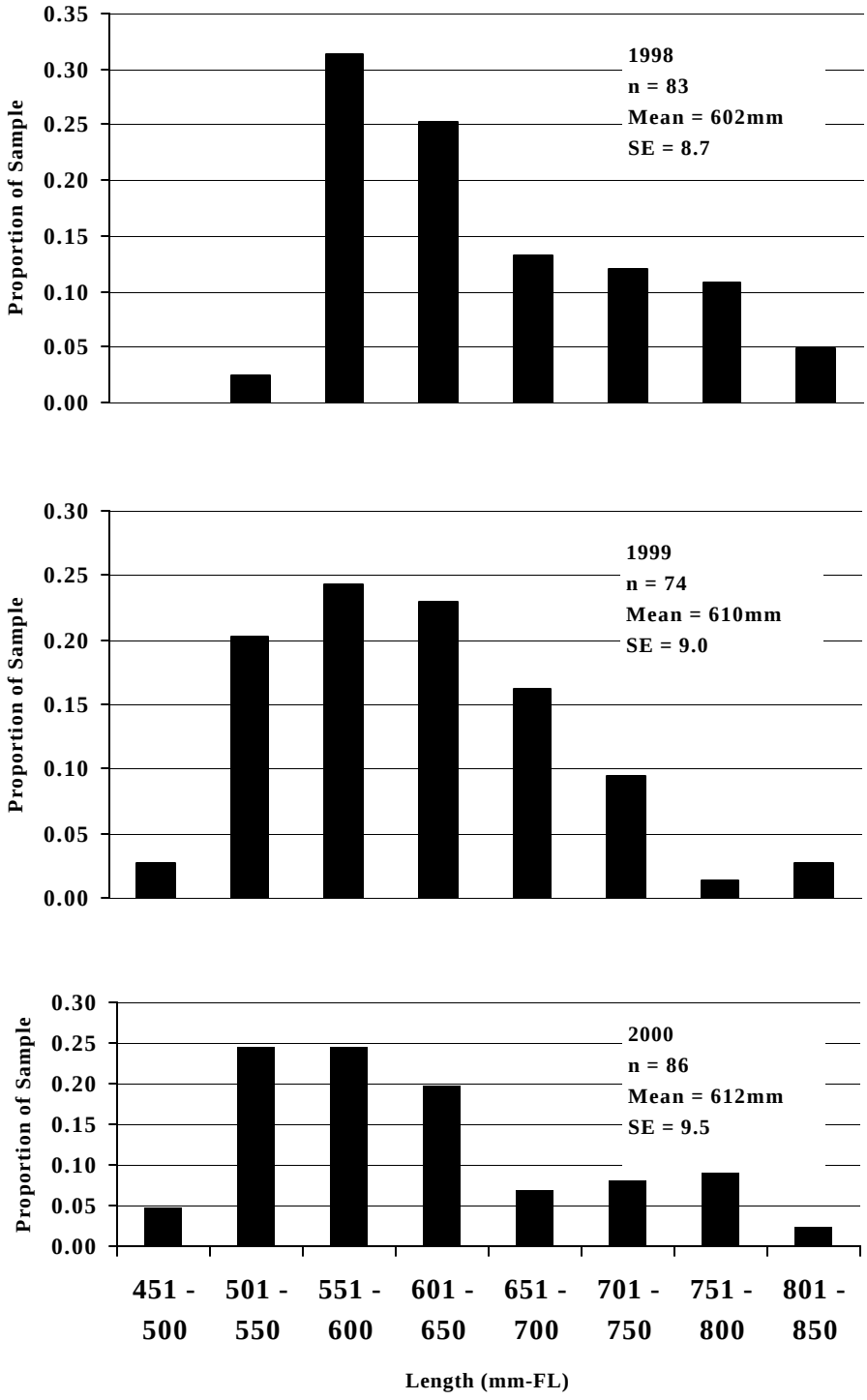

Figure 5.-Proportion of samples by length group of male lake trout sampled in Fielding Lake from 1998-2000.

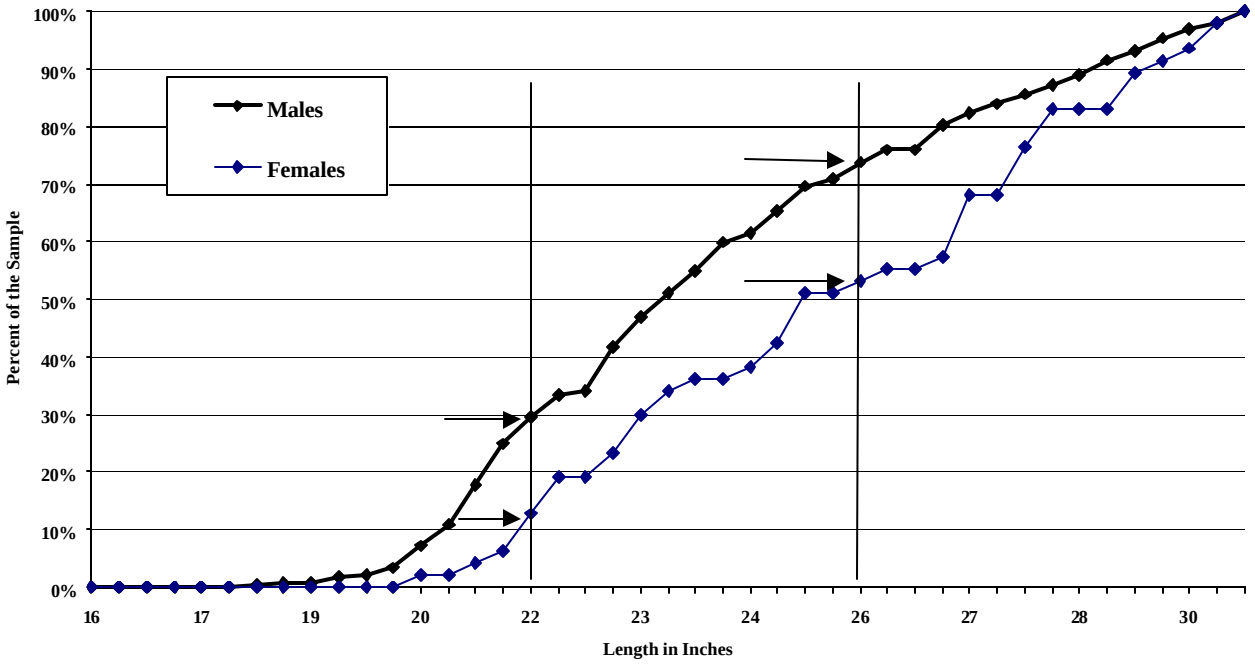

Figure 6.-The cumulative length distribution of male and female lake trout sampled in 1998 to 2000 from Fielding Lake.

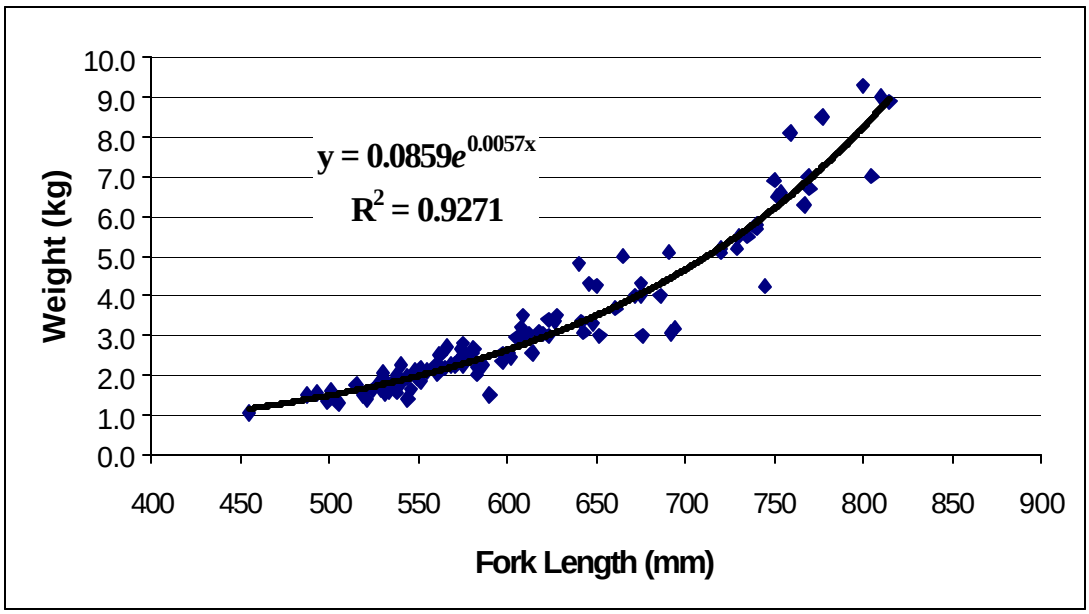

Figure 7.-Length-weight relationship for lake trout sampled in Fielding Lake, 1999-2000.

Table 7.-Number sampled (n), proportion (p), and abundance (N) by length category for male lake trout, captured in Fielding Lake, September 1999. Also, number sampled and proportion by length category for male lake trout captured in 1998 and 2000.

Category	n	P	V[p]	SE[p]	N	V[N]	SE
			1999				
451-500	2	0.03	0.0004	0.019	5	13.87	3.7
501-550	15	0.20	0.0022	0.047	39	130.09	11.4
551-600	18	0.24	0.0025	0.050	47	163.32	12.8
601-650	17	0.23	0.0024	0.049	44	151.97	12.3
651-700	12	0.16	0.0019	0.043	31	99.26	10.0
701-750	7	0.09	0.0012	0.034	18	53.23	7.3
751-800	1	0.01	0.0002	0.013	3	6.80	2.6
801-850	2	0.03	0.0004	0.019	5	13.87	3.7
Total	74				193		
			1998				
451-500	2	0.02	0.0003	0.017			
501-550	26	0.31	0.0026	0.051			
551-600	21	0.25	0.0023	0.048			
601-650	11	0.11	0.0014	0.037			
651-700	10	0.10	0.0013	0.036			
701-750	9	0.09	0.0012	0.034			
751-800	4	0.04	0.0006	0.024			
801-850	0	0.00	0.0000	0.000			
Total	83						
			2000				
451-500	4	0.05	0.023	0.0005			
501-550	21	0.24	0.046	0.0022			
551-600	21	0.24	0.046	0.0022			
601-650	17	0.20	0.043	0.0019			
651-700	6	0.07	0.027	0.0008			
701-750	7	0.08	0.029	0.0009			
751-800	8	0.09	0.031	0.0010			
801-850	2	0.02	0.016	0.0003			
Total	86						

ISLAND LAKE

Since low numbers of lake trout were caught the estimate of abundance and estimate of length composition were not within the criteria of the objective. During the marking event, 11 unique lake trout > 200 mm FL were sampled, and one fish was captured twice. During the recapture event, six unique fish were sampled, two of these fish were captured twice, and two were recaptures from the first event. Two lake trout were killed in the recapture event during sampling. The lake trout sampled during this experiment ranged from 432 mm FL to 630 mm FL. Using Chapman's modification of the Peterson estimator, abundance of lake trout in Island Lake was estimated to be 27 fish ≥ 430 mm FL (SE = 9). The 90% confidence interval for abundance was estimated as nine to 45 fish ≥ 430 mm FL. Fourteen unique fish were sampled and released in this experiment, so it is known that there was at least 14 lake trout ≥ 430 mm FL in Island Lake at the time of the experiment. We did not capture enough fish to perform diagnostic tests for differences in catchability.

DISCUSSION

FIELDING LAKE

Using hook-and-line as a sampling method to estimate abundance of adult lake trout was not used to sample mature male fish. Only fish caught on the spawning ground were used to estimate abundance.

The onset of the spawning period is after the first week in September. The earliest date lake trout were first observed on the spawning bed was 9 September (1999) and the latest was 14 September (1998). In all three years fish captured were in spawning condition. Males extruded milt freely but, the eggs in females did not flow easily. It was not determined how long fish stayed on the spawning ground, since most of the fish present were captured and removed to holding pens until no more fish were observed on the spawning ground.

A critical assumption of this experiment was that all lake trout in Fielding Lake were using the one identified spawning site. If other spawning sites exist in Fielding Lake and fish there were not sampled, then abundance of mature male lake trout was underestimated. Burr (1992) radio tagged 10 lake trout larger that 500 mm and tracked locations during September. Of the six lake trout that remained alive during the study, only one was located in another area other than the spawning area. Visual surveys conducted during the fall of 1998 and 1999 also identified the same spawning location, however, visibility was limited to a depth of 2-3 m. Lake trout were caught in gillnets close to the spawning grounds but not elsewhere suggesting that there were not other locations for spawning.

As expected, a disproportionate number of male lake trout were captured on the spawning grounds. The portion of males caught on the spawning ground ranged from 81% in 1999 to 88% in 1998. The disproportionate number of males on the spawning grounds is typical of other lake trout stocks also. Males have been reported to remain longer on the spawning ground than females (Burr 1991, 1992; Martin and Oliver 1980).

From this study and other studies (Burr 1991; Parker and Wuttig 2000) done on lake trout, most spawning activity occurs in the evening. We found that by 2200 hours, fish move on the spawning area and are found there until about 0400 hours. In the 2000 sampling, a practice seine haul over the spawning grounds at 1400 hours resulted in the capture of 13 fish in spawning

condition. Of the thirteen captured fish seven were females, a much higher ratio than was found at night. This suggests that female fish once on the spawning grounds are less likely to leave than the males. After moving these females to the holding pen, lake trout were not seen on the spawning bed at night for another two nights. Male fish were actively moving in the vicinity and were intercepted in gillnets but not venturing onto the spawning site until the females were present. After releasing the females held in the holding pen, lake trout of both sexes reappear on the spawning bed.

Use of a 120 m beach seine was effective in capturing mature male lake trout in Fielding Lake. The advantage of the seine compared to gillnets is the lake trout are not subjected to as much physical stress. In 1998, just prior to the first seine haul approximately 60 lake trout were counted from the boat, and 43 lake trout (40 males and 3 females) were subsequently captured. Burr (1992) found that capturing fish in this same location was difficult because of large rocks and a steep gradient along the shoreline. For successful beach seining the seine cannot be set in any water deeper than the seine depth. The seine, once set, has to be brought in slowly by the float line without lifting the weighted line. Once lake trout were disturbed they sought the deepest water and any gaps under the lead line. Any tension on the lead line while it is lifted over larger rocks allows lake trout to escape. In 1999, the use of a perimeter gillnet proved helpful in catching lake trout that were missed by beach seining. During one seine haul only one lake trout was captured, but the perimeter gillnet captured 12 lake trout.

The abundance of male lake trout (193) in Fielding Lake may be doubled (assuming a 1:1 ratio of male and female lake trout; Martin and Oliver 1980; Szarzi 1992, 1993) to obtain total adult abundance (386 lake trout). In 1999, a harvest of 43 lake trout (> 22 in; minimum size limit) is about 11% of the total estimated lake trout population or 16% of the estimated abundance of 264 (132 males x 2; Table 5) male and female lake trout (> 22 in), available for harvest. The estimated yield based upon the 0.5 kg per ha is a harvest yield of about 269 kg. The average length is 507 mm FL from 124 lake trout that were sampled by the department and from the sport fishery (Appendix A5). This length applied to the length-weight relationship (Figure 7) is 1.5 kg. The harvest of 43 fish over 22 inches in 1999 is about 65 kg which is below the guideline harvest survey.

Burr (1991) determined that the mean length of maturity for male lake trout at which 1% of the population is mature ($L_{1)}$, 50% (L_{50}), and 99% (L_{99}), was 354, 428, and 519 mm, respectively, and was the basis for the 22 in (558 mm) minimum size limit. The minimum size limit is adequate based upon the data from this study and harvest information. Of the spawning population sampled from 1998-2000, 31% of the males were under the 22 in minimum size limit (Table 5, Figure 7).

A public proposal before the Board of Fisheries (BOF) in January 2001 was amended and passed to leave the daily bag and possession limit at one per day but the minimum length for the one fish was increased to 26 in. Only single-hook for terminal fishing gear may be used. The proposal (195) also asked for a "no-bait" restriction, but that was taken out due to the legal use of bait for burbot in Fielding Lake. Fishing is closed in Fielding Lake from September 1-30 to protect spawning lake trout. For complete BOF actions concerning Fielding Lake regulatory changes, refer to appendix A2.

ISLAND LAKE

The reason why insufficient numbers of lake trout were sampled in relation to the objectives was that the predicted abundance of 300 fish by the Area Manager was unreasonably high. This prediction of abundance was not considered unreasonable during the operational planning process, considering the size of the lake. The paucity of fish may be due to overharvest before 1994 or the low productivity of this lake. Anglers could have impacted the population of lake trout in Island Lake adversely before the harvest closure was implemented in 1994. It is more likely, however, that due to the extreme latitude, small size, and low productivity of oligotrophic lakes in this region, production and biomass of lake trout in Island Lake and other nearby lakes has always been low. And while estimates of abundance using Chapman's modification may have a large bias when estimated with small sample sizes (Seber 1982), the abundance estimate of 27 fish ≥ 430 mm FL in Island Lake is plausible. It is probable that the lake trout populations in small lakes along the Dalton Highway will always have low abundance regardless of conservative regulations. Prudent management of these lakes will probably require closure to harvest of lake trout.

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APPENDIX A
Data Summaries

Appendix A1.-Date, length, tag number, tag color, and depth when fish was caught for lake trout captured using hook and line methods at Fielding Lake, June 18-25, 1998.

Order	Date	Length	Tag Number	Color	Depth Caught (ft)	Secondary Mark
1	18-Jun	502	9750	gray	35	LC punch
2	19-Jun	482	9752	gray	30	LC punch
3	22-Jun	387	9753	gray	29	LC punch
4	22-Jun	543	9754	gray	20	LC punch
5	22-Jun	450	9755	gray	24	LC punch
6	24-Jun	592	9756	gray	22	LC punch
7	24-Jun	520	9757	gray	21	LC punch
8	24-Jun	440	9758	gray	20	LC punch
9	24-Jun	465	9759	gray	20	LC punch
10	24-Jun	400	9760	gray	20	LC punch
11	24-Jun	475	9761	gray	26	LC punch
12	24-Jun	387	9762	gray	25	LC punch
13	24-Jun	395	9763	gray	25	LC punch
14	25-Jun	302	9764	gray	20	LC punch
15	25-Jun	483	9765	gray	25	LC punch
16	25-Jun	592	9766	gray	28	LC punch
17	25-Jun	370	9767	gray	20	LC punch
18	25-Jun	551	9768	gray	20	LC punch
19	25-Jun	608	9769	gray	28	LC punch
20	25-Jun	392	9770	gray	22	LC punch
21	25-Jun	444	9771	gray	20	LC punch
22	25-Jun	410	9772	gray	22	LC punch
23	25-Jun	408	9773	gray	25	LC punch
24	25-Jun	445	9774	gray	28	LC punch
25	25-Jun	315	9775	gray	35	LC punch

Appendix A2.-Board of Fisheries actions in January 2001 regarding lake trout in Fielding Lake.

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5 AAC 70.022 is repealed and readopted to read:

5 AAC 70.022. WATERS; SEASONS; BAG, POSSESSION, AND SIZE LIMITS; AND SPECIAL PROVISIONS. (d) This subsection contains bag, possession, and size limits for the waters of the Tanana River portion of the Arctic-Yukon-Kuskokwim Area (all waters of the Tanana River drainage).

(9) in Fielding Lake (species present),

(D) lake trout is ***closed from September 1 – September 30, and may be taken from October 1 - August 31,*** with a bag and possession limit of one fish ***which must be 26 inches or more in length***, ***except as specified in 5 AAC 70.023 (10);***

5 AAC 70 is amended by adding a new section to read:

5 AAC 70.023. SPECIAL PROVISIONS. (d) This subsection gives the special provisions for the waters of the Tanana River portion of the Arctic-Yukon-Kuskokwim Area (all waters of the Tanana River drainage).

(11) in Fielding Lake only the ***use of a single hook*** is allowed.

Appendix A3.-Length composition of male and female lake trout in Fielding Lake, 1998-2000.

		Males			Females		
Year	Size Category	Sample Size	Sample Proportion	SE	Sample Size	Sample Proportion	SE
1998	451 - 500	0	0.00	0.00	0	0.00	0.00
	501 - 550	2	0.02	0.02	1	0.08	0.08
	551 - 600	26	0.31	0.05	2	0.17	0.11
	601 - 650	21	0.25	0.05	0	0.00	0.00
	651 - 700	11	0.13	0.04	4	0.33	0.14
	701 - 750	10	0.12	0.04	3	0.25	0.13
	751 - 800	9	0.11	0.03	2	0.17	0.11
	801 - 850	4	0.05	0.02	0	0.00	0.00
	Total	83			12		
1999	451 - 500	2	0.03	0.02	0	0.00	0.00
	501 - 550	15	0.20	0.05	3	0.18	0.10
	551 - 600	18	0.24	0.05	4	0.24	0.11
	601 - 650	17	0.23	0.05	2	0.12	0.08
	651 - 700	12	0.16	0.04	5	0.29	0.11
	701 - 750	7	0.09	0.03	2	0.12	0.08
	751 - 800	1	0.01	0.01	1	0.06	0.06
	801 - 850	2	0.03	0.02	0	0.00	0.00
	Total	74			17		
2000	451 - 500	4	0.05	0.02	0	0.00	0.00
	501 - 550	21	0.24	0.05	2	0.11	0.08
	551 - 600	21	0.24	0.05	5	0.28	0.11
	601 - 650	17	0.20	0.04	6	0.33	0.11
	651 - 700	6	0.07	0.03	2	0.11	0.08
	701 - 750	7	0.08	0.03	2	0.11	0.08
	751 - 800	8	0.09	0.03	1	0.06	0.06
	801 - 850	2	0.02	0.02	0	0.00	0.00
	Total	86			18		

Appendix A4.-Data files[a] used to estimate parameters of the lake trout population in Fielding Lake, 1998 - 2000.

Data file	Description
U001300L011998.DTA	Hook and line event, Fielding Lake, May 1998.
U001300L011998.DTA	Spawning event, Fielding Lake, September 1998.
U001300L011999.DTA	Spawning event, Fielding Lake, September 1999.
U001300L012000.DTA	Spawning event, Fielding Lake, September 2000.

[a] Data files are archived at and are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage.

Appendix A5.-Sex, length, tag number, age, type of ageing structure used, fate, clip, tag color and weight of sport caught lake trout in Fielding Lake, from 1971-2001.

Date	Fishery	Sex	Length[a] (mm)	Tag Number	Age	Age Structure	Release/ Killed	Tag Color	Weight (g)
8/05/1971	SP	F	450				R		976
8/05/1971	SP	F	450				R		1080
8/05/1971	SP	M	495				R		1590
8/05/1971	SP	F	565				R		2125
8/05/1971	SP	F	690				R		
7/09/1982	SP		300				R		
7/31/1982	SP	F	455				R		1300
7/04/1983	SP		647				R		4080
6/16/1984	SP		370		6	SC	K		
6/16/1984	SP		370		7	SC	K		
6/16/1984	SP		380		6	SC	K		
6/24/1984	SP		410		7	SC	K		
7/06/1984	SP	F	597		8	SC	K		
7/18/1984	SP		558	2434			R	2	
10/5/1984	SP	F	284		4	SC	K		
10/8/1984	SP		512	16421			R	5	1750
6/28/1985	SP		694	1198	13	OT	K	2	
7/06/1985	SP		318		4	OT	K		
7/06/1985	SP		378		5	OT	K		
7/06/1985	SP		422		7	OT	K		
7/14/1985	SP		320				K		
8/03/1985	SP		325		4	OT	K		
8/21/1985	SP		507	1800			R	4	
6/26/1986	SP		360		5	OT	K		
6/26/1986	SP		382		6	OT	K		
6/26/1986	SP		418		8	OT	K		
6/26/1986	SP		430		8	OT	K		
6/29/1986	SP		372		5	OT	K		
6/29/1986	SP		443		7	OT	K		
6/29/1986	SP		450		7	OT	K		
6/29/1986	SP		480	4617	6	OT	K	2	
6/30/1986	SP		380		6	OT	K		
6/30/1986	SP		415		7	OT	K		
7/05/1986	SP		420	1654			K	4	
7/05/1986	SP		442		7	OT	K		
7/06/1986	SP		460		7	OT	K		

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Date	Fishery	Sex	Length[a] (mm)	Tag Number	Age	Age Structure	Release/ Killed	Tag Color	Weight (g)
7/06/1986	SP	F	605				K		3400
7/07/1986	SP		350	4615			K	2	
7/07/1986	SP		432		8	OT	K		
8/10/1986	SP	F	427		7	OT	K		
8/17/1986	SP		375		6	OT	K		
8/17/1986	SP		405		7	OT	K		
8/17/1986	SP		505		7	OT	K		
8/17/1986	SP		580	16421	9	OT	K	5	
8/23/1986	SP		374		6	OT	K		
8/23/1986	SP		405		6	OT	K		
6/20/1987	SP		483		9	OT	K		
6/20/1987	SP		521		8	OT	K		
6/23/1987	SP				6	OT	K		
6/23/1987	SP						K		
7/03/1987	SP	F	705		13	OT	K		2600
7/05/1987	SP				6	OT	K		900
7/08/1987	SP	M	470		5	OT	K		760
7/12/1987	SP		480		8	OT	K		1100
6/20/1988	SP		830	1200	8	OT	K	2	6810
7/06/1988	SP		490	1199			K	2	
6/25/1989	SP	M	478		8	OT	K		1625
7/11/1990	SP		495	88089	8	OT	K	3	
4/05/1991	SP		496	38646			K	3	
4/05/1991	SP		550				K		
6/20/1991	SP	F	455		9	OT	K		
6/20/1991	SP	M	495		8	OT	K		
6/20/1991	SP	M	497		6	OT	K		
6/20/1991	SP	F	502		10	OT	K		
6/20/1991	SP	M	577		10	OT	K		
6/20/1991	SP		580		0	OT	K		
6/20/1991	SP		635	35540			R	3	
6/20/1991	SP	M	660		13	OT	K		
6/20/1991	SP		712		0	OT	K		
6/21/1991	SP	F	536		9	OT	K		
6/21/1991	SP		584		12	OT	K		
6/21/1991	SP	F	673		12	OT	K		
7/14/1991	SP	F	585	19639			K	5	

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Date	Fishery	Sex	Length[a] (mm)	Tag Number	Age	Age Structure	Release/ Killed	Tag Color	Weight (g)
6/21/1992	SP		580	39496			K	3	
6/21/1992	SP	F	600	37019			K	3	
6/24/1992	SP		409		4	OT	K		
6/25/1992	SP		508		7	OT	K		
6/25/1992	SP		559		6	OT	K		
6/25/1992	SP		560		10	OT	K		
6/28/1992	SP		612	2676	14	OT	K	3	
6/28/1992	SP	M	642	35543	15	OT	K	3	
7/03/1992	SP		470		5		K		
7/03/1992	SP	F	826		24	OT	K		
7/04/1992	SP	F	402		6	OT	K		
7/04/1992	SP	F	455		5	OT	K		
7/04/1992	SP		511	43875	10	OT	K	3	
7/04/1992	SP	M	590		11	OT	K		
7/17/1992	SP	F	445		6	OT	K		
2/10/1995	SP		700				K		6795
6/18/1995	SP		540	37042			K	3	
6/18/1995	SP		612				K		
7/01/1997	SP	F	914	6516			K	5	
8/01/1997	SP		610	4295			K	5	
6/18/1998	TE		502	9750			R	8	
6/19/1998	TE		482	9752			R	8	
6/22/1998	TE		387	9753			R	8	
6/22/1998	TE		450	9755			R	8	
6/22/1998	TE		543	9754			R	8	
6/24/1998	TE		387	9762			R	8	
6/24/1998	TE		395	9763			R	8	
6/24/1998	TE		400	9760			R	8	
6/24/1998	TE		440	9758			R	8	
6/24/1998	TE		465	9759			R	8	
6/24/1998	TE		475	9761			R	8	
6/24/1998	TE		520	9757			R	8	
6/24/1998	TE		592	9756			R	8	
6/25/1998	TE		302	9764			R	8	
6/25/1998	TE		315	9775			R	8	
6/25/1998	TE		370	9767			R	8	
6/25/1998	TE		392	9770			R	8	
6/25/1998	TE		408	9773			R	8	

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Date	Fishery	Sex	Length[a] (mm)	Tag Number	Age	Age Structure	Release/ Killed	Tag Color	Weight (g)
6/25/1998	TE		410	9772			R	8	
6/25/1998	TE		444	9771			R	8	
6/25/1998	TE		445	9774			R	8	
6/25/1998	TE		483	9765			R	8	
6/25/1998	TE		551	9768			R	8	
6/25/1998	TE		592	9766			R	8	
6/25/1998	TE		608	9769			R	8	
2/21/1999	SP		686	32694			K	3	
5/01/1999	SP	M	711	37040			K	3	
9/01/1999	SP		670	9915			K	8	
9/02/1999	SP		704	9890			K	8	
2/03/2001	SP		778	9867			K	8	
2/18/2001	SP		640	9940			R	8	
3/10/2001	SP		610	9928			K	8	
3/10/2001	SP		610				K		
3/11/2001	SP		635				K		

[a] Average length of samples from the sport fishery is 507 mm FL, SE = 10.9, minimum length = 284 mm FL, maximum length = 914 mm FL, and a total of 124 samples.

APPENDIX B

Appendix B1.-Data logger temperature profiles in Fielding Lake. First data bgger station is 2.4 m below surface, second station is at 7.3 m third station at 14.0 m, and fourth station at 21.2 m. Total depth is 21.2 m. Loggers initialized on 3/23/00 and removed on 9/12/00.